several other pressure measurements. Tighter emissions control and improved efficiency may necessitate further sensor use in future systems.

Manifold, Barometric and Turbo Boost Pressure. Manifold absolute pressure (MAP) is used as an input to fuel and ignition control in internal combustion engine control systems. The speed-density system that uses the MAP sensor has been preferred over mass air flow (MAF) control because it's less expensive, but stricter emission standards are causing more manufacturers to use mass air flow for future models.

Higher resolution from 32-bit engine controllers, with greater analog-to-digital (A/D) conversion capability and higher operating frequencies, will provide greater accuracy for a given MAP sensor during the critical transitions of the engine cycle. As shown in Fig. 2.2, previous changes from 8-bit to 16-bit controllers have resulted in a two-time improvement in resolution in the digital conversion for the intake manifold pressure. The 8-bit control unit performed the A/D conversion on a 4-ms timer interrupt in order to maintain a balance with other controls, with the resulting 1.1-ms lag time (worst case) during periods of overlapping interrupts. The 16-bit microcontroller performs the A/D conversion every 2 ms, which reduces the lag time to 0.3 ms. The actual system improvements that can result from using the higher performing microcontrol units is a result of other factors such as more precise and faster control of fuel injectors and sparkplugs, and additional and/or more accurate sensors and control algorithms.

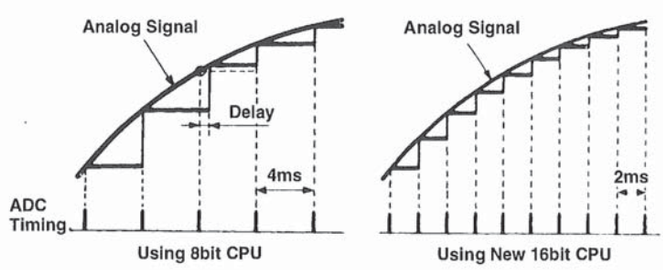


FIGURE 2.2 Effect of A-D on pressure measurements.

The MAP error band is also being tightened with a goal of 1 percent accuracy over the entire automotive temperature range. Existing specifications allow tolerances to increase as shown by the bowtie specification in Fig. 2.3 with associated multiplier(s).

The need for barometric pressure is often desirable in MAF systems to provide altitude information to the engine control computer. The barometric pressure range is typically from 60 to 115 kpA with accuracy on the order of 1.5 percent over the operating pressure range. The error band tolerance increases by a temperature multiplier of up to 2× outside the 0 to 85 °C range. MAP and barometric pressure sensors are frequently mounted inside control modules making the mounting technique a key consideration for manufacturability. The increased usage of surface mount technology, and the need to reduce space so that additional features can be included in control modules are factors that will affect next-generation sensor designs.

A typical turbocharger can provide boost pressure in the range of 80 kPa over the naturally aspirated internal combustion engine. This increases the maximum rating for the sensor to 200 kPa absolute, but other requirements are scaled appropriately.

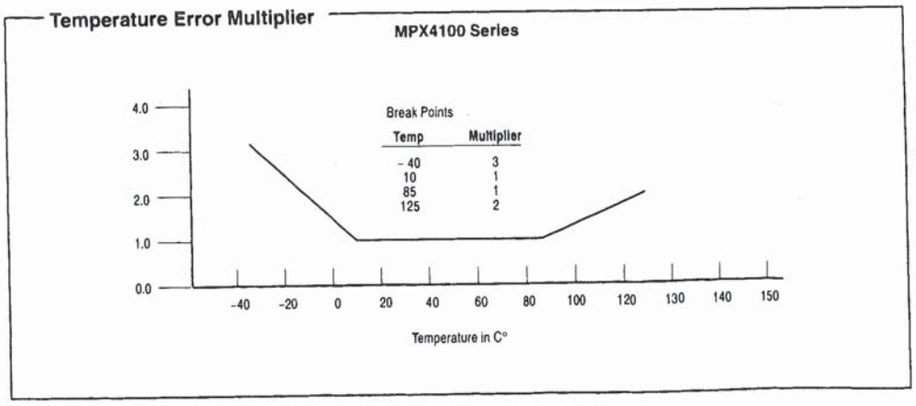
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MPX4100 • MPX4101 SERIES

Transfer Function

Nominal Transfer Value: $V_{out} = V_S (0.01059 \times P - 0.1518)$
+/– (Pressure Error x Temp. Mult. x 0.01059 x V_S)
$V_S = 5.1\ V \pm 5\%$ P_{in} kPa

Temperature Error Multiplier



Pressure Error Band

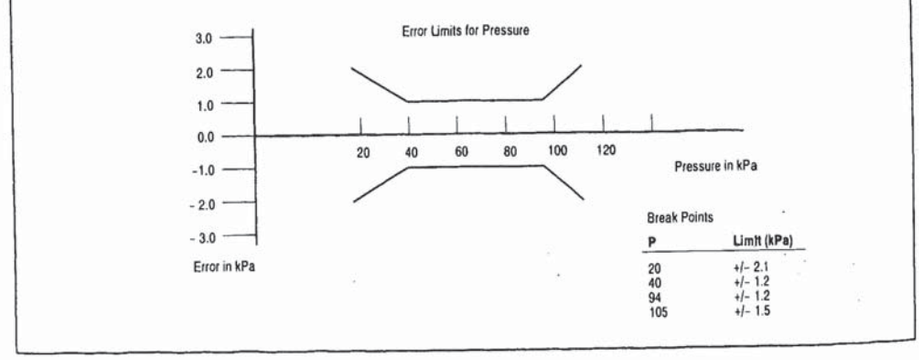


FIGURE 2.3 Error band for MAP sensor.

Oil Pressure. Oil pressure on automobiles has traditionally been measured by the deflection of a rubber diaphragm which closes a set of contacts (switch) providing a lamp indication with low oil pressure or moves a potentiometer to provide an analog signal for a gage.

A replacement for the conventional electromechanical oil pressure sending unit is an electronic device such as the one designed by Chrysler's Acustar Division. In addition to a silicon

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piezoresistive pressure sensor, the unit contains transient protection circuitry, signal amplification for the sensor output, and output drivers for both an electromagnetic gauge and a fuel pump. The FET output drivers are capable of handling 10 A based on the heat dissipated though a heatsink that is integral to the sensor package.

The unit utilizes a supply voltage from 9 to 16 V and operates over a media temperature range of –40 to +150 °C. The overall accuracy is ±3.25 percent with linearity ≤ ±0.25 percent over the entire operating pressure range of 200 psi. The switch point for the low pressure indication is 4 psi ± 1.5 psi.

The sensor package was specially designed for easy assembly. The housing interfaces to the sensor with an extremely reliable O-ring seal that can withstand a burst pressure over 400 psi. Special materials were used for both the package and the protective gel that covers the sensor, which allow it to survive qualification tests with over 1 million pressure cycles, including portions conducted at high temperatures. This exceeds the number of cycles that can be achieved with traditional diaphragm-driven potentiometers that have been used for providing the indication of oil pressure. The sensor has been designed for a 10-year/100,000-mile life that could be required for future vehicle warranties.

Media Compatibility in Automotive Measurements. Pressure sensors frequently have to interface with an environment that is more demanding than other electronic components. For example, the measurement of engine oil pressure, transmission oil pressure, fuel pressure, and so on, or fluid level (oil, gas, coolant, etc.) requires the sensor package to be exposed to one or more fluids that are detrimental to the operation of semiconductor circuitry. Each of these media interface problems is addressed separately, depending on the application. Automotive cost requirements usually limit the usage of stainless steel as the isolation technique. Instead, more cost-effective protective polymers and chemically tolerant plastic and rubber materials have been developed for sensor packages.

2.2.2 New Applications for Pressure Sensing

The list of potential applications for sensing pressure in the automobile includes several new applications. These measurements are frequently made during the development of new vehicle systems. Their actual use on the vehicle is determined by factors such as cost, legislated requirements, need for diagnostics, and value added to the system. Applications in this section will identify areas of concern, range of pressure measurement, and factors that affect the usage of a pressure sensor.

Transmission Oil Pressure and Brake Pressure. Transmission pressure is required as an input in computer-controlled transmission shift points. This pressure can be measured with sensors similar to those developed for engine oil pressure.

Pressure in a hydraulic system, such as the master cylinder of an antilock brake system (ABS), is much higher than transmission oil pressure typically requiring a sensor with minimum rating of 500 psig. Pressures in other locations in the ABS system can be lower. The dynamic pressures in brake tubing can be of interest during the development phase of passenger vehicles and may be of interest in heavy duty commercial vehicles. These pressures can be below 150 psig.

The ABS system controls front and rear tire slip. Tradeoffs that exist in developing an ABS system for a particular vehicle include stopping deceleration to achieve the shortest possible stopping distance versus more steering control. Increased yaw stability can be obtained by reducing the deceleration rate of the rear wheels. The addition of traction control to the system improves stability during acceleration and provides independent control of each wheel during a variety of driving maneuvers for improved vehicle performance.

Passenger vehicles may have a single pressure sensor to monitor the pressure in the hydraulic system. One system, General Motors' ABS-VI, provides information on the brake pressure by detecting the current going to motors in the system. For the ABS-VI system, a pres-

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sure sensor is not required to provide optimum brake pressure at each wheel. However, other systems rely on the rate of brake application and release to control lockup. Commercial vehicles may have several sensors for sensing brake pressures. Sensors close to brake cylinders report the actual pressure, which is compared to the reference value stored in the control unit.

Tire Pressure. The continuous monitoring of tire pressure offers increased fuel economy and safety to passenger cars or commercial vehicles. Underinflated tires create excessive rolling friction and therefore decrease fuel economy. Overinflated tires have excessive stress that can result in failure during operation. Improperly inflated, either over- or underinflated, tires have uneven wear patterns which decrease tire life. Available tire pressure systems consist of a tire pressure sensor (or switch) at each wheel, wheel speed indicator, temperature sensor, a radio frequency transmitter, electronic receiver/controller, and a display unit. The dashboard display provides an indication to the driver that the tires are improperly inflated. Tire pressure increases with temperature approximately 1.5 psi for every 10 °C of tire air temperature rise, so the system must provide correction for this effect. Abrupt increases in temperature and pressure can be sensed by these systems and provide a warning of eminent tire failure providing an additional safety factor.

Another tire pressure system utilizes a separate hand-held reader to easily verify the proper tire inflation when the vehicle is stationary. Yet another commercial vehicle system for trucks with dual tires operates while the vehicle is stationary and employs a visual indication for the driver that adequate pressure exists. This system provides a single fill point for the dual tires, maintains equal pressure under normal conditions, and provides an isolation valve in the event that a blowout or slow leak develops in one tire.

EGR Pressure. EGR (exhaust gas recirculation) back pressure and a pressure differential exist across the EGR valve used to control NO_x emissions in the engine control system. The valve is modulated by a vacuum which lifts a pintle from its seated position to allow exhaust gas to be recirculated. A change in vacuum pressure from 50 to 90 mm Hg is sufficient to fully open the valve, and a pressure differential across the valve of 200 mm Hg is typical. Pressure measurements are made during the development phase to determine system operating characteristics. However, a position sensor is typically used to measure the EGR valve's position and control NO_x emissions during normal vehicle operation.

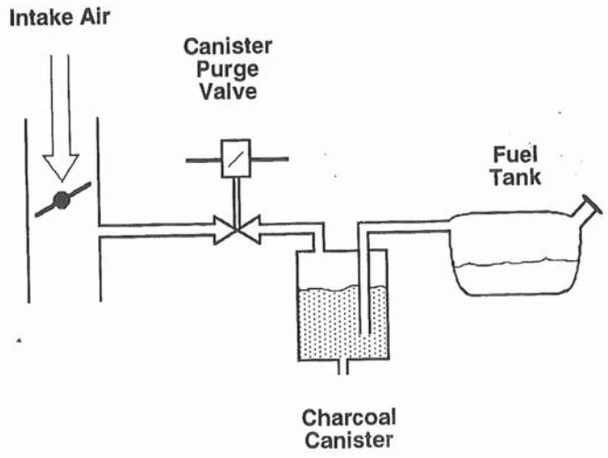


FIGURE 2.4 Canister purge system.

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Fuel Rail and Vapor Pressure. Evaporative emissions that occur when the engine is off are currently stored in an activated charcoal canister of about 850 to 1500 cc until the engine is running, as shown in Fig. 2.4. The vapors are then consumed by the combustion chamber and catalytic converter. One implementation of on-board vapor containment of refueling hydrocarbons (on-board refueling vapor recovery or ORVR) would require refueling canisters on the vehicle that could be three to four times the volume of existing canisters. If leaks need to be detected in this system, a diagnostic pressure sensor may be required.

One approach to fuel routing, employed in the 5.9-liter Dodge Magnum engine, is to mount the fuel filter and pressure regulator at the fuel tank. The fuel pump is mounted inside the tank. Therefore, since only a fuel supply line to the fuel rail and a line to the evaporative canister are necessary, the fuel return line is eliminated. This system maintains lower fuel tank temperatures, resulting in lower evaporative emissions.

Monitors required for on-board diagnostic (OBD) systems per California Air Resources Board's (CARB's) OBDII legislation were originally targeted to be phased in between model year 1994 and model year 1996. A Bosch fuel injection system with on-board diagnostics is shown in Fig. 2.5 that identifies a differential air pressure sensor for tank vapor pressure.

Overpressure Occurrences. Fuel supply pressures in automobile fuel injection systems normally operate at pressures below 75 psi; however, fuel pumps develop pressures up to 3200 psi to open injectors. Pressure spikes can be reflected back through the fuel supply system that measure up to 300 psi during each fuel injection pulse.

Overpressure created by backfire can also apply a positive pressure of 75 psi and higher to the intake manifold absolute pressure sensor. Techniques used to prevent failure from over-

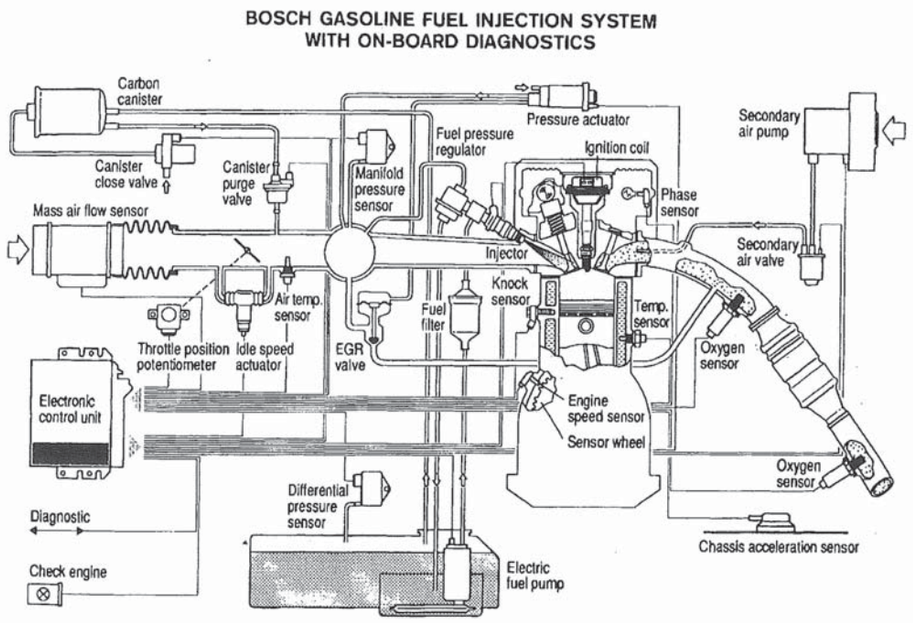


FIGURE 2.5 Fuel vapor control in electronic fuel injection system. *(Courtesy Robert Bosch, GMBh)*

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pressure include overpressure stop built into the transducer, mechanical pulse filtering, and a sensor designed to operate within the overpressure range.

Mechanical stops have been a traditional protection technique for mechanical pressure sensors. This is possible where the amount of diaphragm deflection is large. Silicon pressure sensors have a modulus of elasticity that is the same as steel (30×10^6 psi) and a yield strength (180,000 to 300,000 psi) that is higher than steel, allowing high overpressure without diaphragm damage. However, the sensor package itself must be designed to handle the maximum pressure safely.

Snubbing, or mechanical filtering, is commonly used for static pressure measurements. A small diameter tube reduces the dynamic variation in applied pressure. If dynamic measurements are desired, the ac component of the desired signal may also be attenuated.

Increasing the diaphragm thickness of the sensor to safely handle the full range of pressure within normal operating range will also result in a lower sensitivity.

Alternate Fuel and Alternate Engine Implications to Pressure. Legislation that requires a percentage of the vehicles sold in California to be LEV (low emissions vehicles) and even ZEV (zero emissions vehicles) is increasing the demand for alternate fuel and electric vehicles. Among the alternate fuel vehicles, CNG (compressed natural gas) and hydrogen cells most likely would require sensors for pressure measurements. CNG is pressurized at 3000 psi and the distribution system includes pressure regulators, a transducer, valves, and idle air solenoids. Before the natural gas enters the engine, a regulator reduces the fuel pressure to near atmospheric pressure. Sensing may be required in both low- and high-pressure portions of the system. Development of alternative engines, such as the two-stroke engine for vehicle applications, will utilize electronics for control functions similar to four-cycle engines. However, the range and necessity for pressure measurements will differ from four-cycle engines. The pressure range for direct fuel injection is considerably higher for a two-stroke engine. The need to control the oil pump may necessitate pressure sensing in two-stroke systems as well.

Hydrogen fuel cells are another potential source of energy for use in electric vehicles. In one design, the proton-exchange membrane (PEM) design, a turbocompressor is used to pressurize the system and maintain hydration of the membrane. A pressure of at least three atmospheres (0.3 MPa) is required to remove the water. This pressure or the pressure drop across the membrane may need to be monitored during operation.

2.2.3 Other Applications for Pressure Sensors

Pressure sensors can be used on vehicles for measuring flow through pressure differential, or delta-P, measurements and for determining liquid level.

Delta-P (Flow-Sensing) Measurements. Applications on the vehicle for flow sensing include mass air flow; heating compartment flow; oil, fuel, and cooling liquid flow; and vehicle flow in an air stream. Mass air flow is typically accomplished by hot-wire anemometer or Karman vortex flow meters which do not use pressure-sensing techniques. Other vehicle flow requirements, including the pressure drop across the air filter, could be sensed and monitored by a differential pressure sensor. In addition to requirements such as media compatibility (Sec. 2.2.1), the lower-level signals require higher-sensitivity pressure sensors and/or additional amplification and must tolerate faults that could apply full line pressure to only one side of the sensor.

One of the more interesting applications of differential pressure measurements applied to flow analysis is the flow of the vehicle itself relative to crosswinds. A rear-wheel steering system developed by Daimler-Benz uses two pressure sensors to measure the pressure caused by wind on the vehicle's sides. An electronic control unit analyzes the pressure difference and inputs from other sensors, and alters the rear-wheel setting according to the wind strength. The system that measures the crosswinds directly is faster than yaw sensors, which are reactive and measure the change in attitude and direction of the vehicle.

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Other laboratory measurements of airflow and crosswind force have also been made by Daimler-Benz that utilize 10 differential pressure gages with a range of ±3700 kPa. All pressure sensors were connected to a single pressure vessel to have a common reference. The reference pressure was measured by a 100-kPa absolute pressure sensor. The measurements were used to determine aerodynamic forces and moments and to compensate for wind effects in an active steering system.

Fluid Level Sensing. Various liquid levels can be measured in a vehicle, as shown in Table 2.4. All of these requirements, except fuel level, could be satisfied by a switch that simply detects that a predefined minimum level of liquid has been reached so that a driver indication can be provided. This can be accomplished by directly illuminating a dash lamp or through a microcontroller in a body computer which activates an output driver.

TABLE 2.4 Liquid Level Measurements

Level	Type	Range
Engine oil	Switch	38.1 cm of water
Transmission oil	Switch	30.5 cm of water
Coolant	Switch	61 cm of water
Windshield washer fluid	Switch	30.5 cm of water
Battery	Refraction switch	5.1 cm below reference
Power steering fluid	Switch	7.6 cm below reference
Brake fluid	Switch	30.5 cm of water
Fuel	Sensor and switch	38.1 cm of water

Sensing the fuel level has traditionally been performed by a float to sense the fluid level and a variable resistor with the wiper arm connected to the float. Configuration for the sensor depends upon the specific tank for which it was designed, necessitating a unique sensor for each vehicle. Manufacturers with several different vehicle models have the additional impetus to replace the existing techniques with a nonwearing, more accurate, self-calibrating electronic alternative. However, media compatibility for fuel level is among the harshest requirements for a pressure sensor. In addition to gasoline, oxygenated fuels containing ethanol, methanol, benzene, MTBE, engine additives, and even sour gas must be tolerated by the sensor. Nonintrusive differential sensors isolate the liquid from the sensor interface but must still tolerate fuel vapors. Also, the sloshing of the fuel in a vehicle's tank requires a time amplitude filter to smooth out the indication provided to the driver.

2.2.4 Combustion Pressure

The direct measurement of combustion pressure is being investigated for detecting misfire to meet CARB OBDII requirements. The high pressure (≥16 MPa) and temperature ranges combined with other environment factors make the design of a pressure sensor for this application extremely expensive. As a result, other techniques are being developed as alternatives to direct pressure measurement. These technologies include optical, fiberoptics measuring luminous emissions from combustion, and noncontact torque sensors. Section 2.3.7 explains a fiber optic technique.

The operation of the reciprocating-piston, internal combustion engine is represented by a constant volume process and the engine power cycle is analyzed by using pressure-versus-volume and pressure-versus-crank angle diagrams. To obtain these measurements in a laboratory environment a number of techniques have been developed. Direct (in-cylinder) pressure measurements have been performed with small diameter piezoresistive sensors placed in (or near) the sparkplug and piezoelectric washers placed under the spark plug. A high natural fre-

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quency is required for these sensors based on the dynamic measurement involved in the combustion process. Indirect measurements with shaft torque and optical phase shift are additional possibilities. The need to determine misfire due to component failure during vehicle operation is part of OBDII requirements. A sensor used on production vehicles will be required to survive the high pressure and temperature environment for the life of the vehicle, which could be 100,000 miles and 10 years. It must also have no need for periodic zeroing or calibration and be available at a low cost.

2.2.5 Other Pressure Measurements

An adaptive suspension system (see Chap. 17) can be accomplished with an air pressure controlled shock absorber damping, such as Mitsubishi's Active-ECS (Electronically Controlled Suspension). This system has two air pumps and nine solenoids that regulate air pressure based on inputs from sensors including an air pressure sensor in the rear of the vehicle that measures the passenger and cargo load. The driver can select soft, medium, or hard suspension. Another system utilizes an air reservoir charged to a pressure of 1 Mpa by a compressor. A pressure switch monitors when the pressure drops below 760 kPa to recharge the reservoir. Air springs operate at 300 kPa unloaded and at 600 kPa in the rear when fully loaded.

HVAC (heating, ventilating, and air conditioning) changes are occurring as manufacturers are required to convert from refrigerant CFC-12 to alternatives such as HFC-134a. The theoretical performance of these two refrigerants will mean about a 6 percent loss in efficiency, compressor discharge pressure that is 175 kPa higher, and a discharge temperature that is about 8 °C lower. Measuring the compressor discharge pressure (almost 1900 kPa for the HFC-134a system) is desirable for electric load control as vehicles add more requirements to the 12-V charging system. Also, the effect on engine performance and fuel economy when the A/C is used could make the refrigerant pressure sensor a standard vehicle sensor in the future. An absolute sensor used to measure gage pressure of the refrigerant provides a deadhead effect to prevent refrigerant loss in the event of a sensing diaphragm failure.

The measurement of the pressure developed when the air bag is inflated is part of the evaluation, qualification, and lot acceptance criteria of air bag inflating techniques. Time-to-peak pressure and peak tank pressure measurements require measurements in the tens of milliseconds range. Inflated bag pressures are in the range of 100 kPa or less. Hybrid inflators use a stored inert gas, such as argon, in place of sodium-azide propellant that requires a squib for ignition. The hybrid uses a pressure sensor to monitor the status of the stored gas.

Special heavy duty/commercial truck measurements require pressure measurements that are quite different from those made on passenger cars. Accumulator-type fuel injection systems for direct injection diesel engines have fuel pressurized to 20 to 100 MPa in the accumulator by a high-pressure pump. The accumulator pressure is monitored in this approach to reduce particulates. Another method to reduce diesel particulates utilizes a ceramic fiber as a filter in a canister. A pressure sensor monitors the backpressure and allows the full filter to be regenerated by burning off the accumulated particulates in the filter. A heater element in the trap has power supplied from the power-switching module. A temperature approaching 1300 °F (700 °C) is reached inside the filter cartridge to incinerate the particles.

Lumbar support systems utilize a pressurized system with a pressure sensor (≤7.5 psig) as the feedback element controlling the air pump to provide additional support to the driver's lower back in luxury vehicles. Pressure-sensitive grids have been used in the development process to automatically measure up to 3600 contact points for visual display and weight distribution analysis.

2.2.6 Partial Pressure Measurements

The oxygen (or lambda-) sensor in engine control systems is a chemical sensor that utilizes partial pressures to provide a feedback signal for the closed-loop control system. Lambda is

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defined as the actual air/fuel ratio divided by the stoichiometric (14.6) fuel ratio. The operation of the oxygen sensor is defined by the Nernst equation: $U_L = RT/4F \cdot 1n(P_{O2}''/P_{O2}')$, where U_L is the unloaded output voltage of the sensor, R is the universal gas constant, T is the absolute temperature, F is the Faraday constant, P_{O2}'' is the oxygen partial pressure of the air (about 2.9 psi), and P_{O2}' is the equilibrium partial pressure of the oxygen in the exhaust gases. Equilibrium occurs due to the catalytic activity of the platinum electrodes used to coat the inside and outside of the Y_2O_3 stabilized ZrO_2 ceramic electrode. The oxygen partial pressure changes by a factor of 10^7 at 900°C (or 10^{19} at 500°C) when the exhaust gas changes from a reducing environment (lambda = 0.999) to an oxidizing environment (lambda = 1.001).

2.3 TECHNOLOGIES FOR SENSING PRESSURE

A number of technologies have been used for on-vehicle measurements of static and dynamic pressure: diaphragm-potentiometer, linear variable differential transformer (LVDT), aneroid, silicon or ceramic capacitive, piezoresistive strain gage, piezoelectric ceramic or film, and optical phase shift (combustion pressure). Recent advances in sensing have focused on transducers that provide an electric signal easily interfaced to microcontrollers. Mechanical devices are frequently used in the laboratory for calibration and component development or on the vehicle during the development phase of the vehicle systems. Common mechanical devices include the Bourdon tube, bellows, diaphragms, deadweight gage, and manometer.

The Bourdon tube is a curved or twisted, flattened tube with one end closed that acts as a force collector. When pressure is applied at the open end, the tube tends to straighten and the resulting motion is used as an indication of the applied pressure.

The bellows, or pressure capsule, is a chamber that expands with applied pressure. Absolute pressure can be measured by sealing a reference pressure (e.g., vacuum) inside a closed unit and applying pressure to the outside. The movement of the chamber is proportional to the applied pressure.

Diaphragms are the most common force collector used in modern pressure sensors. The diaphragm material can be rubber, elastomer, stainless steel, silicon, ceramic, or even sapphire. Diaphragm shapes are circular or square and can be supported or clamped around their periphery.

A deadweight tester or piston gage can withstand extreme pressure changes and high overpressure occurrences. The piston is sealed in a cylinder using O-ring or Teflon seals. Pressure on the piston causes a deflection that can be measured by position-sensing techniques. Precision weights allow calibration for high-accuracy measurements. The deadweight tester is one of the few pressure-sensing techniques that measures pressure in terms of its fundamental units—force and area. Errors associated with the measurement are air-bouyancy corrections, gravity error, surface tension, fluidhead, and thermal expansivity. These errors are normally small but should be taken into account when high accuracy is required.

The manometer is used both as a pressure-measuring instrument and a standard for calibrating other instruments. Its simplicity and inherent accuracy result from it being the measurement of the height(s) of a column of liquid. Three basic types of manometers are the U-tube, well (cistern), and slant-tube.

Other measurement devices including McLeod, Pirani, Alphatron, and thermocouple gages which can measure vacuum in the range of 10^{-5} mm Hg.

Sensing techniques that provide a transducer for conversion from mechanical to electrical units include resistive, LVDT, capacitive, piezoresistive, and piezoelectric.

2.3.1 Potentiometric Pressure Sensors

Prior to electronic engine control systems, carburetor dashpots and distributor vacuum advance units used the distance that a rubber diaphragm traveled when pressure was applied

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as a mechanical indication of pressure. A diaphragm which moves a potentiometer (resistor with a sliding element or wiper) provides an electric signal that can be applied to a remote gage such as an oil pressure gage. Potentiometric sensors inherently have some level of noise and wear associated with their operation due to the contact of the wiper to the resistive element. Stiction or static friction is also a potential concern with these devices, especially if control of ≤0.5 percent of the total resistance is required. The finite resolution of wirewound potentiometers is overcome by the use of newer thin-film plastic resistor designs.

2.3.2 Linear Variable Differential Transformer

One of the earliest pressure inputs for engine control systems was provided by the LVDT pressure sensor. The principle of operation is demonstrated in Fig. 2.6. An LVDT pressure sensor consists of a primary winding and two secondary windings positioned on a movable cylindrical core. The core is attached to a force collector which provides differential coupling from the primary to the secondaries resulting in a position output that is proportional to pressure.

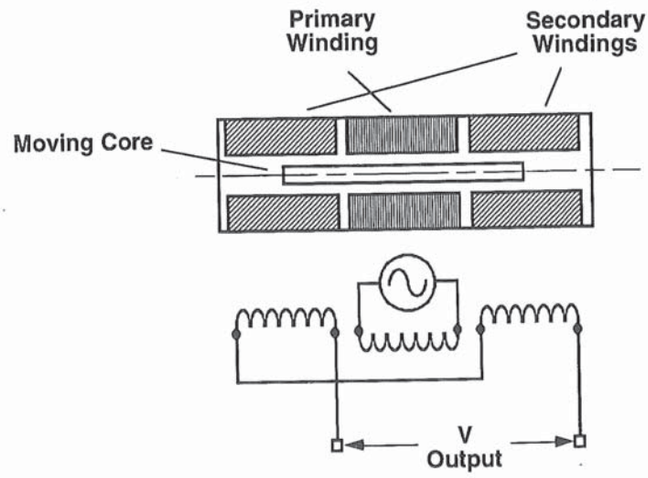


FIGURE 2.6 LVDT pressure sensor.

An alternating current is used to energize the primary winding, which results in a voltage being induced in each of the secondary windings. The windings are connected in series opposing, so the equal but opposite output of each winding tends to cancel (except for a small residual voltage called the null voltage). A pressure applied to a Bourdon tube or diaphragm causes the core to be displaced from its null position and the coupling between the primary and each of the secondaries is no longer equal. The resulting output varies linearly within the design range of the transducer and has a phase change of 180° from one side of the null position to the other. Since the core and coil structures are not in physical contact, essentially frictionless movement occurs.

Electronic devices necessary to signal condition the output of an LVDT consist of an oscillator for the supply voltage, circuitry to transform the constant voltage to a constant current, an amplifier with high input impedance for the output, a synchronous demodulator, and a filter with characteristics designed for quasistatic or dynamic measurements.

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2.3.3 Aneroid Diaphragms

Another early design for sensing automotive manifold pressure consisted of dual sealed aneroid diaphragms. The diaphragms were bonded and sealed with a vacuum inside each unit to a metallized conductive ring on opposite sides of a ceramic substrate. The substrate served as the fixed plates of two separate capacitors. Manifold vacuum was applied to one chamber and the second served as a reference for compensating and signal conditioning that minimized common mode errors due to vibration and shock.

2.3.4 Capacitive Pressure Sensors

Capacitive pressure sensors have one plate that is connected to a force collector (usually a diaphragm), and the distance between the plates varies as a result of the applied pressure. The nominal capacitance is $C = Ae/d$, where A is the area of the plate, e is the permittivity, and d is the distance between the plates. Two common capacitive pressure sensors used in automotive applications are based on silicon and ceramic capacitors.

Silicon. A silicon capacitive absolute pressure (SCAP)-sensing element is shown in Fig. 2.7. The micromachined silicon diaphragm with controlled cavity depth is anodically bonded to a Pyrex® glass substrate. Feedthrough holes are drilled in the glass to provide a precise connection to the capacitor plates inside the unit. The glass substrate is metallized using thin-film deposition techniques. Photolithography is used to define the electrode configuration. After attaching the top silicon wafer to the glass substrate, the drilled holes are solder-sealed under vacuum to provide a capacitive-sensing element with an internal vacuum reference and solder bumps for direct mounting to a circuit board or ceramic substrate. The value of the capacitor changes linearly from approximately 32 to 39 pF with applied pressure from 17 to 105 kPa. The capacitive element is 6.7 mm × 6.7 mm and has a low-temperature coefficient of capacitance (–30 to 80 ppm/°C), good linearity (≈1.4 percent), fast response time (≈1 ms), and no

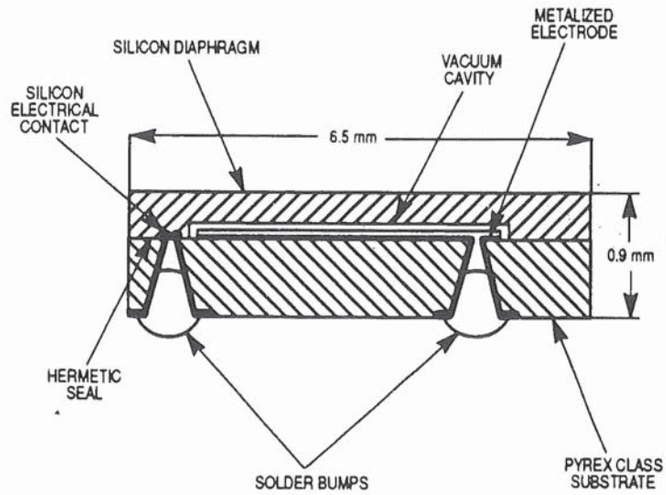


FIGURE 2.7 SCAP sensor.

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exposed bond wires. The output of the sensor is typically signal-conditioned to provide a frequency variation with applied pressure for easy interface to microcontrollers.

Surface micromachining and bulk micromachined silicon-on-silicon techniques (see Sec. 2.3.5) have also been used to build silicon capacitive pressure sensors. These approaches also address the addition of signal-conditioning electronics on the same silicon structure.

Ceramic. The ability to make thin diaphragms from ceramic material combined with thin-film deposition to provide metal plates and connections has been used to manufacture ceramic pressure sensors. Their operation and signal-conditioning requirements are similar to the silicon capacitive sensor described in Sec. 2.3.4.

2.3.5 Piezoresistive Strain Gage

Strain-gage pressure sensors convert the change in resistance in four (sometimes in two) arms of a Wheatstone bridge. The change in the resistance of a material when it is mechanically stressed is called piezoresistivity.

The open-circuit voltage of an unbalanced Wheatstone bridge is given by $V_O = \mathbf{E}[(R1*R3 - R2*R4)/(R1 + R2)(R3 + R4)]$, where V_O is the output voltage, **E** is the applied voltage, and $R1$ through $R4$ are the resistive elements of the bridge. Additional variable resistive elements are typically added to adjust for zero-offset and sensitivity, and to provide temperature compensation.

Different approaches to piezoresistive strain gages range from traditional bonded and unbonded to the newest integrated silicon pressure sensors.

Bonded and Unbonded Strain Gages. The bonded resistance strain-gage pressure sensor consists of a filament-wire or foil, metallic or semiconductor, bulk material or deposited film bonded to the surface of a diaphragm. Pressure applied to the diaphragm produces a change in the dimension of the diaphragm and, consequently, in the length of the gage, and, therefore, a change in its resistance ($R = \rho\ L/A$). The change per unit length is called strain. The sensitivity of a strain gage is indicated by gage factor

$$GF = \Delta R/R \div \Delta L/L = 1 + 2\mu + \Delta\rho/\rho \div \Delta L/L \tag{2.1}$$

Foil strain gages have a negligible piezoresistive effect and their gage factor is usually between 2 and 3.

When a pressure sensor is used for measuring an applied force it is called a load cell.

Integrated Silicon Pressure Sensors. The GF for a strain gage is improved considerably (to about 150) by using a silicon strain gage. In addition to the conventional Wheatstone bridge, silicon processing techniques, and the relative size of piezoresistive elements in silicon enable the design of a unique piezoresistive sensor. The sensor signal can be provided from a single piezoresistive element located at a 45° angle in the center of the edge of a square diaphragm which provides an extremely linear measurement. The offset voltage and full scale span of the basic sensing element vary with temperature, but in a highly predictable manner. In addition to the basic sensing element, an interactively laser-trimmed four-stage network has also been integrated into a single monolithic structure (Fig. 2.8). The size of the silicon die, including the diaphragm, sensing element, and signal-conditioning electronics, is only 0.135 in by 0.145 in. The die is attached to the six-terminal package through the use of a stress-isolating layer of RTV (room temperature vulcanizing) silicone. This approach allows a minimum of external components for amplification to provide a usable output signal.

Two silicon wafers are used to produce the absolute piezoresistive silicon pressure sensor (Fig. 2.9). The top wafer is etched until a thin, square diaphragm, approximately one mil in thickness, is achieved. The square area is extremely reproducible as is the 54.7° angle of the cavity wall based on the characteristics of bulk micromachined silicon. The top wafer is

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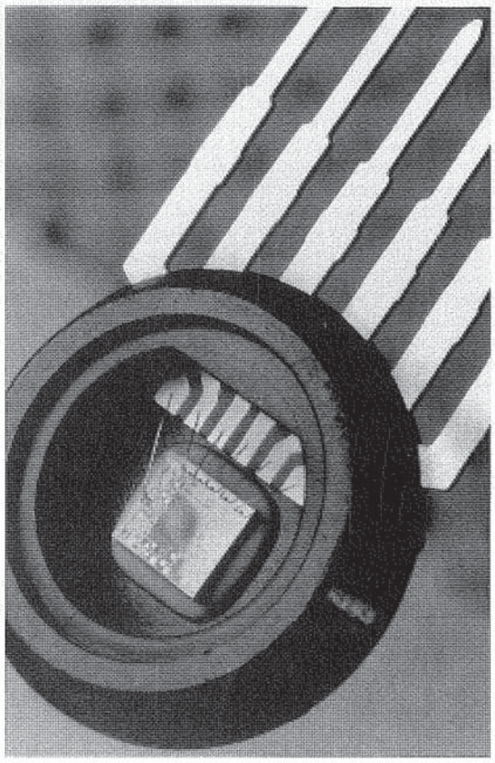


FIGURE 2.8 Silicon pressure sensor with integrated electronics. *(Courtesy Motorola, Inc.)*

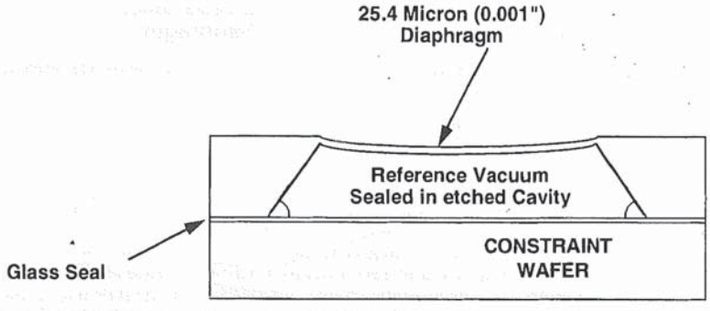


FIGURE 2.9 Cross section of piezoresistive silicon pressure sensor for measuring absolute pressure.

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attached to a support wafer by a glass frit to provide a structure which is isolated from mounting stresses.

The bulk micromachining process used to form the diaphragm and the etched cavity in the majority of silicon pressure sensors is a chemical etching process that allows a thin (0.001-in) mechanical structure—the diaphragm—to be precisely etched from a silicon wafer that is approximately 0.015 in thick. Hundreds of sensors can be formed simultaneously on a 4-in (100-mm) diameter silicon wafer, and several wafers can be batch-processed to yield thousands of sensors in a single lot. Silicon pressure sensors can also be achieved by using surface micromachining techniques. In these sensors, a layer of sacrificial material (usually an oxide) is grown on top of a silicon wafer, and material such as polysilicon is then deposited on the sacrificial layer and patterned to achieve a particular structure. The sacrificial material is removed by a chemical etchant. Both bulk and surface micromachining techniques can be combined with semiconductor processing techniques to provide additional circuitry on the same monolithic structure. A number of new terms are used relative to silicon pressure sensors that are defined in the glossary to this section.

Both bulk and surface micromachining, discussed previously, are performed at the wafer level. A polysilicon thin-film sensor that consists of a thin film of silicon that is doped with boron and vapor-deposited over a stainless steel diaphragm is shown in Fig. 2.10. A thin deposited layer of silicon dioxide insulates the silicon from the stainless steel diaphragm. Silicon nitride is used to cover the strain-sensitive elements. Silicon-on-insulated-stainless-steel (SOISS) sensors are not formed using silicon wafer techniques, but they use batch-processing techniques and are inherently suited for harsh environments.

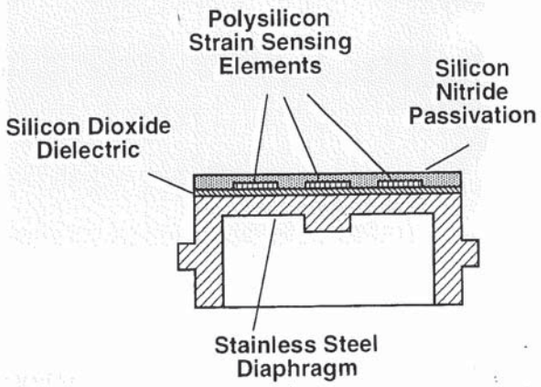


FIGURE 2.10 Polysilicon pressure sensor on stainless steel diaphragm.

2.3.6 Piezoelectric Pressure Sensors

A piezoelectric sensor produces a change in electric charge when a force is applied across the face of a crystal or piezoelectric film. The inherent ability to sense vibration and the necessity for high-impedance circuitry are taken into account in the design of modern piezocrystal sensors. Transducers are constructed with rigid multiple plates and a cultured-quartz sensing element, which contains an integral accelerometer to minimize vibration sensitivity and suppress resonances. A typical unit also contains a built-in microelectronic amplifier to transform the high-impedance electrostatic charge output from the crystals into a low-impedance voltage signal. Units made in stainless steel housings have an invar diaphragm laser welded to seal the

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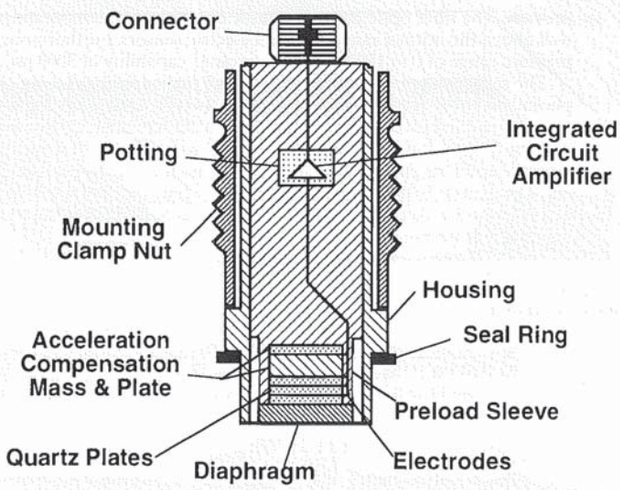


FIGURE 2.11 Piezoelectric pressure sensor.

sensing elements inside the package. Figure 2.11 shows the cross section of a piezoelectric pressure sensor.

More recently, piezo film sensors, which produce an output voltage when they are deflected, provide a very inexpensive method for pressure measurements. One approach has the piezo film cemented to a metallic dimple substrate with the dimple pointed toward the high-pressure source. As the pressure rises, a point is reached when the dimple snaps in the opposite direction and the movement is sufficient for the piezo film to generate a transient voltage.

Surface micromachining techniques have also been combined with piezoelectric thin-film materials, such as zinc oxide, to produce a semiconductor piezoelectric pressure sensor.

2.3.7 Fiber Optic Combustion Pressure Sensor

For extremely high pressure, or pressure measurements at high temperatures, different pressure measurement techniques are used. Figure 2.12 shows an alternative to traditional pressure-sensing techniques that is being developed to sense production vehicles' combustion

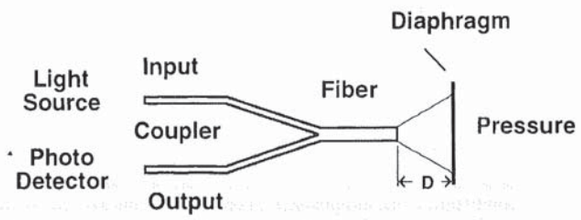


FIGURE 2.12 Fiber optic combustion pressure sensor.

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pressure. The fiber optic pressure sensor can withstand temperatures (up to 550 °C) that are well above the normal range for piezoelectric sensors. Furthermore, the design has a normal pressure range of 0 to 1000 psi and overrange capability of 3000 psi.

The sensor's operation is the result of a light source input to an optical fiber coupler and a photodetector at the receiving end of the coupler. Light exits the optical fiber as a diverging cone which illuminates a diaphragm. The maximum angle is determined by an aperture. The amount of light that is returned to the sensor fiber after it is reflected from the diaphragm depends upon the gap D between the fiber and the diaphragm. The diaphragm can be sized to allow the sensor to be integrated into a spark plug for easy access to the combustion pressure of each cylinder. Accuracy within 5 percent has been demonstrated within the 550 °C operating temperature range.

2.3.8 Pressure Switch

A pressure switch can be simpler and more cost effective than a pressure sensor for an application that only requires detecting a single pressure level. Sufficient motion of the force-collecting diaphragm (e.g., elastomer, Kapton®, fluorosilicon) allows a spring to be compressed and a set of contacts to be closed in a traditional mechanical switch. The design of the contacts may allow several amperes to be switched.

Converting the output of any of the electric sensors in Sec. 2.3 to a threshold-sensing level requires additional circuits, including an electronic switch, such as a power FET, to conduct the current. The sensor can have multiple switch points depending on the amount of additional circuitry that is provided.

2.3.9 Pressure Valves/Regulators

Pressure is frequently controlled in automotive applications by pressure regulators or valves. The actuation of these mechanisms can be a result of applied pressure to a mechanical structure such as an integral piston or relief valve held closed by a spring force, or an electric signal generated from a sensor and subsequent activation of a solenoid, which opens a valve or moves a pintle in an orifice to change the pressure. The thermostat in the engine cooling system allows flow based on a minimum temperature being achieved. It must operate independently of the pressure variations in the cooling system. A common solution is an expansion-element thermostat which actuates a valve to redirect the flow of coolant into a radiator bypass line when the control temperature is reached.

Extremely small and precise silicon-based regulators, and even pumps, are possible using micromachining techniques. Figure 2.13 shows a silicon Fluistor™ (or fluidic transistor) microvalve that is approximately 5.5 mm by 6.5 mm by 2 mm. The valve is actually a thermopneumatic actuator which accepts an electric input. The cavity is etched in the middle silicon chip by bulk micromachining described in Sec. 2.3.4 and filled with a control liquid. When the liquid is heated, the silicon diaphragm moves outward over the valve seat. This approach has demonstrated a dynamic range of 100,000:1 controlling gas flows from 4 μlpm to 4 lpm at a pressure of 20 psid.

The microvalve combined with a pressure sensor and electronic feedback loop provides a solid state pressure regulator. It has potential for usage in both gas and liquid flow control applications on future vehicles. The integration of EGR and idle-air control (IAC) has already been accomplished in a somewhat conventional (patented) manner. A feedback-controlled valve with two inlets and a single outlet orifice eliminate stepper motor programming in the engine controller and only one calibration curve is needed for both EGR and IAC functions. The combination of this approach to control systems and newly developed technologies, such as the silicon microvalve, will allow additional advances in vehicle performance, efficiency, and control.

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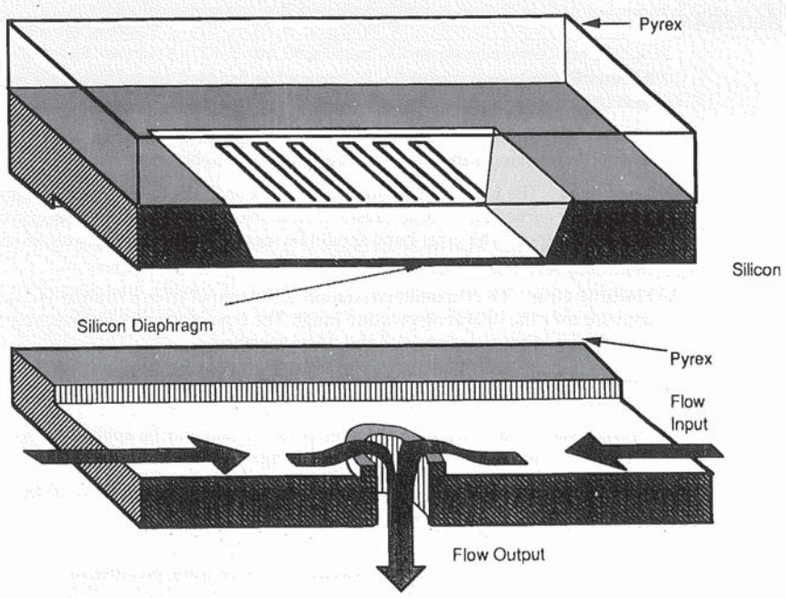


FIGURE 2.13 Silicon microvalve. *(Courtesy of Redwood MicroSystems, Inc.)*

2.4 FUTURE PRESSURE-SENSING DEVELOPMENTS

The different types of pressure measurements, different technologies for measuring pressure, and potential pressure measurements in automotive applications have been explained in this chapter. In addition, alternatives to making pressure measurements, such as indirect sensing and the use of pressure regulators, have been discussed. The use of semiconductor technology applied to sensing applications is producing sensors with inherently more decision and diagnostic capability that can communicate bidirectionally with host microcomputers in complex systems. The desire to directly produce a signal that is compatible with microcomputers rather than requiring analog signals to be converted to digital format through A/D converters is spurring development activity that could affect future automobile systems. Furthermore, recently developed fuzzy logic and neural network approaches to control systems and multiplexing of sensor outputs for use in several systems will make previously cost-prohibitive sensing applications a reality.

Increased and recently initiated sensing activity from industrial organizations such as SAE, the American National Standards Institute (ANSI), and the Institute of Electrical and Electronics Engineers (IEEE) should provide a greater level of understanding, common terminology, and improved specifications and test procedures for the numerous approaches that can be taken to sense pressure in automotive applications.

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GLOSSARY

Altimetric pressure transducer A barometric pressure transducer used to determine altitude from the pressure-altitude profile.

Diaphragm The membrane of material that remains after etching a cavity into the silicon sensing chip. Changes in input pressure cause the diaphragm to deflect.

Error band The band of maximum deviations of the output values from a specified reference line or curve due to those causes attributable to the sensor. Usually expressed as "±% of full-scale output." The error band should be specified as applicable over at least two calibration cycles so as to include repeatability and verified accordingly.

Linearity error The maximum deviation of the output from a straight-line relationship with pressure over the operating pressure range. The type of straight-line relationship (end-point, least-square approximation, etc.) should be specified.

Operating pressure range The range of pressures between minimum and maximum pressures at which the output will meet the specified operating characteristics.

Overpressure The maximum specified pressure that may be applied to the sensing element of a sensor without causing a permanent change in the output characteristics.

Piezoresistance A resistive element that changes resistance relative to the applied stress it experiences (e.g., strain gauge).

Pressure error The maximum difference between the true pressure and the pressure inferred from the output for any pressure in the operating pressure range.

Pressure sensor A device that converts an input pressure into an electric output.

Ratiometric (ratiometricity error) At a given supply voltage, sensor output is a proportion of that supply voltage. Ratiometricity error is the change in this proportion resulting from any change to the supply voltage. Usually expressed as a percent of full-scale output.

Response time The time required for the incremental change in the output to go from 10 to 90 percent of its final value when subjected to a specified step change in pressure.

Temperature error The maximum change in output at any pressure in the operating pressure range when the temperature is changed over a specified temperature range.

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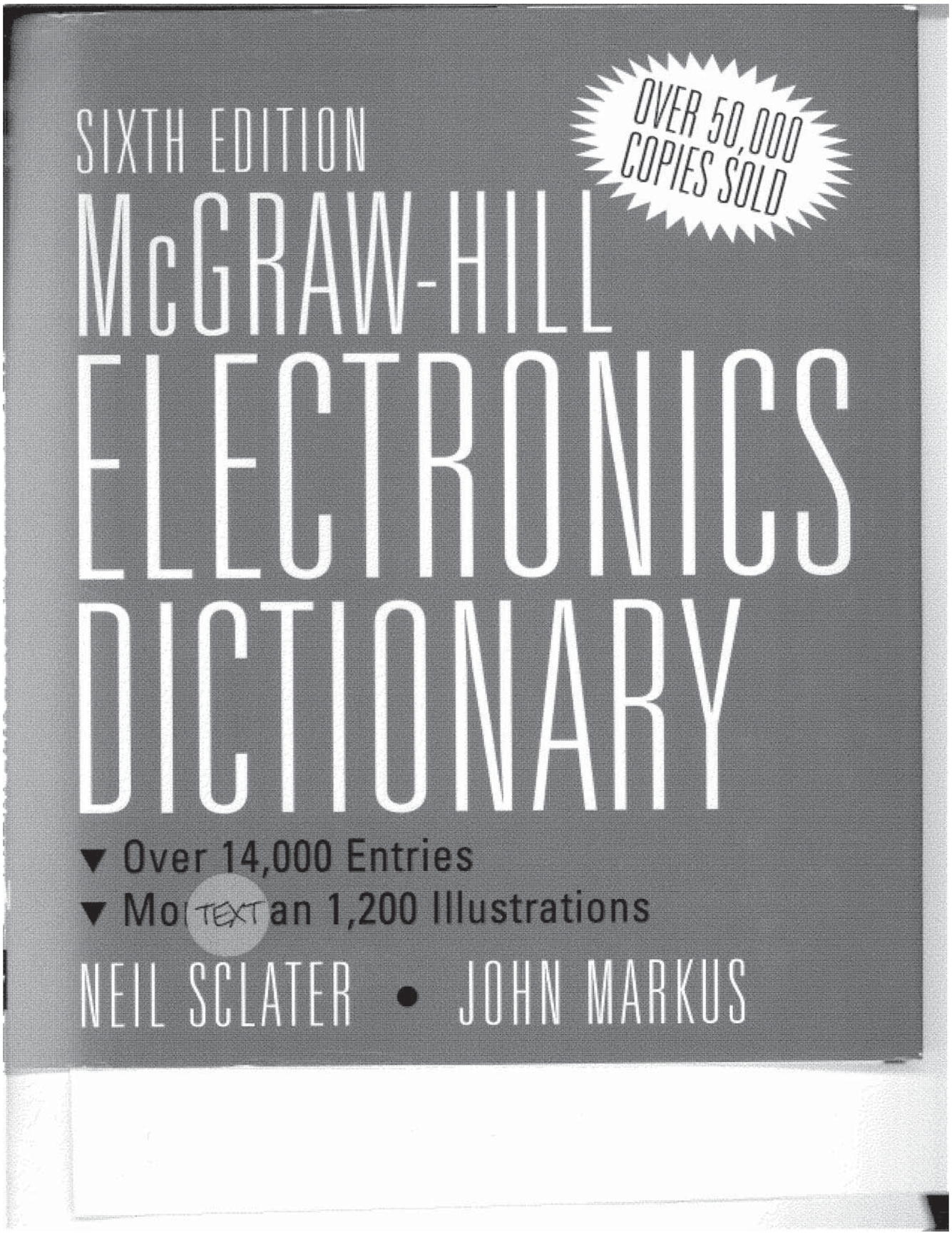
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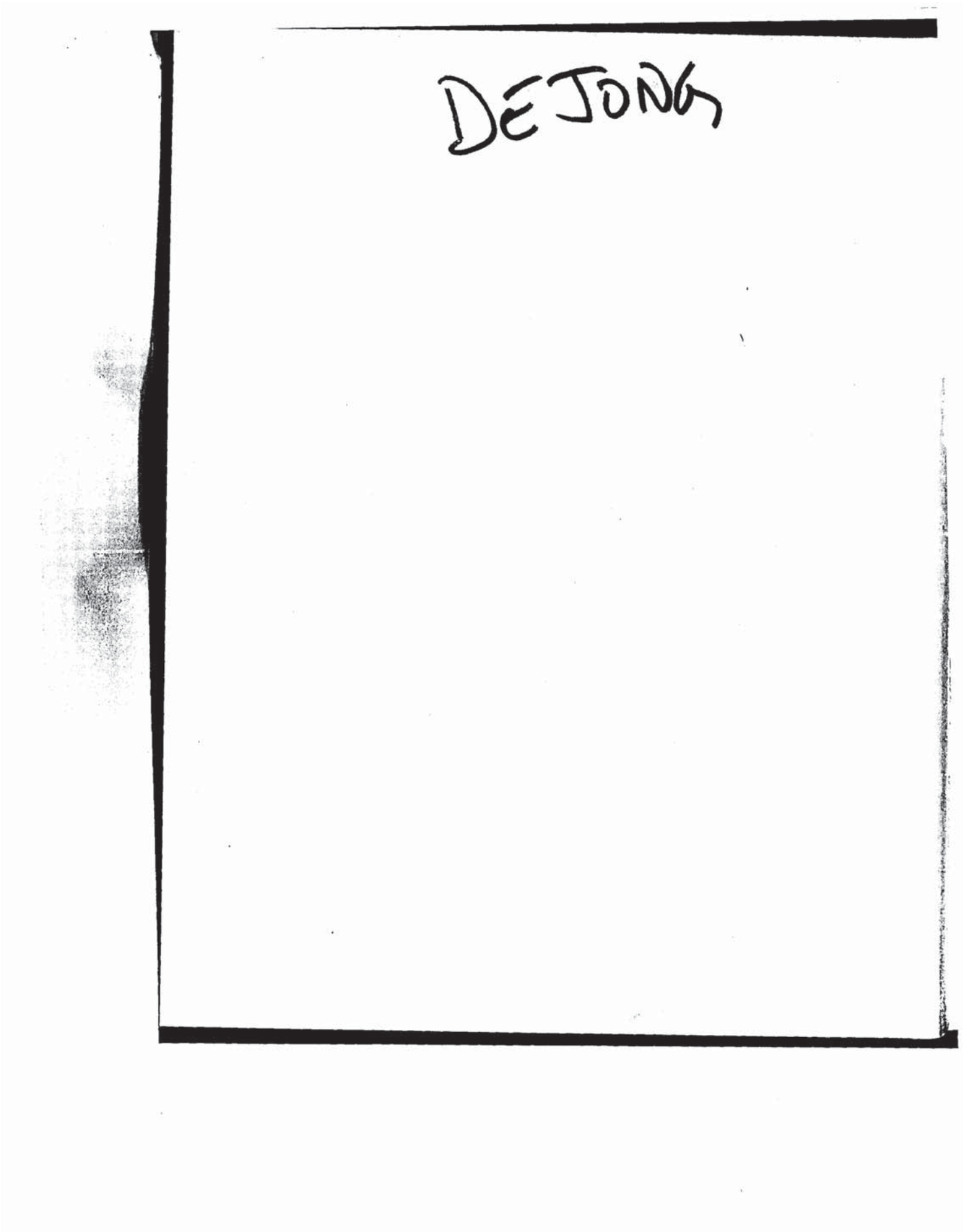
As a private consultant in technical marketing communications for more than 20 years, he has served many clients, including prominent electronics manufacturers. He is the author, coauthor, or editor of eight books.

The late **John Markus** was the coauthor of the first four editions of the *McGraw-Hill Electronics Dictionary* and the author or editor of many other books.

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sitic effects in circuits being rapidly switched. See *parasitic effects.*

equivalent series resistance [ESR] The effective resistance in series with an "ideal" capacitor caused by internal leads or the positions of internal elements.

equivalent sound absorption The area of perfectly absorbing surface that will absorb sound energy at the same rate as the given surface or object under the same conditions. The acoustical unit of equivalent absorption is the sabin.

equivalent stopping power 1. *Relative stopping power.* 2. *Stopping equivalent.*

erasable programmable read-only memory [EPROM] A nonvolatile semiconductor ROM memory that can be erased by exposure to ultraviolet (UV) light and rewritten electrically. The chip is covered with a quartz window permitting it to be exposed to UV light for erasure. The window is recovered with opaque material before the EPROM is reprogrammed. See also *EEPROM* and *OTO EPROM.*

erasable storage A storage whose data can be altered at any time.

erase 1. To remove recorded material from magnetic tape by passing the tape through a strong, constant magnetic field (DC erase) or through a high-frequency alternating magnetic field (AC erase). 2. To change all the binary digits in a digital computer memory to binary zeros. 3. To eliminate previously stored information in a charge-storage tube by charging or discharging all storage elements.

erase oscillator The oscillator in a magnetic recorder that provides the high-frequency signal needed to erase a recording on magnetic tape. The bias oscillator usually serves also as the erase oscillator.

erasing head A magnetic head that obliterates material previously recorded on magnetic tape.

ERC Abbreviation for *electrical rules check.*

E region The region of the ionosphere extending from about 60 to 90 mi (95 to 160 km) above the earth, between the D and F regions.

erg The absolute CGS unit of energy and work. It is the work done when a force of 1 dyn is applied through a distance of 1 cm. One foot-pound is equal to 13.56×10^6 ergs.

ergometer An instrument for measuring the amount of work performed by specific muscles in the body under controlled conditions.

ergonomics The science and technology related to the design and manufacture of tools, controls, equipment, and furniture best suited for long-term human use in homes, offices, factories, ships, aircraft, and vehicles. The term means "measurement of work." It considers all aspects of the environment such as lighting, temperature, humidity, and ambient noise as well as human physiological limitations and fatigue. Its objectives are to maximize human work performance safely. A well-designed workstation will include provisions for long-term comfort, protection against excessive noise or other potential dangers, and provisions for variations in operator size and weight. Tools and controls are designed to fit the hands and/or feet comfortably and will be made of appropriate materials in sizes, shapes, and colors that promote safety and efficient use. It is also called *human factors engineering.*

Erlang A unit of communication traffic density, equal to the average number of simultaneous calls originated during a specific hourly period.

ERP Abbreviation for *effective radiated power.*

error 1. The difference between the true value and a calculated or observed value. 2. *Malfunction.*

error amplifier An operational or differential amplifier that controls feedback in a closed-loop circuit or system. It produces an error voltage when the sensed output differs from the reference voltage. In switching power supplies, it adjusts the pulse-width modulator to correct the sensed output voltage. See *reference amplifier.*

error code A specific character entered into a disk, tape, or memory to indicate that a conscious error was made in the associated block of data. Machines reading the error code can be programmed to throw out the entire block automatically.

error-correcting code A code in which each data signal conforms to rules so that errors in received signals can be automatically detected and some or all of the errors corrected automatically.

error-detecting code *Self-checking code.*

error detection and correction [EDC] A process for storing digital data that has first been given a digital tag derived from that data. When the data is retrieved, the tag is used to check the data for correction.

error rate The ratio of the number of erroneous characters to the total number of characters received in a data-transmission system.

error-rate damping A type of damping in which servo control is accomplished by two voltages: one proportional to the error, and the other proportional to the rate at which the error changes. It is also called a *proportional plus derivative control.*

error signal A voltage or current proportional to the difference between the desired and the actual response in a *closed-loop system.*

error voltage A voltage, usually obtained from a tachometer whose output is proportional to the difference between the angular positions of the input and output shafts of a servosystem. This voltage acts on the system to produce a motion that tends to reduce the error in position. It is also called an *error signal.*

ERTS Abbreviation for *earth resources technology satellite.*

Esaki diode *Tunnel diode.*

escape velocity The minimum velocity that will enable an object to escape from the surface of a planet or other body without further propulsion. The escape velocity for the earth is 25,020 mi/h (40,266 km/h); for the moon, 5364 mi/h (8633 km/h).

ESCA Abbreviation for *electron spectroscopy for chemical analysis.*

E scope A radarscope that produces an E display.

escutcheon An ornamental plate around a dial, window, control knob, or other panel-mounted part.

ESD Abbreviation for *electrostatic discharge.*

ESDI Abbreviation for *enhanced small-device interface.*

ESP Abbreviation for *earth-surface potential.*

ESU Abbreviation for *electrostatic unit.*

etalon An optical device consisting of two spaced, parallel, and partially silvered glass plates. When placed in the cavity of a laser, the etalon is tilted at an angle that pro-

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in the other direction. A ferrite rod is positioned between resistive vanes to rotate the plane of polarization of the waves 45°. With appropriate rectangular-to-circular transitions, the isolator will work with rectangular waveguides.

Faraday rotator phase shifter A latching, reciprocal phase shifter that includes a Faraday rotator section and nonreciprocal quarter-wave plates at each end. It includes a square ferrite-filled waveguide. An axial coil is wound around the waveguide, and its magnetic field is completed outside the waveguide wall with ferrimagnetic yokes. Quarter-wave plates at each end convert energy in the rectangular enclosure either to right- or left-hand circularly polarized energy, depending on the direction of propagation. The energy phase is changed by a variable axial magnetic field supplied by the coil around the waveguide. See *phase shifter.*

Faraday shield 1. An electrostatic shield placed between the primary and secondary windings of a transformer to reduce coupling capacitance and common-mode noise. 2. An electrostatic shield made of open metal-wire mesh. 3. A plastic bag with both outer surfaces metallized to protect delicate, ESD-sensitive components from damage or destruction from ESD. The shield provides electrostatic shielding while passing electromagnetic waves. It need not be grounded. See *electrostatic shield.*

Faraday's law The voltage induced in a circuit is proportional to the rate at which the magnetic flux linkages of the circuit are changing. Also called law of electromagnetic induction.

faradic current An intermittent and nonsymmetrical alternating current similar to that obtained from the secondary winding of an induction coil.

far-end crosstalk Crosstalk that travels along the disturbed circuit in the same direction as desired signals in that circuit. When it occurs at carrier telephone repeater stations, the output signals of one repeater go out also over the output line for the other repeater.

far field The radiation field in the Fraunhofer region surrounding a transmitting antenna.

far region *Fraunhofer region.*

far zone *Fraunhofer region.*

fast Fourier transform [FFT] A Fourier transform method for calculating the frequency spectrum, in both magnitude and angle, for any function of time by means of special operating programs that speed machine computation of complex Fourier series.

fathometer *Depth sounder.*

fault 1. A defect such as an open circuit, short circuit, or inadvertent ground in a component, circuit, or transmission line. 2. A defect in a semiconductor device that can cause the device to fail during normal operation. It is usually the result of a processing defect.

fault mode current The current in a circuit under fault conditions, such as during arcbacks and load short-circuits.

fault simulation This term usually means computer simulation of processing defects in integrated-circuit fabrication. The circuit description is modified (faulted) to correspond to a processing defect, and the simulation is rerun to determine whether the test program would find this defect.

FAX (or fax) Abbreviation for *facsimile.*

fc Abbreviation for *footcandle.*

FC-AL Abbreviation for *fiber-channel arbitrated loop.*

FCC Abbreviation for *Federal Communications Commission.*

FDCC Abbreviation for *forward control channel.*

FDDI Abbreviation for *fiber distributed data interface.*

FDM Abbreviation for *frequency-division multiplex.*

FDMA Abbreviation for *frequency-division multiple-access.*

FDX Abbreviation for *full-duplex transmission.*

FEC Abbreviation for *forward error correction.*

FED Abbreviation for *field-emitter display.*

Federal Aviation Administration [FAA] An agency created by Congress in 1958, with full authority over both military and civilian airspace requirements.

Federal Communications Commission [FCC] A U.S. government agency responsible for the following: 1. The policy governing allocation of radiated emissions (frequencies). 2. Establishing owner eligibility for commercial radio and TV stations and their licensing. 3. The qualification and licensing of amateur and professional radio and radar operators and electronic technicians.

feed 1. To supply a signal to the input of a circuit, transmission line, or antenna. 2. That part of a radar antenna connected to or mounted on the end of the transmission line which radiates RF energy to the reflector or receives energy therefrom.

feedback The return of a portion of the output of a circuit or device to its input. With positive feedback, the signal fed back is in phase with the input and increases amplification but can cause oscillation. With negative feedback, the signal fed back is 180° out of phase with the input and decreases amplification but stabilizes circuit performance and tends to minimize noise and distortion.

feedback amplifier An amplifier with a passive network that returns a portion of the output signal to its input in a way that changes the performance characteristics of the amplifier.

feedback controller A circuit or element in a *closed-loop system* that controls the motor or other actuator in a closed loop system to correct an *error signal.*

feedback control loop A control loop circuit that senses any deviation from the desired output level and changes the drive waveforms of the power switch to compensate for those changes.

feedback control system *Closed loop control system.*

feedback oscillator An oscillating circuit with an amplifier whose output is fed back in phase with the input. Oscillation is maintained at a frequency determined by the values of the reactive components in the amplifier and the feedback circuits.

feedback path The transmission path from the loop output signal to the loop feedback signal in a feedback control loop.

feedback regulator A feedback control system that tries to maintain a prescribed relationship between certain system signals and other predetermined quantities. Some system signals in a regulator are adjustable reference signals. Under certain methods of operation, a feedback regulator can also be a servomechanism.

feedback resistor The resistor in parallel with an operational amplifier to couple output to input and act as a voltage control.

feedback signal *Primary feedback.*

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feedback winding A winding that makes feedback connections in a magnetic amplifier.

feeder A transmission line between a transmitter and an antenna.

feed forward A method for improving line regulation by directly sensing the input voltage of a circuit.

feed-forward control Process control in which changes are detected at the process input, and an anticipating correction signal is applied before process output is affected.

feed-forward network An external distortion-reducing network for use with a class C amplifier in communication-satellite service. Signal samples are taken before and after the distorting amplifier to obtain an error signal. This error signal is processed and combined beyond the amplifier output, to provide an undistorted signal by cancellation of the common error terms.

feed line A wire or cable for connecting an antenna to the transmitter and receiver. See *transmission line.*

feedthrough A conductor that connects patterns on opposite sides of a printed-circuit board. It is also called a *via* connection.

feedthrough capacitor A feedthrough insulator that provides a desired value of capacitance between the feedthrough conductor and the metal chassis or panel through which the conductor is passing. It serves as a bypass in UHF circuits.

feedthrough insulator *Feedthrough terminal.*

feedthrough terminal An insulating sleeve with a coaxial conductor, made to mount in a hole formed in a metal panel, case, or firewall to pass electrical power or signals through a partition. It is also called a *feedthrough insulator.*

feet per second [ft/s] A unit for specifying the speed of sound through a medium. In air at standard sea-level conditions, the speed of sound is approximately 1080 ft/s (330 m/s), and 4800 ft/s (1460 m/s) in water.

female connector A connector that has one or more contacts set into recessed openings. Jacks, sockets, and wall outlets are examples of female connectors.

femto- [f] A prefix representing 10^{-15}, which is 0.000 000 000 000 001, or one-thousandth of a millionth of a millionth.

femtoampere [fA] A unit of current equal to 10^{-15} A.

femtosecond [fs] A unit of time equal to 10^{-15} second.

femtovolt [fV] A unit of voltage equal to 10^{-15} V.

femtowatt [fW] A unit of power equal to 10^{-15} W.

FEP An abbreviation for *fluorinated ethylene propylene.*

Fermat's principle An electromagnetic wave will take the path of least travel time when propagating between two points.

fernico An iron-nickel cobalt alloy whose coefficient of expansion is similar to that of glass, making it suitable for making glass-to-metal seals for power tubes and other vacuum chambers. See also *Kovar.*

ferric Containing a trivalent compound of iron.

ferric oxide [Fe_2O_3] A magnetic iron oxide (red) used as a coating on magnetic recording tapes.

ferrimagnetic limiter A power limiter that replaces TR tubes in microwave systems. It uses ferrimagnetic material that exhibits nonlinear properties, such as ferrite or garnet.

ferrimagnetic material A ferrite material that exhibits ferrimagnetism, such as yttrium-iron garnet polycrystalline materials.

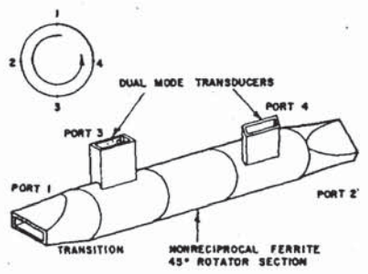
ferrimagnetism A type of magnetism in which the magnetic moments of neighboring ions tend to align antiparallel to each other. The moments are of different magnitudes, however, so there can be a large resultant magnetization. It is observed in the ferrites and similar compounds.

ferristor A miniature two-winding saturable reactor that operates at a high carrier frequency and can be connected as a coincidence gate, current discriminator, free-running multivibrator, oscillator, or ring counter.

ferrite A powdered, compressed, and sintered magnetic material that has high resistivity, consisting chiefly of ferric oxide combined with one or more other metals. The high resistance makes eddy current losses extremely low at high frequencies. Examples of ferrite compositions include nickel ferrite, nickel-cobalt ferrite, manganese-magnesium ferrite, yttrium-iron garnet, and single-crystal yttrium-iron garnet. It is also called ferrospinel.

ferrite bead A bead made of ferrite powder, placed on a connecting wire in a high-frequency circuit to introduce inductance for suppressing parasitic oscillations.

ferrite circulator A combination of two dual-mode transducers and a 45° ferrite rotator that control and switch microwave energy in a rectangular waveguide.



Ferrite circulator with four rectangular ports.

ferrite-core memory A magnetic memory consisting of read-in and read-out wires threaded through a matrix of tiny toroidal cores molded from a square-loop ferrite. Some cores of this type are only 0.018 in (0.5 mm) in diameter. It is also called a core memory and a core plane. It is now an obsolete technique.

ferrite isolator An isolator that passes energy in one direction through a waveguide while making possible the absorption of energy from the opposite direction. A ferrite rod, centered on the axis of a short length of circular waveguide, is located between rectangular-waveguide end sections displaced 45° with respect to each other. A signal in the desired direction is rotated 45° by the ferrite rod to make it correct for the output waveguide. A backward signal is rotated 45° in the wrong direction, and its energy is absorbed by resistance cards.

ferrite limiter A passive low-power microwave limiter that has an insertion loss of less than 1 dB when it is operating in its linear range, with minimum phase distortion. The input signal is coupled to a single-crystal sample of

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coming /'kʌmɪŋ/ *n.* ME. [f. COME *v.* + -ING¹.] **1** The action of COME *v.*; a movement towards or arrival at a specified or understood point, time, or result. Also foll. by adv. or prep. ME. †**2** A means of access, an approach; *coming in*, a means of entrance, an entry. LME–E18. **3** *comings in*, revenues, receipts. L16.

1 MILTON At his coming to the Crown. T. S. ELIOT A cold coming we had of it. R. GITTINGS His financial position at coming-of-age. A. POWELL A . . dance on the 'coming out' of a daughter. *second coming*: see SECOND *a.*

coming /'kʌmɪŋ/ *a.* LME. [f. COME *v.* + -ING².] **1** That comes. Also foll. by adv. LME. **2** Inclined to make or meet advances; ready, eager, complaisant, forward. *arch.* L16. **3** Likely to be important in the future, rising into prominence. M19.

1 *have* (*got*) *another guess coming*: see GUESS *n.* **3** H. ROBBINS People will pay to see the pictures. . . It's the coming thing.

comingle *v.* var. of COMMINGLE.

Comintern /'kɒmɪntɜːn/ *n.* E20. [Russ. *Komintern*, f. *kom*(*munisticheskiĭ* communist + *intern*(*atsional'nyĭ* international.] The Third International (see INTERNATIONAL *n.* 2).

comitadji /kɒmɪ'tadʒi/ *n.* Also **komitadji**, **komitaji**. E20. [Turk. *komitact* lit. 'member of a (revolutionary) committee'.] A member of a band of irregular soldiers in the Balkans; *spec.* (*Hist.*) a Balkan rebel against the Ottoman Empire before the war of 1914–18.

comital /'kɒmɪt(ə)l/ *a.* M19. [med.L *comitalis*, f. *comit-*, *comes* in sense 'a count': see -AL¹.] Of or pertaining to a count or earl; of the rank of a count or earl.

comitant /'kɒmɪt(ə)nt/ *a.* & *n. rare.* E17. [L *comitant-* pres. ppl stem of *comitari* accompany, f. *comit-* *comes* companion: see -ANT¹.] (Something) accompanying; (a) concomitant.

comitative /'kɒmɪtətɪv/ *a.* M19. [f. L *comitat-* pa. ppl stem of *comitari* (see prec.), + -IVE.] *Gram.* Expressing accompaniment or association.

comitatus /kɒmɪ'teɪtəs/ *n.* Pl. same. L19. [L *comitatus*, f. *comit-*, *comes* companion: see -ATE¹.] *Hist.* A body of warriors, nobles, etc., attached to the person of a king or chieftain; the status of such a body.

See also POSSE COMITATUS.

comites *n.* pl. of COMES.

comitia /kə'mɪʃə, -ʃɪə/ *n.pl.* (also treated as *sing.*). E17. [L, pl. of *comitium* assembly, f. as COM- + *-itium*, f. *it-*, *ire* go.] **1** *gen.* An assembly. *rare.* E17. **2** An assembly of the Fellows of the Royal College of Physicians, London. L17. **3** *Rom. Hist.* An assembly of the Roman people to elect magistrates and pass legislation. M18.

comitial /kə'mɪʃ(ə)l, -ʃɪəl/ *a.* M16. [L *comitialis*, f. as prec.: see -AL¹.] **1** *Rom. Hist.* Of or pertaining to the comitia. M16. †**2** Designating or pertaining to any of various Presbyterian or political assemblies. L16–L18.

comity /'kɒmɪti/ *n.* M16. [L *comitas*, f. *comis* courteous: see -ITY.] **1** Courtesy, civility; kindly and considerate behaviour towards others. M16. **2a** *comity of nations*, *international comity*, the friendly recognition as far as is practicable by nations of each other's laws and usages. M19. **b** An association of or *of* nations etc. for mutual benefit; the community of civilized nations. M19.

2b C. R. ATTLEE Germany was back in the comity of nations. P. USTINOV Voices which spoke for Russia in the comity of civilised people.

comma /'kɒmə/ *n.* L16. [L f. Gk *komma* piece cut off, short clause.] **1** In *Class. Pros.* & *Rhet.*, a phrase or group of words shorter than a colon (COLON *n.*² 1); *loosely* (now *rare* or *obs.*) a short clause or phrase within a sentence. L16. †**b** A clause or short passage of a treatise or argument. L16–L17. **2** A punctuation mark (now ,) indicating the least discontinuity of grammatical construction, also used to separate (groups of) figures etc. L16. **b** A short pause such as may be indicated by a comma. L16. **c** *fig.* A break of continuity, an interval, a pause. E17. **3** *Mus.* A definite minute interval or difference of pitch. L16. **4** In full *inverted comma*. A comma (sense 2) placed upside down (single or paired) above the line before a quotation; in *pl.* also, quotation marks (including the erect comma(s) or apostrophe(s) above the line closing a quotation). E18. **5** In full *comma butterfly*. A nymphalid butterfly, *Polygonia c-album*, having a white comma-shaped mark on the underside of the wing. M18. **6** In full *comma bacillus*. A cholera bacillus (of curved shape). L19.

command /kə'mɑːnd/ *n.* LME. [f. the vb.] **1** The act of commanding; an authoritative statement that a person must do something; an order, bidding; a commandment. LME. **b** A symbolic expression which defines an operation in a computer; a signal initiating the performance of such an operation. M20. **2** The faculty of commanding; rule, control; the exercise or tenure of authority, esp. naval or military. Also, a commander's position. LME. **b** Those in command. Esp. in *the high(er) command*, the army commander-in-chief and his staff. E20. **3** Power of control, sway, mastery, possession. M16. **b** Domination from an elevated or superior strategic position; range of vision, outlook, prospect. E17. **c** Despotism, coercion. *rare.* L17. **4** A body of troops, a district, etc., under a commander (esp. naval or military) or one particular authority; a unit of an army, air force, etc., organized for a particular duty or operating in a particular area. L16.

1 at or **by a person's command** in pursuance of a person's bidding. **word of command** the customary order for movement in drill; spoken signal to begin. **2** DRYDEN He assumed an absolute command over his readers. LD MACAULAY The places and commands which he held under the Crown. C. S. FORESTER The command of a regular brigade of cavalry. **in command** (**of**) commanding, in control (of). *second in command*: see SECOND *a.* **under** (**the**) **command of** commanded by. **3** B. JOWETT Having gifts of courage . . and command of money and friends. I. COMPTON-BURNETT Duncan . . had lost his command of himself. **at command** ready to be used at will. **command of language** skill in speech, articulacy. **b** K. DIGBY I . . gott my fleete out of command of the fortes. DRYDEN The steepy stand, which overlooks the vale with wide command. **4** G. CATLIN Colonel Dodge ordered the command to halt. B. HORROCKS Before the war Western Command had always been regarded as a backwater. *Bomber Command*, *Coastal Command*, *Fighter Command*, *Strike Command*, *Support Command*, *Transport Command*, etc.

Comb.: **command language** *Computing* a source language composed chiefly of a set of commands or operators, used esp. for communicating with the operating system of a computer; *spec.* a job control language; **command module** the control compartment of a spacecraft; **Command Paper** a paper laid by command of the Crown before Parliament etc.; **command performance** a theatrical etc. performance given by royal command; **command post** the headquarters of a military unit.

command /kə'mɑːnd/ *v.* ME. [AN *comaunder*, OFr. *comander* (mod. *commander*) f. late L *commandare*, f. as COM- + *mandare* commit, enjoin: cf. COMMEND *v.*] **I1** *v.t.* Lay down as a command; give a command or commands to; order, bid, enjoin, with authority and influence. (With a command, a person etc. given a command (historically an indirect obj.), or both as object(s); a person etc. *to do*, (arch.) *do*, †*to* a thing; *that* something (*should*) *be* done; a person or thing *to be* + pa. pple.) ME. **b** *v.i.* Issue commands. LME. **2** *v.t. ellipt.* **a** Order to come or go *to*, *from*, *away*, etc. *arch.* LME. †**b** Order to be sent or given; demand. L16–L18. **3** *v.t.* Have authority over; be in command of (forces, a ship, etc.); be in control of; master, restrain, (oneself, one's passions, etc.). LME. **b** *v.i.* Have authority or control; be in command, be supreme. L16. **4** *v.t.* Have (a person etc.) at one's call; have (money, skill, etc.) at one's disposal or within easy reach. M16. **5** *v.t.* Deserve and get; exact, compel. L16. **6** *v.t.* Dominate from an elevated or superior strategic position; look down on or over. E17. **b** *v.i.* Dominate by looking down *over*, have a commanding position. E17.

1 AV *Acts* 25:6 He . . commanded Paul to be brought. W. BLACKSTONE The rule of life which religion commands. J. B. PRIESTLEY 'Go to Liverpool at once,' he commanded. E. O'NEILL His Imperial Majesty commands that you stop talking. T. CAPOTE When the next boy commanded him to halt, he at once obeyed. **2a** MILTON Commanded home for doing too much. **b** SHAKES. *Cymb.* You have commanded of me these most poisonous compounds. **3** C. MARLOWE The haughty Dane commands the narrow seas. M. EDGEWORTH: F. commanded his temper. **b** DEFOE Colonel Forbes . . commanded at the siege. **4** A. C. BOULT Eugène Ysaÿe commanded a breadth of tone as a violinist which remains unmatched. H. WILSON Whether A or B can in fact command a majority in the House of Commons. **yours to command** *arch.*: a formula used for closing a letter. **5** K. TYNAN He could not command my sympathy nor even . . my interest. F. HERBERT He . . commanded their attention with a knuckle rap against the table. **6** J. RUSKIN My bedroom window commanded . . a very lovely view. E. BOWEN Combe Farm commanded the valley.

†**II7** *v.t.* Commend, recommend, confide, LME–M16.

commandable *a.* LME.

commandant /kɒmən'dant, 'kɒməndant; -ɑːnt/ *n.* L17. [Fr. *commandant*, It., Sp. *commandante*; in sense 2 Afk. *kommandant*: see COMMAND *v.*, -ANT¹.] **1** A commanding officer, esp. of a particular force, a military academy, etc. L17. **2** In *S. Afr. Hist.*, the leader of a Boer commando. Now, an officer in the South African armed forces ranking between a major and a colonel. L18.

2 commandant-general a commander-in-chief. **commandantship** *n.* the office or position of commandant M19.

Commandaria /kɒmən'dɛːrɪə/ *n.* Also **-eria** /-ɪərɪə/. E20. [med.L *commandaria* (from being made on the former commanderies): see COMMANDERY 1.] A sweet red or dark brown wine from Cyprus.

commandeer /kɒmən'dɪə/ *v.t.* E19. [Afk. *kommandeer* f. Du. *commanderen* f. Fr. *commander* COMMAND *v.*] Seize (men or goods) for military service; take arbitrary possession of.

commander /kə'mɑːndə/ *n.* ME. [OFr. *comandere*, *-eor*, AN *comandour*, (mod. *commandeur*), f. Proto-Romance, f. late L *commandare*: see COMMAND *v.*, -ER².] **1** A person who commands; a person who has the control or disposal *of*; a ruler, a leader. ME. **2** *spec.* **a** An officer in command of a ship, a military force, etc.; a naval officer ranking next below a captain; an officer in charge of a London police district. LME. **b** *Hist.* The administrator of a commandery of a knightly order. E17. **c** More fully *knight commander*. A member of a higher class in some orders of knighthood. E19. **3** A large wooden mallet. L16. †**4a** A surgical instrument for reducing dislocations. L17–L18. **b** A mechanical device for straightening, reshaping, etc. L19.

1 Commander of the Faithful: a title of the Caliphs. **2a** *master and commander*: see MASTER *n.*¹ *wing commander*: see WING *n.*

Comb.: **commander-in-chief** a supreme commander.

commandership *n.* the office or position of commander E17.

Commanderia *n.* var. of COMMANDARIA.

commandery /kə'mɑːndəri/ *n.* Also **-dry** /-dri/. LME. [Fr. *commanderie*, f. as COMMANDER: see -ERY. Partly f. med.L *commendaria*, f. *commenda* benefice.] **1** *Hist.* An estate, manor, etc., belonging to a religious and military order of knights, as the Knights Hospitallers. LME. **b** A conventual priory of a non-military religious order. M16. †**2** An ecclesiastical or other benefice held *in commendam*. M16–E19. †**3** The tenure of command. L16–M17. **4** The rank of commander in an order of knighthood; a benefice or pension attached to such a commandership. E17. †**5** A district under a commander. M17–E19.

commanding /kə'mɑːndɪŋ/ *a.* L15. [f. COMMAND *v.* + -ING².] **1** Possessing or exercising command; ruling; controlling. L15. **2** Indicating or expressing command; (of a person,

For other words beginning with *co-* see the entry for **co-**

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PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Exhibit No. 1015

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

_____

HYUNDAI MOTOR COMPANY,

Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,

Patent Owner

Patent No. 6,557,540

Issue Date: May 6, 2003

Title: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

Inter Partes Review No. IPR2018-01061

DECLARATION OF SYLVIA HALL-ELLIS, PH.D.

HMC EXHIBIT 1015

I. INTRODUCTION

1. My name is Sylvia D. Hall-Ellis. I have been retained as an expert by Hyundai Motor Company ("Hyundai").

2. I have written this report at the request of Hyundai to provide my expert opinion regarding the authenticity and public availability of several books and journal articles. My report sets forth my opinions in detail and provides the basis for my opinions regarding the public availability of these publications.

3. I reserve the right to supplement or amend my opinions, and bases for them, in response any additional evidence, testimony, discovery, argument, and/or other additional information that may be provided to me after the date of this report.

4. I am being compensated for my time spent working on this matter at my normal consulting rate of $300 per hour, plus reimbursement for any additional reasonable expenses. My compensation is not in any way tied to the content of this report, the substance of my opinions, or the outcome of this litigation. I have no other interests in this proceeding or with any of the parties.

5. All of the materials that I considered are discussed explicitly in this declaration.

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II. QUALIFICATIONS

6. I am currently an Adjunct Professor in the School of Information at San José State University. I obtained a Masters of Library Science from the University of North Texas in 1972 and a Ph.D. in Library Science from the University of Pittsburgh in 1985. Over the last 50-plus years, I have held various positions in the field of library and information resources. I was first employed as a librarian in 1966 and have been involved in the field of library sciences since, holding numerous positions.

7. I am a member of the American Library Association (ALA) and its Association for Library Collections & Technical Services (ALCTS) Division, and I served on the Committee on Cataloging: Resource and Description (which wrote the new cataloging rules) and as the chair of the Committee for Education and Training of Catalogers and the Competencies and Education for a Career in Cataloging Interest Group. I also served as the Chair of the ALCTS Division's Task Force on Competencies and Education for a Career in Cataloging. Additionally, I have served as the Chair for the ALA Office of Diversity's Committee on Diversity and a member of the REFORMA National Board of Directors. Currently I serve as a member of the Editorial Board for the ALCTS premier cataloging journal, *Library Resources and Technical Services*.

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8. I have also given over one hundred presentations in the field, including several on library cataloging systems and Machine-Readable Cataloging ("MARC") standards. My current research interests include library cataloging systems, metadata, and organization of electronic resources.

9. My full curriculum vitae is attached hereto as Exhibit 1016 .

III. LIBRARY CATALOGING PRACTICES

10. I am fully familiar with the library cataloging standard known as the MARC standard, which is an industry-wide standard method of storing and organizing library catalog information.[1] MARC was first developed in the 1960's by the Library of Congress. A MARC-compatible library is one that has a catalog consisting of individual MARC records for each of its items. Today, MARC is the primary communications protocol for the transfer and storage of bibliographic metadata in libraries.[2]

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[1] The full text of the standard is available from the Library of Congress at http://www.loc.gov/marc/bibliographic/.

[2] Almost every major library in the world is MARC-compatible. *See, e.g.*, *MARC Frequently Asked Questions (FAQ)*, Library of Congress, https://www.loc.gov/marc/faq.html (last visited March 10, 2018) ("MARC is the acronym for Machine-Readable Cataloging. It defines a data format that emerged

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11. A MARC record comprises several fields, each of which contains specific data about the work. Each field is identified by a standardized, unique, three-digit code corresponding to the type of data that follow. For example, a work's title is recorded in field 245, the primary author of the work is recorded in field 100, an item's International Standard Book Number ("ISBN") is recorded in field 020, an item's Library of Congress call number is recorded in field 050, and the publication date is recorded in field 260 under the subfield "c." If a work is a periodical, then its publication frequency is recorded in field 310, and the publication dates (*e.g.*, the first and last publication) are recorded in field 362, which is also referred to as the enumeration/chronology field.

12. The library that created the record is recorded in field 040 in subfield "a" with a unique library code. When viewing the MARC record online via Online Computer Library Center's ("OCLC") Connexion database, hovering over this code with the mouse reveals the full name of the library. I used this method of

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from a Library of Congress-led initiative that began nearly forty years ago. It provides the mechanism by which computers exchange, use, and interpret bibliographic information, and its data elements make up the foundation of most library catalogs used today."). MARC is the ANSI/NISO Z39.2-1994 (reaffirmed 2016) standard for Information Interchange Format.

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"mousing over" the library codes in the OCLC database to identify the originating library for the MARC records discussed in this report. Where this "mouse over" option was not available, I consulted the Directory of OCLC Libraries in order to identify the institution that created the MARC record.[3]

13. MARC records also include several fields that include subject matter classification information. An overview of MARC record fields is available through the Library of Congress at http://www.loc.gov/marc/bibliographic/. For example, 6XX fields are termed "Subject Access Fields." *See* http://www.loc.gov/marc/bibliographic/bd6xx.html. Among these, for example, is the 650 field; this is the "Subject Added Entry – Topical Term" field. *See* http://www.loc.gov/marc/bibliographic/bd650.html. The 650 field is a "[s]ubject added entry in which the entry element is a topical term." *Id.* These entries "are assigned to a bibliographic record to provide access according to generally accepted thesaurus-building rules (*e.g.*, *Library of Congress Subject Headings* (LCSH), *Medical Subject Headings* (MeSH))." *Id.* Further, MARC records include call numbers, which themselves include a classification number. For example, the 050 field is the "Library of Congress Call Number." *See* http://www.loc.gov/marc/bibliographic/bd050.html. A defined portion of the

[3] http://www.oclc.org/contacts/libraries.en.html.

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Library of Congress Call Number is the classification number, and "source of the classification number is *Library of Congress Classification* and the *LC Classification-Additions and Changes*." *Id.* Thus, included in the 050 field is a subject matter classification. Each item in a library has a single classification number. A library selects a classification scheme (*e.g.*, the Library of Congress Classification scheme just described or a similar scheme such as the Dewey Decimal Classification scheme) and uses it consistently. When the Library of Congress assigns the classification number, it appears as part of the 050 field. If a local library assigns the classification number, it appears in a 090 field. In either scenario, the MARC record includes a classification number that represents a subject matter classification.

14. The OCLC was created "to establish, maintain and operate a computerized library network and to promote the evolution of library use, of libraries themselves, and of librarianship, and to provide processes and products for the benefit of library users and libraries, including such objectives as increasing availability of library resources to individual library patrons and reducing the rate of rise of library per-unit costs, all for the fundamental public purpose of furthering ease of access to and use of the ever-expanding body of worldwide scientific,

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literary and educational knowledge and information."[4] Among other services, OCLC and its members are responsible for maintaining the WorldCat database (http://www.worldcat.org/), used by independent and institutional libraries throughout the world.

15. OCLC also provides its members online access to MARC records through its OCLC Connexion database. When an OCLC member institution acquires a work, it creates a MARC record for this work in its computer catalog system in the ordinary course of its business. MARC records created at the Library of Congress are tape-loaded into the OCLC database through a subscription to MARC Distribution Services daily or weekly. Once the MARC record is created by a cataloger at an OCLC member institution or is tape-loaded from the Library of Congress, the MARC record is then made available to any other OCLC members online, and therefore made available to the public. Accordingly, once the MARC record is created by a cataloger at an OCLC member institution or is tape-loaded from the Library of Congress or another library anywhere in the world, any publication corresponding to the MARC record has been cataloged and indexed

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[4] Third Article, Amended Articles of Incorporation of OCLC Online Computer Library Center, Incorporated (available at http://www.oclc.org/en-US/councils/documents/amended_articles.html).

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according to its subject matter such that a person interested in that subject matter could, with reasonable diligence, locate and access the publication through any library with access to the OCLC Connexion database or through the Library of Congress.

16. When an OCLC member institution creates a new MARC record, OCLC automatically supplies the date of creation for that record. The date of creation for the MARC record appears in the fixed field (008), characters 00 through 05. The MARC record creation date reflects the date on which, or shortly after which, the item was first acquired or cataloged. Initially, field 005 of the MARC record is automatically populated with the date the MARC record was created in year, month, day format (YYYYMMDD) (some of the newer library catalog systems also include hour, minute, second (HHMMSS)). Thereafter, the library's computer system may automatically update the date in field 005 every time the library updates the MARC record (*e.g.*, to reflect that an item has been moved to a different shelving location within the library). Field 005 is visible when viewing a MARC record via an appropriate computerized interface, but when a MARC record is printed to hardcopy, no "005" label appears. The initial field 005 date (*i.e.*, the date the MARC record was created) does appear, however,

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next to the label "Entered."[5] The date upon which the most recent update to field 005 occurred also appears, next to the label "Replaced." Thus, when an item's MARC record has been printed to hardcopy—as is the case with the exhibits to this report—the date reflected next to the label "Entered" is necessarily on or after the date the library first cataloged and indexed the underlying item.

17. Once one library has cataloged and indexed a publication by creating a MARC record for that publication, other libraries that receive the publication do not create additional MARC records—the other libraries instead rely on the original MARC record. They may update or revise the MARC record to ensure accuracy, but they do not replace or duplicate it. This practice does more than save libraries from duplicating labor. It also enhances the accuracy of MARC records. Further, it allows librarians around the world to know that a particular MARC record is authoritative (in contrast, a hypothetical system wherein duplicative records were created would result in confusion as to which record is authoritative).

18. The date of creation of the MARC record by a cataloger at an OCLC member institution reflects when the underlying item is accessible to the public. Upwards of two-thirds to three-quarters of book sales to libraries come from a

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[5] In this report, I sometimes refer to the "Entered" entry as field 008, characters 00-05.

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jobber or wholesaler for online and print resources. These resellers make it their business to provide books to their customers as fast as possible, often providing turnaround times of only a single day after publication. Libraries purchase a significant portion of the balance of their books directly from publishers themselves, which provide delivery on a similarly expedited schedule. In general, libraries make these purchases throughout the year as the books are published and shelve the books as soon thereafter as possible in order to make the books available to their patrons. Thus, books are generally available at libraries across the country within just a few days of publication.

19. Catalogers can create MARC records for all types of print, online, and digital resources. For example, MARC records cover serial publications, including both serially-published monographs and journals. OCLC hosts MARC records for more than 320 million serial publications. Serial publications are those publications that have the same collective title but are intended to be continued indefinitely with enumeration such as a volume or issue number (*e.g.*, magazines, journals, etc.). In the OCLC Connexion database, the first issue of the serial publication is typically cataloged (*i.e.*, a corresponding MARC record is created), but the date is left open-ended with the use of a punctuation mark such as a dash. OCLC serial publication MARC records represent the entire run of the serial title. With knowledge of the first issue published, future issues can be predicted based

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on the information provided in the MARC record, for example in field 362. In my extensive professional experience, is it highly unusual for a library to stop collecting and shelving a serial publication prior to the end of its publication run. If a subscription to a serial publication ends its run or is cancelled before the end of its run, the library will denote that it has stopped receiving new volumes by filling in the end date in the MARC record.

20. The handling of printed journal subscriptions is shown on the covers of individual issues. As was the best practice among libraries, issues arrived at a central facility and were immediately received, verified as part of a subscription, checked in, and stamped with the institution's name and date. Determining that the issue was part of the library subscription ensured that the entire set of publications for the year had been received so that they could be professionally bound and retained. This process also verified that all of the published issues arrived so that the library staff did not have to request or claim an issue that did not arrive as expected. In large public libraries with branches and multi-campus libraries within academic institutions, the journals were sorted and delivered to the subscribing unit. The issues were frequently stamped again to acknowledge receipt. The new issue was placed in the public area; the older issue was stored so that it remained available.

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21. The foregoing process has been standard library practice longer than I have been working in the profession. I first learned the steps in the process in the late 1970s and later supervised it. Although the checking in process has become automated and now links electronically to holdings records for the MARC record for each serial title, the manual stamping and placing the issue in a public area has not changed for 50 years. Unless I note otherwise below in reference to a specific serial publication, it is my expert opinion that this standard protocol was followed for each of the serial publications discussed below.

22. In preparing this report, I used authoritative databases, such as the OCLC Connexion database and the Library of Congress Online Catalog, to confirm citation details of the various publications discussed. Unless I note otherwise below in reference to a specific serial publication, it is my expert opinion that this standard protocol was followed for each of the serial publications discussed below.

23. *Indexing.* A researcher may discover material relevant to his or her topic in a variety of ways. One common means of discovery is to search for relevant information in an index of periodical and other publications. Having found relevant material, the researcher will then normally obtain it online, look for it in libraries, or purchase it from the publisher, a bookstore, a document delivery service, or other provider. Sometimes, the date of a document's public

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accessibility will involve both indexing and library date information. However, date information for indexing entries is often unavailable. This is especially true for online indices.

24. Indexing services use a wide variety of controlled vocabularies to provide subject access and other means of discovering the content of documents. The formats in which these access terms are presented vary from service to service.

25. Online indexing services commonly provide bibliographic information, abstracts, and full-text copies of the indexed publications, along with a list of the documents cited in the indexed publication. These services also often provide lists of publications that cite a given document. A citation of a document is evidence that the document was publicly available and in use by researchers no later than the publication date of the citing document.

26. Prominent indexing services include the following:

27. *ACM Digital Library*. This index is produced by the Association for Computing Machinery, the world's largest scientific and educational computing society. AMC Digital Library contains the full text of all AMC publications, hosted full-text publications from selected publishers, and the ACM Guide to Computing Literature—a comprehensive bibliography of computing literature beginning in the 1950s with more than a million entries. All metadata in the

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database are freely available on the Web, including abstracts, linked references, citing work, and usage statistics. Full-text articles are available with subscription.

28. *IEEE Xplore*. This scholarly research database includes indexes, abstracts, and full-text for articles and papers on computer science, electrical engineering, and electronics. The database mainly covers material from the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Engineering and Technology. The IEEE *Xplore* digital library provides Web access to more than 4.3-million full-text documents from some of the world's most highly cited publications. The content comprises over 180 journals, over 1,400 conference proceedings, more than 3,800 technical standards, over 1,800 eBooks and over 400 educational courses. Approximately 20,000 new documents are added to IEEE Xplore each month. Abstracts are free to access, but access to full text requires a subscription or institutional login.

IV. PRELIMINARIES

29. *Scope of this declaration.* I am not an attorney and will not offer opinions on the law. I am, however, rendering my expert opinion on the authenticity of the documents referenced herein and on when and how each of these documents was disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising

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reasonable diligence, could have located the documents before December 11, 2001, which is the filing date of U.S. Patent No. 6,557,540.

30. I am informed by counsel that a printed publication qualifies as publicly accessible as of the date it was disseminated or otherwise made available such that a person interested in and ordinarily skilled in the relevant subject matter could locate it through the exercise of ordinary diligence.

31. While I understand that the determination of public accessibility under the foregoing standard rests on a case-by-case analysis of the facts particular to an individual publication, I also understand that a printed publication is rendered "publicly accessible" if it is cataloged and indexed by a library such that a person interested in the relevant subject matter could locate it (*i.e.*, I understand that cataloging and indexing by a library is sufficient, though there are other ways that a printed publication may qualify as publicly accessible). One manner of sufficient indexing is indexing according to subject matter category. I understand that the cataloging and indexing by a single library of a single instance of a particular printed publication is sufficient, even if the single library is in a foreign country. I understand that, even if access to a library is restricted, a printed publication that has been cataloged and indexed therein is publicly accessible so long as a presumption is raised that the portion of the public concerned with the relevant subject matter would know of the printed publication. I also understand that the

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cataloging and indexing of information that would guide a person interested in the relevant subject matter to the printed publication, such as the cataloging and indexing of an abstract for the printed publication, is sufficient to render the printed publication publicly accessible.

32. I understand that routine business practices, such as general library cataloging and indexing practices, can be used to establish an approximate date on which a printed publication became publicly accessible.

33. *Persons of ordinary skill in the art.* I am told by counsel that the subject matter of this proceeding generally relates to the automotive industry, and more specifically to, an engine system that comprises a method to calculate a valve timing command.

34. I have been informed by counsel that a "person of ordinary skill in the art at the time of the inventions" is a hypothetical person who is presumed to be familiar with the relevant field and its literature at the time of the inventions. This hypothetical person is also a person of ordinary creativity, capable of understanding the scientific principles applicable to the pertinent field.

35. I am told by counsel that persons of ordinary skill in this subject matter or art would have had a Bachelor's degree in electrical engineering and at least 4-5 years of work experience in automotive electrical or electronics systems

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design, or would have had a Master's degree in electrical engineering and at least 2 years of work experience in automotive electrical or electronics systems design.

36. It is my opinion that such a person would have been engaged in research, learning though study and practice in the field and possibly through formal instruction the bibliographic resources relevant to his or her research. In the time before the filing date of the '540 patent, such a person would have had access to a vast array of long-established print resources in the design, specification, or manufacturing of internal combustion engines or similar devices, as well as to a rich set of online resources providing indexing information, abstracts, and full text services for design, specification, or manufacturing of internal combustion engines or similar devices.

V. DOCUMENT 1: EXHIBIT 1005 ("JANKOVIC")

37. Document 1 is a true and correct copy of Volume 46, Number 2 of the journal *IEEE Control Systems* found in the Library of Congress. The article "Torque Management of Engines with Variable Cam Timing," by Mrdjan Jankovic, Florian Frischmuth, Anna Stefanopoulou, and Jeffrey A. Cook appears beginning on page 34 of this issue dated October 1998. The exhibit filed in this proceeding as Exhibit 1005 (hereinafter "Jankovic") is a true and correct partial copy of Document 1. Specifically, the text of Exhibit 1005 comprises all pages that constitute the article (Ex. 1005 at 1-9). The text of Exhibit 1005 is complete within

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the aforementioned range of pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 1, which comprises Exhibit 1005, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 1 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1005 is a true and correct partial copy of Document 1.

38. Attached hereto as Exhibit 1033 is a true and correct copy of the MARC record for the journal *IEEE Control Systems* at the Library of Congress. The library ownership is indicated by the presence of the library's code (DLC) in the 035 field. I personally identified and retrieved the MARC record that is Exhibit 1033. As noted in the holdings information, the Library of Congress has received the journal *IEEE Control Systems* since March 1981 and continues to receive the publication.[6] In view of the MARC record for Exhibit 1005, the Jankovic article was publicly available no later than October 31, 1998, because the

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[6] The journal began publication as *Control Systems Magazine* (March 1981-November 1984). The title changed to *IEEE Control Systems Magazine* (February 1985-December 1990). The journal adopted its current name *IEEE Control Systems* in January 1991.

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serial title had been cataloged and indexed at the Library of Congress and made part of its online catalog database.

39. Attached hereto as Exhibit 1034 is a true and correct copy of the MARC record for the journal *IEEE Control Systems* obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1034. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1034, that library code is "NYG," which means that the MARC record for this serial was cataloged at the New York State Library. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the New York State Library created OCLC record number 26522522 on September 2, 1992. The "BLvl" entry in Exhibit 1034 is "s," which indicates that the journal *IEEE Control Systems* is a serial publication. Field 310 of Exhibit 1034 reads "Bimonthly, 1994-." The two Field 321 entries of Attachment 1b indicate that the frequency varied, seven times a year (1991) and six times a year (1992-1993). Accordingly, the MARC record for Exhibit 1005 corresponds to those issues of the journal *IEEE Control Systems* from the time of the serial title began publication under the current title in January 1991 to the present day.

40. Exhibit 1034 further includes an entry in field 050 ("TJ212 ‡b .C69") as described above, this includes a subject matter classification number consistent

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with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1034 further includes an entry in field 082 ("629"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1034 further includes an English language field 650 entry reading "Automatic control ‡v Periodicals." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1034 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 060 entry, and the field 650 entry. Further, as of September 2, 1992, the MARC record attached hereto as Exhibit 1034 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library regularly subscribed to this serial, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

41. Exhibit 1034 indicates that the journal *IEEE Control Systems* as cataloged at the New York State Library is currently available from 268 libraries. In view of above, this issue of the journal *IEEE Control Systems* was publicly available no later than September 2, 1992, because by that date it had been cataloged and indexed at the New York State Library, made part of the OCLC Connexion database, and received at the Library of Congress. For these reasons, I

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find that Exhibit 1005 was published and accessible to the public no later than October 31, 1998.

VI. DOCUMENT 2: EXHIBIT 1006 ("AIRD")

42. Document 2 is a true and correct copy of a book, *Bosch Fuel Injection Systems,* 1st edition, by Forbes Aird and published by HP Books with a 2001 copyright date. The exhibit filed in this proceeding as Exhibit 1006 is a true and correct partial copy of Document 2 (hereafter "Aird"). Specifically, the text of Exhibit 1006 comprises all pages leading up to Chapter 1 of Document 2 (Ex. 1006 at 1-6), all pages that constitute Chapter 2 of Document 2 (Ex. 1006 at 7-24), and pages 134-137 of Document 2 (Ex. 1006 at 25-28). The text of Exhibit 1006 is complete within the aforementioned range of Chapters and pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 2, which comprises Exhibit 1006, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 2 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1006 is a true and correct partial copy of Document 2.

43. Attached hereto as Exhibit 1021 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership is indicated by the presence of the library's code (DLC) in the 040 field. I

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personally identified and retrieved the library catalog record which is Exhibit 1021.

44. Based on finding a print copy of Document 2 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1021, it is my opinion that *Bosch Fuel Injection Systems,* by Aird (Document 2 and Exhibit 1006) was available in the Library of Congress as of September 19, 2002, as shown in Field 008.

45. Attached hereto as Exhibit 1022 is a true and correct copy of the MARC record for *Bosch Fuel Injection Systems* by Aird obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1022. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1022, that library code is "EYB," which means that the MARC record for this book was created at the Suburban Library Cooperative (Sterling Heights, Michigan). The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Suburban Library Cooperative created OCLC record number 47389322 on September 19, 2002.

46. Exhibit 1022 further includes an entry in field 050 ("TL214.F78 ‡b A47 2001")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to

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the Dewey Decimal System). Exhibit 1022 further includes an entry in field 082 ("629.253"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1022 further includes an English language field 650 entry reading "Automobiles ‡x Motors ‡x Fuel injection systems." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1022 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of September 19, 2002, the MARC record attached hereto as Exhibit 1022 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

47. Exhibit 1022 indicates that the book *Bosch Fuel Injection Systems,* by Aird (Document 2 and Exhibit 1006) as cataloged at the Library of Congress is currently available from 33 libraries. In view of above, this book was publicly available no later than September 19, 2002, because by that date it had been cataloged and indexed at the Library of Congress, made part of the OCLC Connexion database, and received at the Library of Congress. For these reasons, I find that Exhibit 1006 was published and accessible to the public no later than

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VII. DOCUMENT 3: EXHIBIT 1007 ("PROBST")

48. Document 3 is a true and correct copy of a book, *Bosch Fuel Injection & Engine Management,* by Charles O. Probst and issued by Bentley Publishers with a 1989 copyright date. The exhibit filed in this proceeding as Exhibit 1007 is a true and correct partial copy of Document 3 (hereafter "Probst").Specifically, the text of Exhibit 1007 comprises all pages leading up to Chapter 1 of Document 3 (Ex. 1007 at 1-8), all pages that constitute Chapter 2 of Document 3 (Ex. 1007 at 9-26), all pages that constitute Chapter 3 of Document 3 (Ex. 1007 at 27-68), and all pages that constitute Chapter 5 of Document 3 (Ex. 1007 at 69-104). The text of Exhibit 1007 is complete within the aforementioned range of Chapters and pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 3, which comprises Exhibit 1007, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 3 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1007 is a true and correct partial copy of Document 3.

49. Attached hereto as Exhibit 1019 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership

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is indicated by the presence of the library's code (DLC) in the 040 field. I personally identified and retrieved the library catalog record which is Exhibit 1019.

50. Based on finding a print copy of Document 3 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1019, it is my opinion that *Bosch Fuel Injection & Engine Management* by Probst (Document 3 and Exhibit 1007) was available in the Library of Congress as of May 26, 1989, as shown in Field 008.

51. Attached hereto as Exhibit 1020 is a true and correct copy of the MARC record for *Bosch Fuel Injection & Engine Management* by Probst obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1020. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1020, that library code is "DLC," which means that the MARC record for this book was created at the Library of Congress. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 21265250 on May 26, 1989.

52. Exhibit 1020 further includes an entry in field 050 ("TL214.F78 ‡b P76 1989")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to

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the Dewey Decimal System). Exhibit 1020 further includes an entry in field 082 ("629.253"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1020 further includes two English language field 650 entries reading "Automobiles ‡x Motors ‡x Fuel injection systems" and "Automobiles ‡x Motors ‡x Fuel injection systems ‡x Maintenance and repair." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1020 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entries. Further, as of May 26, 1989, the MARC record attached hereto as Exhibit 1020 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

53. Exhibit 1020 indicates that the book *Bosch Fuel Injection & Engine Management* by Probst (Document 3 and Exhibit 1007) as cataloged at the Library of Congress is currently available from 96 libraries. In view of above, this book was publicly available no later than May 26, 1989, because by that date it had been cataloged and indexed at the Library of Congress, made part of the OCLC Connexion database, and received at the Library of Congress. For these reasons, I

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find that Exhibit 1007 was published and accessible to the public no later than May 26, 1989.

VIII. DOCUMENT 4: EXHIBIT 1008 ("STEFANOPAULO")

54. Document 4 is a true and correct copy of a dissertation, *Modeling and Control of Advanced Technology Engines* by Anna Stefanopoulou, and issued by University of Michigan with a 1996 copyright date. The exhibit filed in this proceeding as Exhibit 1008 is a true and correct partial copy of Document 4 (hereafter "Stefanopoulou"). Specifically, the text of Exhibit 1008 comprises all pages leading up to Chapter 1 of Document 4 (Ex. 1008 at 1-12), and all pages that constitute Chapter 1 of Document 4 (Ex. 1008 at 13-22). The text of Exhibit 1008 is complete within the aforementioned range of pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 4, which comprises Exhibit 1008, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 4 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1008 is a true and correct partial copy of Document 4.

55. Attached hereto as Exhibit 1031 is a true and correct copy of the MARC record for this dissertation from the University of Michigan Library. The library ownership is indicated by the presence of the library's code (MiU) in the

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040 field. I personally identified and retrieved the library catalog record which is Exhibit 1031.

56. Based on finding a print copy of Document 4 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1031, it is my opinion that *Modeling and Control of Advanced Technology Engines* by Stefanopoulou (Document 4 and Exhibit 1008) was available in the University of Michigan Library as of June 27, 1996, as shown in Field 008.

57. Attached hereto as Exhibit 1032 is a true and correct copy of the MARC record for *Modeling and Control of Advanced Technology Engines* by Stefanopoulou obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1032. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1032, that library code is "AD#," which means that the MARC record for this book was created at the Naval Postgradute School (San Diego, CA). The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Naval Postgraduate School Library created OCLC record number 49862211 on May 24, 2002.

58. Exhibit 1032 further includes an entry in field 050 ("TJ250 ‡b .S74 1996") as described above, this includes a subject matter classification number

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consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1032 further includes an English language field 650 entry reading "Engines." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1032 was indexed according to its subject matter by virtue of at least two independently sufficient classifications: the field 050 entry and the field 650 entry. Further, as of May 24, 2002, the MARC record attached hereto as Exhibit 1032 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

59. Exhibit 1032 indicates that the book *Modeling and Control of Advanced Technology Engines* by Stefanopoulou (Document 3 and Exhibit 1008) as cataloged at the Naval Postgraduate School Library is currently available from 2 libraries. In view of above, this book was publicly available no later than June 27, 1996, because by that date it had been received, cataloged, and indexed at the University of Michigan Library. For these reasons, I find that Exhibit 1008 was published and accessible to the public no later than June 27, 1996.

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IX. DOCUMENT 5: EXHIBIT 1009 ("TOBOLDT")

60. Document 5 is a true and correct copy of a book, *Automotive Encyclopedia,* edited by William K. Toboldt and Larry Johnson and issued by The Goodheart-Wilcox Company, Inc. Publishers with a 1979 copyright date. The exhibit filed in this proceeding as Exhibit 1009 is a true and correct partial copy of Document 5 (hereafter "Toboldt"). Specifically, the text of Exhibit 1009 comprises all pages leading up to Chapter 1, which is entitled "Automotive Tools," of Document 5 (Ex. 1009 at 1-6), and all pages that constitute Chapter 21, which is entitled "Principles of Carburetion" of Document 5 (Ex. 1009 at 7-30). The text of Exhibit 1009 is complete within the aforementioned range of chapters and pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 5, which comprises Exhibit 1009, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 5 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1009 is a true and correct partial copy of Document 5.

61. Attached hereto as Exhibit 1023 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership

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is indicated by the presence of the library's code (DLC) in the 040 field. I personally identified and retrieved the library catalog record which is Exhibit 1023.

62. Based on finding a print copy of Document 5 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1023, it is my opinion that *Automotive Encyclopedia,* by Toboldt (Document 5 and Exhibit 1009) was available in the Library of Congress as of October 25, 1979, as shown in Field 008.

63. Attached hereto as Exhibit 1024 is a true and correct copy of the MARC record for *Automotive Encyclopedia,* by Toboldt obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1024. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1024, that library code is "DLC," which means that the MARC record for this book was created at the Library of Congress. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 4593063 on December 20, 1978.

64. Exhibit 1024 further includes an entry in field 050 ("TL205 ‡b .G66 1979") as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the

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Dewey Decimal System). Exhibit 1024 further includes an entry in field 082 ("629.2222"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1024 further includes two English language field 650 entries reading "Automobiles" and "Automobiles ‡x Maintenance and repair." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1024 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entries. Further, as of December 20, 1978, the MARC record attached hereto as Exhibit 1024 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

65. Exhibit 1024 indicates that the book *Automotive Encyclopedia,* by Toboldt (Document 5 and Exhibit 1009) as cataloged at the Library of Congress is currently available from 97 libraries. In view of above, this book was publicly available no later than December 20, 1978, because by that date it had been received, cataloged, and indexed at the Library of Congress and made part of the OCLC Connexion database. For these reasons, I find that Exhibit 1009 was published and accessible to the public no later than December 20, 1978.

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X. DOCUMENT 6: EXHIBIT 1010 ("BOSCH")

66. Document 6 is a true and correct copy of a book, *Bosch Automotive Handbook,* 5th revised and extended edition, edited by Horst Bauer and issued by Robert Bosch GmbH with a 2000 copyright date. The exhibit filed in this proceeding as Exhibit 1010 is a true and correct partial copy of Document 6 (hereafter "Bosch"). Specifically, the text of Exhibit 1010 comprises all pages leading up to Chapter 1, which is entitled "Basic Principles, Physics" of Document 6 (Ex. 1010 at 1-6), all pages that constitute Chapter 1, Section 7, which is entitled "Heat," of Document 6 (Ex. 1010 at 7-8), and all pages that constitute Chapter 13, which is entitled "Engine Management Spark-Ignition (SI) Engines" of Document 6 (Ex. 1010 at 9-41). The text of Exhibit 1010 is complete within the aforementioned range of chapters and pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 6, which comprises Exhibit 1010, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 6 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1010 is a true and correct partial copy of Document 6.

67. Attached hereto as Exhibit 1025 is a true and correct copy of the MARC record for this book from the San Francisco Public Library. The library

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ownership is indicated by the presence of the library's code (SFR) in the 040 field. I personally identified and retrieved the library catalog record which is Exhibit 1025.

68. Based on finding a print copy of Document 6 in the San Francisco Public Library and MARC record in its online library catalog attached as Exhibit 1025, it is my opinion that *Bosch Automotive Handbook,* by Bosch (Document 6 and Exhibit 1010) was available in the Library of Congress as of January 15, 2001, as shown in Field 008.

69. Attached hereto as Exhibit 1026 is a true and correct copy of the MARC record for *Bosch Automotive Handbook,* by Bosch obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1026. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1026, that library code is "DLC," which means that the MARC record for this book was created at the Library of Congress. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 1001864331 on January 15, 2001.

70. Exhibit 1026 further includes an entry in field 050 ("TL151 ‡b .A98 2000")—as described above, this includes a subject matter classification number

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consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1026 further includes an entry in field 082 ("629.2872 ‡b Au825 2000"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1026 further includes two English language field 650 entry reading "Automobiles ‡x Maintenance and repair ‡v Handbooks, manuals, etc." and "Automobiles ‡x Design and construction ‡v Handbooks, manuals, etc." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1026 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entries. Further, as of January 15, 2001, the MARC record attached hereto as Exhibit 1026 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

71. Exhibit 1026 indicates that the book *Bosch Automotive Handbook,* by Bosch (Document 6 and Exhibit 1010) as cataloged at the Library of Congress is currently available from 296 libraries. In view of above, this book was publicly available no later than January 15, 2001, because by that date it had been received, cataloged, and indexed at the Library of Congress and made part of the OCLC

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Connexion database. For these reasons, I find that Exhibit 1010 was published and accessible to the public no later than January 15, 2001.

XI. DOCUMENT 7: EXHIBIT 1012 ("JURGEN")

72. Document 7 is a true and correct copy of a book, *Automotive Electronics Handbook,* edited by Ronald K. Jurgen and issued by McGraw Hill in 1994. The exhibit filed in this proceeding as Exhibit 1012 is a true and correct partial copy of Document 7 (hereafter "Jurgen"). Specifically, the text of Exhibit 1012 comprises all pages leading up to Chapter 1 of Document 7 (Ex. 1012 at 1-19), all pages that constitute Chapter 1 of Document 7 (Ex. 1012 at 20-23), and all pages that constitute Chapter 2 of Document 7 (Ex. 1012 at 24-47). The text of Exhibit 1012 is complete within the aforementioned range of chapters and pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 7, which comprises Exhibit 1012, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 7 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1012 is a true and correct partial copy of Document 7.

73. Attached hereto as Exhibit 1017 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership

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is indicated by the presence of the library's code (DLC) in the 040 field. I personally identified and retrieved the library catalog record which is Exhibit 1017.

74. Based on finding a print copy of Document 7, which comprises Exhibit 1012, in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1017, it is my opinion that the *Automotive Electronics Handbook,* edited by Jurgen (Document 7 and Exhibit 1012) was available in the Library of Congress as of October 5, 1994, as shown in Field 008.

75. Attached hereto as Exhibit 1018 is a true and correct copy of the MARC record for the *Automotive Electronics Handbook,* edited by Jurgen obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1018. As previously noted, the library that created the record is recorded in field 040 with a unique library code. Exhibit 1018, that library code is "DLC," which means that the MARC record for this book was created at the Library of Congress. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 31375278 on October 5, 1994.

76. Exhibit 1018 further includes an entry in field 050 ("TL272.5 ‡b .A982 1995")—as described above, this includes a subject matter classification

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number consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1018 further includes an entry in field 082 ("629.2549"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1018 further includes an English language field 650 entry reading "Automobiles ‡x Electronic equipment." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1018 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of October 5, 1994, the MARC record attached hereto as Exhibit 1018 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

77. Exhibit 1018 indicates that the book *Automotive Electronics Handbook,* edited by Jurgen (Document 7 and Exhibit 1012) as cataloged at the Library of Congress is currently available from 255 libraries. In view of above, this book was publicly available no later than October 5, 1994, because by that date it had been cataloged and indexed at the Library of Congress, made part of the OCLC Connexion database, and received at the Library of Congress. For these

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reasons, I find that Exhibit 1012 was published and accessible to the public no later than October 5, 1994.

XII. DOCUMENT 8: EXHIBIT 1013 ("MCGRAW-HILL ELECTRONICS DICTIONARY")

78. Document 8 is a true and correct copy of a book, *McGraw-Hill Electronics Dictionary,* by Neil Sclater and John Markus and issued by McGraw-Hill with a 1997 copyright date. The exhibit filed in this proceeding as Exhibit 1013 is a true and correct partial copy of Document 8 (hereafter "Sclater"). Specifically, the text of Exhibit 1013 comprises all pages leading up to the table of contents of Document 8 (Ex. 1013 at 1-11), the page that corresponds to the term definition for "Error signal" of Document 8 (Ex. 1013 at 12), the page that corresponds to the term definition for "Feedback controller" of Document 8 (Ex. 1013 at 13), and the page that corresponds to the term definition for "Feed forward control" of Document 8 (Ex. 1013 at 14). The text of Exhibit 1010 is complete within the aforementioned range of pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 8, which comprises Exhibit 1013, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 8 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1013 is a true and correct partial copy of Document 8.

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79. Attached hereto as Exhibit 1027 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership is indicated by the presence of the library's code (DLC) in the 040 field. I personally identified and retrieved the library catalog record which is Exhibit 1027.

80. Based on finding a print copy of Document 8 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1027, it is my opinion that *McGraw-Hill Electronics Dictionary*, by Sclater (Document 8 and Exhibit 1013) was available in the Library of Congress as of April 14, 1997, as shown in Field 008.

81. Attached hereto as Exhibit 1028 is a true and correct copy of the MARC record for *McGraw-Hill Electronics Dictionary*, by Sclater obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1028. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1028, that library code is "DLC," which means that the MARC record for this book was created at the Library of Congress. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Library of Congress created OCLC record number 36767742 on April 14, 1997.

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82. Exhibit 1028 further includes an entry in field 050 ("TK7804 ‡b .M354 1997")—as described above, this includes a subject matter classification number consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1028 further includes an entry in field 082 ("621.3803"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1028 further includes an English language field 650 entry reading "Electronics ‡v Dictionaries." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1028 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entry. Further, as of April 14, 1997, the MARC record attached hereto as Exhibit 1028 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

83. Exhibit 1028 indicates that the book *McGraw-Hill Electronics Dictionary*, by Sclater (Document 8 and Exhibit 1013) as cataloged at the Library of Congress is currently available from 399 libraries. In view of above, this book was publicly available no later than April 14, 1997, because by that date it had been received, cataloged, and indexed at the Library of Congress and made part of

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the OCLC Connexion database. For these reasons, I find that Exhibit 1013 was published and accessible to the public no later than April 14, 1997.

XIII. Document 9: EXHIBIT 1014 ("Oxford Dictionary")

84. Document 9 is a true and correct copy of a book, *The New Shorter Oxford English Dictionary*, edited by Lesley Brown and published by Oxford University Press Inc. with a 1993 copyright date. The exhibit filed in this proceeding as Exhibit 1014 is a true and correct partial copy of Document 9 (hereafter "Oxford Dictionary"). Specifically, the text of Exhibit 1014 comprises all pages leading up to the table of contents of Document 9 (Ex. 1014 at 1-3), and the page that corresponds to the term definition for "Command" of Document 9 (Ex. 1014 at 4). The text of Exhibit 1014 is complete within the aforementioned range of pages; no pages are missing, and the text on each page appears to flow seamlessly from one page to the next; further, there are no visible alterations to the document. Document 9, which comprises Exhibit 1014, was found within the custody of a library – a place where, if authentic, a copy of this book would likely be. Document 9 is a true and correct copy in a condition that creates no suspicion about its authenticity, and Exhibit 1014 is a true and correct partial copy of Document 9.

85. Attached hereto as Exhibit 1029 is a true and correct copy of the MARC record for this book from the Library of Congress. The library ownership

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is indicated by the presence of the library's code (DLC) in the 035 field. I personally identified and retrieved the library catalog record which is Exhibit 1029.

86. Based on finding a print copy of Document 9 in the Library of Congress and MARC record in its online library catalog attached as Exhibit 1029, it is my opinion that *The New Shorter Oxford English Dictionary,* by Oxford University Press (Document 9 and Exhibit 1014) was available in the Library of Congress as of November 17, 1993, as shown in Field 008.

87. Attached hereto as Exhibit 1030 is a true and correct copy of the MARC record for *The New Shorter Oxford English Dictionary*, by Oxford University Press obtained from the OCLC Connexion database. I personally identified and retrieved the MARC record that is Exhibit 1030. As previously noted, the library that created the record is recorded in field 040 with a unique library code. For Exhibit 1030, that library code is "OCo," which means that the MARC record for this book was created at the Columbus Metropolitan Library. The library continues to update this MARC record and enhanced the MARC record to meet current cataloging rules. As can be seen in the "Entered" field in the MARC record for this exhibit, a cataloger at the Columbus Metropolitan Library created OCLC record number 29470987 on October 20, 1994.

88. Exhibit 1030 further includes an entry in field 050 ("PE1625 ‡b .N539 1993")—as described above, this includes a subject matter classification number

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consistent with the Library of Congress classification system (analogous to the Dewey Decimal System). Exhibit 1030 further includes an entry in field 082 ("423"), a subject matter consistent with the Dewey Decimal Classification System. Exhibit 1030 further includes two English language field 650 entries reading "English language ‡v Dictionaries" and "English language ‡x Etymology ‡v Dictionaries." Thus, as of its cataloging, the publication corresponding to the MARC record attached hereto as Exhibit 1030 was indexed according to its subject matter by virtue of at least three independently sufficient classifications: the field 050 entry, the field 082 entry, and the field 650 entries. Further, as of October 20, 1994, the MARC record attached hereto as Exhibit 1030 was accessible through any library with access to the OCLC Connexion database or the online catalog at a library, which means that the corresponding publication was publicly available on or before that same date through any library with access to the OCLC Connexion database or through an individual library.

89. Exhibit 1030 indicates that the book *The New Shorter Oxford English Dictionary*, by Oxford University Press (Document 9 and Exhibit 1014) as cataloged at the Library of Congress is currently available from 1,653 libraries. In view of above, this book was publicly available no later than October 20, 1994, because by that date it had been received, cataloged, and indexed at the Library of Congress and made part of the OCLC Connexion database by October 20, 1994.

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For these reasons, I find that Exhibit 1014 was published and accessible to the public no later than November 17, 1993.

XIV. SUMMARY OF OPINIONS

90. In view of the foregoing, it is my opinion that the publication described above were publicly available no later than the corresponding date listed in the table below:

Exhibit	Publication	Publicly Available No Later Than
1005	Jankovic, Mrdjan, Florian Frischmuth, Anna Stefanopoulou, and Jeffrey A. Cook. "Torque Management of Engines with Variable Cam Timing." *IEEE Control Systems*, vol. 18, issue 5 (October 1998): 34-42.	October 31, 1998
1006	Aird, Forbes. *Bosch Fuel Injection Systems.* 1st ed. New York: HP Books, ©2001.	September 19, 2002
1007	Probst, Charles O. *Bosch Fuel Injection & Engine Management*. Cambridge, MA: Bentley Publishers, 1991, c1989.	May 26, 1989
1008	Stefanopoulou, Anna G. *Modeling and Control of Advanced Technology Engines*. Dissertation. Preface and Chapter 1. Ann Arbor, MI: University of Michigan, c1996.	June 27, 1996
1009	*Goodheart-Willcox Automotive Encyclopedia: Fundamental Principles, Operation, Construction, Service, Repair*. Edited by William K. Toboldt and Larry Johnson. South Holland, IL: Goodheart-Wilcox Co. Inc., c1979.	December 29, 1978
1010	*Bosch Automotive Handbook*. Horst Bauer, editor-in-chief. 5th ed., rev. and extended. Stuttgart, Germany: Robert Bosch GmbH ; Warrendale, PA: Distributed by SAE, Society of Automotive Engineers, 2000.	January 15, 2001
1012	*Automotive Electronics Handbook*. Ronald K. Jurgen, editor-in-chief. New York: McGraw-Hill,	October 5, 1994

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Exhibit	Publication	Publicly Available No Later Than
	1995, c1994.	
1013	Sclater, Neil, and John Markus. *McGraw-Hill Electronics Dictionary*. 6th ed. New York: McGraw-Hill, 1997.	April 14, 1997
1014	*The New Shorter Oxford English Dictionary*, edited by Lesley Brown. 2 vols. New York: Oxford University Press, c1993.	November 17, 1993

91. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

92. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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DATED: May 14, 2018

By: Dr. Sylvia D. Hall-Ellis
Dr. Sylvia D. Hall-Ellis

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CURRICULUM VITAE
SYLVIA D. HALL-ELLIS

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EDUCATION

Ph.D., University of Pittsburgh, Pittsburgh, Pennsylvania, 1985
M.P.S., University of Denver, Denver, Colorado, 2014
Post Graduate Studies, University of Texas – San Antonio, Texas, 1975-1976
M.L.S., University of North Texas, Denton, Texas, 1972
B.A., Rockford University, Rockford, Illinois, 1971

PROFESSIONAL EXPERIENCE

1981- **Consultant for higher education, non-profit organizations, and corporations.**

2002- **Adjunct Professor, School of Information, San José State University, San José, California.** Serve as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), "core courses," and special topics.

2014-2016 **Director, Grants and Resource Development, Colorado Community College System.** Provided leadership and vision to foster the continued growth of rigorous scholarship, innovative projects, and creative work for statewide system, 13 campuses, and 50 teaching sites serving 155,000 students. Responsible for leadership and ensured efficient functioning of contract and grants in compliance with state & federal requirements and successful implementation and management. Served as a subject matter expert and liaison for college Grant Directors for all issues relating to grants and subcontracts.

2010-2014 **Senior Grant Administrator, Morgridge College of Education, University of Denver (Colorado).** Provided leadership and vision to foster continued growth of rigorous scholarship, innovative research, and creative work in the Morgridge College of Education. Ensure that contract and grants processes function effectively and efficiently for 60 faculty and researchers with a focus on the successful progression and efficient management of grants totaling $13M. Worked effectively and collegially with Department Chairs and Program Coordinators on operational grant-related management activities and with a broad range of internal and external constituencies. Supported the dissemination and promotion of faculty research and scholarship to outside constituents at conferences and through publications. Assisted Principal Investigators and grant project teams by coaching, mentoring, and financial management.

2011-2013 **Interim Director & Assistant Dean, Westminster Law Library, Sturm College of Law, University of Denver.** Planned, organized, and directed all administrative activities for the library serving students, faculty, and alumni; oversaw the employment, retention, promotion, transfer and termination of library personnel; represented the library at professional conferences and public meetings; created and promoted a climate and culture of acceptance for new programs and services, a positive high-quality image of the law library, and that reflect the organization's values, encourage excellent performance, and reward high productivity and innovation; provided leadership and set strategic direction of the organization; ensured that the library provided excellent customer service through solution-oriented staff response to patron needs and by responsiveness and continuous improvement of the organization; promoted, developed, and maintained positive working relationships with colleagues and customers including key stakeholders and groups, higher education institutions, the legal community, other regional libraries and districts statewide, and national library organizations.

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2007-2014 **Associate Professor, Library & Information Science, Morgridge College of Education, University of Denver (Colorado).** Served in leadership role and worked collaboratively in program, college, campus and community environments. Advised and supervised students, taught core and specialized courses at the graduate level in an integrative, student-centered learning environment. Served on LIS, College, and University committees, and maintained working relationships with colleagues in other academic units and information professionals in the Rocky Mountain region and beyond. Served on and chair doctoral student dissertation committees. Oversaw and facilitated the College and LIS graduate student association.

2002-2007 **Assistant Professor, Library & Information Science, College of Education, University of Denver (Colorado).** Served as tenure-track faculty member teaching graduate students in "core courses," resource description and access, service learning, and independent studies. Advised graduate students, participate on LIS and College committees, and serve on doctoral student dissertation committees. Oversaw and facilitated the LIS graduate student association and alumni association.

2000-2002 **Affiliate Faculty, Library & Information Science, College of Education, University of Denver (Colorado).** Served as part-time faculty member teaching graduate students in technical services (cataloging, bibliographic control, classification), "core courses," and special topics. Oversaw and facilitated the LIS graduate student association and alumni association.

2000-2001 **Special Assistant to the Secretary's Regional Representative, U.S. Department of Education, Region VIII, Denver, Colorado.** Served as the principal advisor and representative of the U. S. Secretary of Education's Regional Representative (SRR). Ensured the implementation of major goals of the SRR and the Secretary. Provided leadership on behalf of the SRR in contacts with high-level officials in Region VIII requiring sensitive policy interpretation in communication with senior Department officials to solve problems and resolve issues raised by State and local education officials. Served as the primary contact for School-to-Work/Career, Children's Health Insurance Program, and Safe and Drug-Free Schools. Delivered technical assistance to local education agencies and institutions of higher education in technology, professional development, and school construction.

1999-2000 **Catalog Librarian, Jefferson County Public Library, Lakewood, Colorado.** Performed original, copy cataloging and classification of library materials (English and Spanish) using standard library protocols; completed original descriptive cataloging and subject analysis; enhanced brief catalog and authority records in III.

1997-1999 **Development Officer, McREL International, Aurora, Colorado.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for educational agencies. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.

1995-1997 **Education Specialist, Education Service Center, Region One, Edinburg, Texas.** Served as member of Administrative Cabinet team in strategic planning, development of proposals and contracts, implementation, and evaluation of telecommunications capabilities, services, products, and programs for 40 school districts serving 283,000 students in 7 counties. Provided creative leadership to regional and state committees to solicit ideas, identify strategic goals and objectives, plan, develop, present, and evaluate funding opportunities and professional development for 400 librarians.

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1993-1996 **Assistant Professor of Library Science, Sam Houston State University, Huntsville, Texas.** Served a faculty member teaching 400 graduate students in technical services (cataloging, bibliographic control, classification), automation, and networking. Participated in distance education program and coordinated annual conference. Conducted university and Texas Library Association-funded field research focused on library collection development and academic achievement.

1992-1993 **Head Librarian, Rocky Mountain College of Art & Design, Denver, Colorado.** Responsible for the daily operation, selection and acquisition of materials, formulation of policies for library operations, media center, and photography/slides archives. Designed and implemented library automation and delivery of electronic resources to college community.

1981-1985 **Development Officer, PRLC, Inc., Pittsburgh, Pennsylvania.** Served as senior member of corporate management team in strategic planning, development of proposals and contracts, implementation, and evaluation of new services, products, and programs for 100 institutional member organizations. Coordinated the development of proposals and contracts totaling $4,000,000 annually. Provided creative leadership to corporate committees to solicit ideas, identify goals and objectives, plan, develop, present, and evaluate professional development opportunities.

1981 **Director of Library Development, Pennsylvania Department of Education, Harrisburg, Pennsylvania.** Responsible for statewide development, technical assistance, professional development, resource sharing, children's services, institutional library services, networking, and state aid program for all libraries throughout the Commonwealth. Functioned as liaison to Governor's Advisory Council, LSCA Advisory Council, District Administrators, private colleges, universities, consortia managers, and network directors. Supervised $14,000,000 formula-based state aid program and $3,000,000 grant awards to individual libraries, consortia, and networks.

1978-1981 **Assistant Director, Southern Tier Library System, Corning, New York.** Coordinated operation of system-wide programs (technical assistance, professional development, resource sharing, technical services, outreach) to 40 public libraries in 5 counties serving 500,000 residents. Solicited ideas, identified goals, sponsored, and evaluated professional development opportunities and technical assistance sessions.

1976-1978 **Division Librarian for Technical Services, Corpus Christi Public Libraries, Corpus Christi, Texas.** Provided leadership in acquisitions, cataloging, serials control, and processing for main library and 4 branches serving 250,000 residents. Participated as senior member of library management team. Compiled and prepared technical evaluations, reports, and statistical analyses of Division operations to measure the achievement and cost of annual goals, objectives, and staff performance.

1975-1976 **System Coordinator, San Antonio Major Resource Center, San Antonio, Texas.** Served as senior member of the management team for District X Office, charged to provide technical assistance, resource sharing, media services, and professional development to librarians and staff representing 30 public library jurisdictions in 21 counties serving 1,500,000 residents. Functioned as liaison to System Director, staff, and members of governing bodies with the System Board of Directors and the Texas State Library and Historical Commission. Prepared LSCA grant applications and monitored awards totaling $1,100,000 annually.

1973-1975 **Bilingual Branch Librarian, San Antonio Public Library, San Antonio, Texas.** Worked as librarian providing reference, information, and readers' advisory services in branch serving 50,000 Spanish-speaking residents in southwest San Antonio. Participated in collection development and resource acquisition activities, specializing in children's work, Spanish language resources, and multicultural studies.

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1972-1973 **Librarian, Holding Institute, Laredo, Texas.** Worked as high school librarian serving 500 boarding students in Spanish-speaking environment of private school. Provided reference, research assistance, and library instruction to students and 35 faculty members.

1966-1971 **Rockford Public Library, Rockford, Illinois.** Worked in branches as part-time as a Library Assistant, Clerk, and Page in city library serving 150,000 residents.

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PUBLICATIONS

Editor-reviewed Monographs (Completed and in Progress)

Hall-Ellis, Sylvia D., and Mary Beth Weber. *Contemporary Cataloging in an RDA Environment: A Handbook for Students and Practitioners.* Chicago, IL: American Library Association. Under contract & In development.

RDA Testing: Lessons Learned and Challenges Revealed. Sylvia D. Hall-Ellis and Robert O. Ellett, Jr., eds. Binghamton, N.Y.: Haworth, 2012. 128 p.

Hall-Ellis, Sylvia D., Stacey L. Bowers, Christopher D. Hudson, and M. Claire Williamson. *Librarian's Handbook for Seeking, Writing, and Managing Grants.* Santa Barbara, Calif.: Libraries Unlimited, 2011. 315 p.

Hall-Ellis, Sylvia D., with Ann Jerabek, and Merrie W. Valliant. *Contemporary Cataloging: A Handbook for Practitioners and Students.* Open access text. Athens, GA: University of Georgia System Regents, 2011. 767 p.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *From Research to Practice: The Scholarship of Teaching and Learning in LIS Education.* Westport, Conn.: Libraries Unlimited, 2009. 175 p.

Hall-Ellis, Sylvia D. with J. Ann Jerabek. *Grants for School Libraries.* Westport, Conn.: Libraries Unlimited, 2003. 197 p.

Hall-Ellis, Sylvia D., Doris Meyer, Frank W. Hoffmann, with J. Ann Jerabek. *Grant Writing for Small Libraries and School Library Media Centers.* Boulder, Colo.: NetLibrary, 2001. 173 p.

Hall-Ellis, Sylvia D., Doris Meyer, Frank W. Hoffmann, with J. Ann Jerabek. *Grant Writing for Small Libraries and School Library Media Centers.* Englewood, Colo: Libraries Unlimited, 2000. 173 p.

Editor-reviewed Chapters (Completed and In Progress)

Hall-Ellis, Sylvia D. "Grant Writing and Sponsored Research Funding for Academic Librarians." In *The New Librarianship.* Vol. 4. Bradford Lee Eden, ed. New York: Scarecrow Press, 2015. (pp. 163-174)

Hall-Ellis, Sylvia D. "Organizing Information: Technical Services." In *Information Services Today: An Introduction.* Sandra Hirsch, ed. Lantham, Md.: Rowman and Littlefield, 2015. (pp. 139-148)

Hall-Ellis, Sylvia D. "Metadata, MARC, and More." In *Rethinking Technical Services, Considering Our Profession and Ourselves: What's the Future of Our Profession?* Mary Beth Weber, ed. Lantham, Md.: Rowman and Littlefield, 2015. (pp. 29-55)

Hall-Ellis, Sylvia D., ed. "Contingent Faculty: Non-Tenure Track Faculty Series." In the *Faculty Personnel Guidelines Relating to Appointment, Promotion, and Tenure.* November 2011. Denver, Colo.: University of Denver, 2011. 42 p.

Hall-Ellis, Sylvia D., ed. "Standard VII: Information Resources." In the *Sturm College of Law Self-Study Presentation for Accreditation by the American Bar Association.* Denver, Colo.: University of Denver, Sturm College of Law, 2011. 20 p.

Hall-Ellis, Sylvia D. "Applying for Grants from Foundations, Corporations, or Government." In *The Volunteers' Guide to Fundraising: Raise Money for Your School Team, Library or Community Group.* 1st ed. Ilona M. Bray, ed. Berkeley, Calif.: Nolo, 2011. (pp. 1-38 on accompanying disc)

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Hall-Ellis, Sylvia D., ed. "Standard III: The Faculty." In the *Library and Information Science Program Self-Study Document for Accreditation by the American Library Association.* Denver, Colo.: University of Denver, Morgridge College of Education, 2010. 22 p.

Hall-Ellis, Sylvia D. "Library and Information Science Programs and Education for Catalogers and Metadata Specialists: Challenges for the Twenty-first Century." In *Conversations with Catalogers in the Twenty-First Century.* Elaine R. Sanchez, ed. Santa Barbara, Calif.: ABC-Clio, 2010. (pp. 226-254)

Hall-Ellis, Sylvia D., ed. "Standard III: The Faculty." In the *Library and Information Science Program Self-Study Document for Accreditation by the American Library Association.* Denver, Colo.: University of Denver, College of Education, 2003. 15 p.

Lesesne, Teri S. and Sylvia D. Hall-Ellis. "The Selection, Evaluation, and Integration of Culturally Authentic Texts: A Case for Making the Online Catalog Reflect Parallel Cultures." In *Literacy: Traditional, Cultural, Technological.* Pittsburgh, Pa.: International Association of School Librarianship, 1995. (pp. 110-113)

Lesesne, Teri S. and Sylvia D. Hall-Ellis. *The Selection, Evaluation, and Integration of Culturally Authentic Texts: A Case for Making the Online Catalog Reflect Parallel Cultures.* In *Conference Proceedings* of the 23rd Annual International Association of School Librarianship, Pittsburgh, Pennsylvania, July 17-22, 1994. ERIC Document ED374816. 17 p.

Hall-Ellis, Sylvia D. "Curriculum Folio for School Library Media Specialist Programs." In the *National Council for Accreditation of Teacher Education Self-Study for Sam Houston State University.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1994. 25 p.

Bruntjen, Scott and Sylvia D. Hall. "Attempting to Automate: Lessons Learned Over Five Years." In *Advances in Library Administration*. Volume 4. Weston, Conn.: JAI Press, 1985. (pp. 177-192)

Peer-Reviewed Journal Articles (Completed and In Progress)

Hall-Ellis-Sylvia D. "Job Design for Cataloging and Metadata Librarians." Submitted to *Journal of Library Administration.* In progress.

Hall-Ellis, Sylvia D. "The Relationship of Situational Leadership and the Dreyfus Model of Skill Acquisition for Supervisors in Cataloging and Metadata Services." To be submitted to *Library Resources and Technical Services.* In progress.

Hall-Ellis, Sylvia D. *The Relationship of Core Competencies on Learning Outcomes and Employers' Expectations for Catalog Librarians and Metadata Specialists.* To be submitted to the *Journal of Education for Library and Information Science.* In progress.

Hall-Ellis, Sylvia D. "Building Cataloger Competencies: The Dreyfus Model as a Prototype for the Education and Professional Development of Catalog Librarians and Metadata Specialists in Bibliographic Control." To be submitted to the *Cataloging & Classification Quarterly.* In progress.

Hall-Ellis, Sylvia D. "Descriptive Impressions of Entry-Level Cataloger and Metadata Specialists Positions, 2000-2016: Reflections and Trends." To be submitted to *Library Resources and Technical Services.* In progress.

Hall-Ellis, Sylvia D. "Competencies for Metadata and Cataloging Leaders: What Employers Expect as Reflected in Position Descriptions, 2000-2016." *Cataloging & Classification Quarterly.* In progress.

Hall-Ellis, Sylvia D. "Stackable Micro-credentials – A Framework for the Future." *The Bottom Line 29*, no. 4 (April 2016), http://www.emeraldinsight.com/doi/pdfplus/10.1108/BL-02-2016-0006

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Hall-Ellis, Sylvia D. "Nudges and Decision Making: A Winning Combination." *The Bottom Line 28*, no. 4 (July 2015): 133-136.

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Hall-Ellis, Sylvia D. "Metadata Competencies for Entry-Level Positions: What Employers Expect as Reflected in Position Descriptions, 2000-2013." *Journal of Library Metadata 15*, no. 2 (June 2015): 102-134.

Hall-Ellis, Sylvia D. "Onboarding to Improve Library Retention and Productivity." *The Bottom Line 27*, no. 4 (October 2014).

Hall-Ellis, Sylvia D. "Accept, Coach, and Inspire: A Formula for Success." *The Bottom Line 27*, no. 3 (July 2014): 103-106.

Hall-Ellis, Sylvia D. *Reward Systems for Staff in Higher Education Institutions: Case Studies of 15 Higher Education Institutions in Colorado.* Capstone Thesis. Denver, Colo.: University of Denver, University College, 2014.

Hall-Ellis, Sylvia D. "Reward Systems Promote High-Performance Work Teams Achieving Library Mission." *The Bottom Line 27*, no. 2 (April 2014): 66-69.

Hall-Ellis, Sylvia D. "Investment in Staff Development for Seeking External Grant Funds." *The Bottom Line 27*, no. 1 (January 2014): 22-25.

Hall-Ellis, Sylvia D. "Staff Investments for High Performance Teams." *The Bottom Line 26*, no. 4 (October 2013): 149-152.

Hall-Ellis, Sylvia D. and Deborah S. Grealy. "Service Learning in LIS Education: A Case for Holistic Assessment." *Catholic Library World* 82, no. 3 (March 2012): 178-187.

Hall-Ellis, Sylvia D., and Deborah S. Grealy. "The Dreyfus Model of Skill Acquisition: A Career Development Framework for Succession Planning and Management in Academic Libraries." *College and Research Libraries* (June 2012). http://crl.acrl.org/content/early/2012/06/19/crl12-349.full.pdf+html

Hall-Ellis, Sylvia D. "Cataloger Competencies…What Do Employers Require?" *Cataloging & Classification Quarterly* 46, no. 3 (2008): 305-330. http://ccq.haworthpress.com/doi:10.1080/01639370802034565

Hall-Ellis, Sylvia D. "Subject Access for Readers' Advisory Services: Their Impact on Contemporary Spanish Fiction in Selected Public Library Collections." *Public Library Quarterly* 27, no.1 (2007): 1-18. http://plq.haworthpress.com/doi:10.1080/01616840802122377

Hall-Ellis, Sylvia D. "Language Proficiencies among Catalogers and Technical Services Librarians." *Technical Services Quarterly* 25, no. 2 (2007) 31-47. http://tsq.haworthpress.com/doi:10.1300/J124v25n02_03

Hall-Ellis, Sylvia D. "Cataloging Electronic Resources & Metadata: Employers' Expectations as Reflected in *American Libraries and AutoCAT,* 2000-2005." *Journal of Education for Library and Information Science* 47, no. 1 (2006): 38-51.

Hall-Ellis, Sylvia D. "Descriptive Impressions of Managerial & Supervisory Cataloger Positions as Reflected in *American Libraries, AutoCAT,* and the *Colorado State Library Jobline,* 2000-2004: A Content Analysis of Education, Competencies, and Experience." *Cataloging & Classification Quarterly* 42, no. 1 (2006): 55-88.

Hall-Ellis, Sylvia D. "Descriptive Cataloging Proficiencies among Beginning Students: A Comparison among Traditional and Virtual Class Students." *Journal of Library & Information Services in Distance Education* 2, no. 2 (2005): 13-44.

Hall-Ellis, Sylvia D. "Descriptive Impressions of Entry-Level Cataloger Positions as Reflected in *American Libraries, AutoCAT,* and the *Colorado State Library Jobline,* 2000-2003." *Cataloging & Classification Quarterly* 40, no. 2 (2005): 33-72.

Hall-Ellis, Sylvia D. and Mary Ann Berry. "The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas: Preliminary Findings." *Texas Library Journal* 71, no. 2 (Summer 1995): 94-97.

Hall-Ellis, Sylvia D. "Visual Arts as Foundation for Successful Library Automation: The Rocky Mountain College of Art & Design Experience." *Art Reference Serials Quarterly* 4 (1994): 43-54.

Hall, Sylvia D. *High School Databases: An Examination of Bibliographic Data Elements*. Dissertation. Pittsburgh, Pa.: University of Pittsburgh, School of Library and Information Science, 1985.

Technical Reports

Hall-Ellis, Sylvia D. *Colorado Community College System Grant Handbook.* Denver, CO: Colorado Community College System, 2015.

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Faculty Voices: Testimonials from the Frontiers of a Development Education Redesign. Elaine DeLott Baker, Marilyn Smith, and Sylvia D. Hall-Ellis, eds. Denver, CO: Colorado Community College System, 2014.

Lewis, Melanie, Jamie M. Van Leeuwen, and Sylvia D. Hall-Ellis. *Project Homeless Connect 7 Event Evaluation.* Denver, Colo.: University of Colorado Denver, 2009.

Hall-Ellis, Sylvia D. *Grant Writing Tips and Resources.* Denver, Colo.: University of Denver, 2008-2014. http://portfolio.du.edu/grants

Hall-Ellis, Sylvia D. and Duan Zhang. *Project Homeless Connect 6 Event Evaluation.* Denver, Colo.: Center for Community Engagement and Service Learning, 2008.

Hall-Ellis, Sylvia D. *Strategic Plan for Denver Medical Library System: Final Report.* Denver, Colo.: HealthONE and Denver Medical Library, 2008.

Hall-Ellis, Sylvia D. and Duan Zhang. *Project Homeless Connect 5 Event Evaluation.* Denver, Colo.: Center for Community Engagement and Service Learning, 2008.

Hall-Ellis, Sylvia D. *Strategic Plan for Denver Medical Library System: Phase Two Report.* Denver, Colo.: HealthONE and Denver Medical Library, 2007.

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Hall-Ellis, Sylvia D. *Resources in Grant Writing for Colorado Schools and Libraries.* Sponsored by the Colorado Department of Education, Educational Telecommunications Unit, 1999. Revised September 2000.

Hall-Ellis, Sylvia D. *Lewis & Clark Fellows Concept Paper for the Bicentennial Commemoration.* Vancouver, Wash.: Lewis and Clark Bicentennial Council, 1998.

Hall-Ellis, Sylvia D. and Mary Ann Berry. *The Impact of Library Resource Centers on Academic Achievement in Public Schools in Texas: The Final Report.* Prepared under the sponsorship of the Research Enhancement Fund award from Sam Houston State University, the Texas Association of School Librarians, the Children's Services Round Table, and the Young Adults' Services Round Table. Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1997.

Hall-Ellis, Sylvia D. *The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in Texas.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1997.

Hall-Ellis, Sylvia D. *Planning for Educational Technology: the Distance Education Implementation Phase: An Investigation of Technology and Telecommunication Needs for Region One Education Service Center, South Texas Community College, TCI Cablevision of South Texas, Inc., Tech Prep of the Rio Grande Valley, Inc., Texas State Technical College, Centro Cultural en el Valle de Texas, McAllen Independent School District, Harlingen Consolidated Independent School District, Donna Independent School District, Edinburg Consolidated Independent School District, La Joya Independent School District, Mercedes Independent School District, Pharr-San Juan-Alamo Independent School District, Sharyland Independent School District, Easter Seal Society of the Rio Grande Valley, Inc., and McAllen Memorial Library.* Harlingen, Tex.: Tech Prep of the Rio Grande Valley, 1996.

Hall-Ellis, Sylvia D. "Barcodes for the Texas Library Connection." Prepared under the sponsorship of the Office of Technology Services, Texas Education Agency. Austin, Tex.: TENET News and Conferences, March 1995.

Hall-Ellis, Sylvia D. *[et. al.] Planning for Educational Technology: A Study of Future Technology Needs for the Donna Independent School District, Region One Education Region Service Center, Tech Prep of the Rio Grande Valley, Inc. South Texas Community College, and the Department of Library Science, Sam Houston State University.* Research team: Sylvia D. Hall-Ellis, Ruth Ann Riggins, Noe Torres, Patricia G. Bubb, and Michael D. Bell. Harlingen, Tex.: Tech Prep of the Rio Grande Valley, 1994. Funded through a grant award from the Texas Education Agency.

Hall-Ellis, Sylvia D. and Mary Ann Berry. *The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas.* Huntsville, Tex.: Sam Houston State University, College of Education and Applied Science, 1993. Funded through a grant award from the Sam Houston State University Research Enhancement Fund.

Hall-Ellis, Sylvia D., Alice Krueger, and Linda Brannan. *Thesaurus Development for National Curriculum Materials Database at the Eisenhower National Clearinghouse for Mathematics and Science Education, Columbus, Ohio.* Developed under the sponsorship of Mid-Continent Regional Educational Laboratory Corporate Library, Aurora, Colo. Washington, D.C.: National Science Foundation; Columbus, Ohio: ERIC Clearinghouse for Mathematics and Science Education, 1993.

Hall-Ellis, Sylvia D. and Clarence L. Coffindaffer. *Partners in Progress: The 1992 Montana Library Federation Study Final Report*. Helena, Mont: Montana State Library and The Blue Bear Group, Inc., 1992.

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Bruntjen, Scott and Sylvia D. Hall. *Recommendations on the Development of System-Wide Efforts of the Northern Waters Library Service.* Ashland, Wisc.: Northern Waters Library Service and The Blue Bear Group, Inc., 1989.

Hall, Sylvia D. *The Iowa Union List of Serials as A Part of The Iowa Locator: Planning Document*. Des Moines, Ia.: State Library of Iowa, 1988.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. IBM Compatible Edition: Version 7.0.* Des Moines, Ia.: State Library of Iowa, 1988.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. IBM Compatible Edition: Version 5.0.* Des Moines, Ia.: State Library of Iowa, 1986.

Hall, Sylvia D. *Iowa Computer-Assisted Network (ICAN Users' Manual. Apple MacIntosh Edition: Version 5.0.* Des Moines, Ia.: State Library of Iowa, 1986.

Bruntjen, Scott and Sylvia D. Hall. *The District of Columbia Public Library Planning for Retrospective Conversion of Bibliographic Records and Automation Issues for the 1990's: Final Report*. Central City, Colo.: The Blue Bear Group, Inc., 1986.

Bruntjen, Scott and Sylvia D. Hall. *The Iowa Locator: Final Report.* Central City, Colo.: The Blue Bear Group, Inc., 1986.

Bruntjen, Scott and Sylvia D. Hall. *Discovering Resource Sharing Treasures: Accessing Pennsylvania's High School Library Collections*. Harrisburg, Pa.: State Library of Pennsylvania, Bureau of School Library Media Resources, 1985.

Hall, Sylvia D. *Retrospective Conversion and the Completeness of Cataloging in Pennsylvania High School Libraries.* Pittsburgh, Pa.: PRLC, Inc., 1985.

Bruntjen, Scott and Sylvia D. Hall. *The Iowa Locator*. Des Moines, Ia.: State Library of Iowa, 1985- http://www.statelibraryofiowa.org/ld/silo/locator

Bruntjen, Scott and Sylvia D. Hall. *ICAN Analysis*. Des Moines, Ia.: State Library of Iowa, 1985.

Bruntjen, Scott and Sylvia D. Hall. *Zebras: Bar Codes, Standards, and Library Automation*. Central City, Colo.: The Blue Bear Group, Inc., 1985.

Hall, Sylvia D. and Scott Bruntjen. *Access Pennsylvania.* Harrisburg, Pa.: State Library of Pennsylvania, 1984- http://www.accesspa.org

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Hall, Sylvia D. *Retrospective Conversion for Major Public Libraries in South Central New York State: A Technical Report*. 2 vols. Corning, N.Y.: Southern Tier Library System, 1979-1980.

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Other Publications

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Hall-Ellis, Sylvia D., and Robert O. Ellett, Jr., guest editors. *RDA Testing: Lessons Learned and Challenges Revealed: A Special Issue of Cataloging & Classification Quarterly* 49, no. 7-8 (November 2011).

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Fundamentals of Cataloging I: An Online ALCTS Course.* Chicago, Ill.: American Library Association, 2009.

Hall-Ellis, Sylvia D., Angela J. Kinney and Martha Ann Bace, editors. *Best Practices in Cataloging Education Identified at the 2007 ALCTS Pre-conference: A Special Issue of the Journal for Library and Information Science Education* 49, no. 2 (Spring 2008).

Hall-Ellis, Sylvia D. *Cataloging Education: A New Emphasis for the Library and Information Science Curriculum.* Presentation delivered to the ALCTS Pre-conference, 132nd Annual Conference, American Library Association, Washington, D.C., June 22, 2007. http://www.loc.gov/aba/professional/

Hall-Ellis, Sylvia D. "*Cataloger Competencies: Do the Employers Require What the Professors Teach?*" Presentation delivered to the ALCTS CCS Heads of Cataloging Discussion Group, 131st Annual Conference, American Library Association, New Orleans, Louisiana, June 26, 2006. http://dlist.sir.arizona.edu/

Hall-Ellis, Sylvia D., guest editor, with Deborah S. Grealy, Clara L. Sitter, and Tassos Petrou. *Library Students' Voices in Colorado: An Issue of Colorado Libraries* 31:1 (Spring 2005).

Hall-Ellis, Sylvia D., ed. *Library and Information Science Program Self-Study Document for Accreditation by the American Library Association.* Denver, Colo.: University of Denver, College of Education, 2003. 125 p. with CD-ROM.

Hall-Ellis, Sylvia D. and Deborah S. Grealy, guest editors. *Library Education in Colorado: An Issue of Colorado Libraries* 29, no. 2 (Summer 2003).

Hall-Ellis, Sylvia D., ed. *Library and Information Science Program Self-Study Document for Accreditation by the American Library Association.* Denver, Colo.: University of Denver, College of Education, 2003.

Hall-Ellis, Sylvia D. "Adaptive Furniture for the ADA-Qualified: An Investigative Study." 2001. Unpublished manuscript.

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Hall-Ellis, Sylvia D. "Cataloging Electronic Serials: A Study in User Access and Article Delivery." 2001. Unpublished manuscript.

Hall-Ellis, Sylvia D. "E-books: Acquisition and Circulation Issues in Public Libraries." 2001. Unpublished manuscript.

Hall-Ellis, Sylvia D. "Authority Control and Its Importance in School Library Media Online Catalogs." 1999. Unpublished manuscript.

Hall, Sylvia D. "Cooperation Improving Service in San Antonio System." *Texas Libraries* XXXVII (Spring 1976): 27-29.

Hall, Sylvia D. "Summer is Sea Monstrously Fun!" *Texas Library Journal* L (December 1974): 224-226.

Hall, Sylvia D. "A Brief Annotated Bibliography of Non-book Materials on the Mexican American." *Texas Library Journal* XLVIII (October 1972): 213-232.

Book Reviews

ALA Book of Library Grant Money. Ann Kepler, ed. 8th ed. Chicago, IL: American Library Association, 2011. 978-0-8389-1058-0, $175.00 [*Colorado Libraries,* June 2012]

Developing a Compensation Plan for Your Library. Paula M. Singer and Laura L. Francisco, comps. 2nd ed. Chicago, IL: American Library Association, 2009. 978-0-8389-0985-0, $57.00 [*Colorado Libraries,* March 2012]

Frugal Librarian. Carol Smallwood, ed. Chicago, IL: American Library Association, 2011. 978-0-83891-075-7, $42.00 [*Colorado Libraries,* February 2012]

Dowlin, Ken. *Getting the Money: How to Succeed in Fundraising for Public and Nonprofit Libraries.* Westport, Conn.: Libraries Unlimited, 2008. 978-1-59158-597-X, $50.00 [*Colorado Libraries,* February 2009]

Lundahl, Mats. *Bebo de Cuba; Bebo Valdés y Su Mundo*, by Mats Lundahl. Traducción de Linda Oakeshott Dragó. Barcelona: RBA Libros, 2008. 978-849-86-7259-6, $33.99 [*Críticas*, November 2008]

Bonelli, Florencia. *Marlene*, by Florencia Bonelli. Buenos Aires: Aguilar, Altea, Taurus, Alfaguara, 2008. 978-987-04-0995-3, $24.95 [*Críticas*, October 2008]

Keret, Etgar. Traducción de Ana María Bejarano. *Pizzería Kamikaze y Otras Relatos.* México, D.F.: Editorial Sexto Piso, 2008. 968-5679-29-0, no price given [*Críticas*, September 2008]

Littauer, Marita, and Florence Littauer. *Enriquece tu Comunicación. Miami, Fla.: Editorial Unilit, 2008.* 978-0-7899-1521-4, $11.99 [*Críticas*, August 2008]

Martínez, Guillermo. *La Muerte Lenta de Luciana B.* New York: Rayo Planeta, 2008. 978-0-06-156551-9, $14.95 [*Críticas*, May 2008]

Matthews, Joseph R. *The Evaluation and Measurement of Library Services.* Westport, Conn.: Libraries Unlimited, 2007. 978-1-59158-532-9, $50.00 [*Colorado Libraries,* April 2008]

Gómez-Jurado, Juan. *A Masacre de Virginia Tech: Anatomía de una Mente Torturada.* Barcelona: Ediciones El Andén, 2007. 978-84-935789-4-7, €16.50 [*Críticas*, February, 2008]

Matthews, Joseph R. *Library Assessment in Higher Education.* Westport, Conn.: Libraries Unlimited, 2007. 978-1-59158-531-2, $45.00 [*Colorado Libraries,* February 2008]

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Chacón, Inma. *La Princesa India: Cuando el Viento Azul.* México: Alfaguara, 2006. 970-770398-9, $19.95 [*Críticas*, June 2006]

Vargas Llosa, Mario. *Israel/Palestina: Paz o Guerra Santa.* fotogs. by Morgana Vargas Llosa. Spain/U.S.: Aguilar: Santillana, 2006. 84-03-09691-7, paper, $19.95 [*Críticas*, May 2006]

Findlay, Diane. *Digging into Dewey.* Fort Atkinson, Wisc.: Upstart Books, 2005. 978-1-932146-18-9, $16.95 [*Colorado Libraries,* May 2006]

Pequeñas Resistencias 4: Antología del Nuevo Cuento Norteamericano y Caribeño. Menéndez, Ronaldo, Ignacio Padilla & Enrique del Risco, eds. Madrid**:** Páginas de Espuma, 2005. 84-95642-59-X, paper, $36.95 [*Críticas*, April 2006]

Rueda, André. *Vengo a Salvar a España: Biografía de Un Franco Desconocido.* Madrid**:** Nowtilus (Investigación Abierta), 2005. photogs., bibliog. 84-9763-202-8, paper, $23.95 [*Críticas*, March 2006]

Becerra, Ángela. *El Penúltimo Sueño.* 1st ed. Barcelona: Planeta, 2005. 84-08-05795-2, $25.95. [*Críticas*, January 2006]

Aguilar Camín, Héctor. *La Conspiración de la Fortuna.* 1st ed. México: Planeta, 2005. 970-37-0368-2, $19.95 [*Críticas*, October 2005]

México en Sus Libros. Enrique Florescano with Pablo Mijangos, editors & compilers. 1st ed. México, D.F.: Taurus Aguilar, 2004. 968-19-0783-3, $16.95 [*Críticas*, September 2005]

Historia Económica de México. Coordinator, Enrique Semo. México: Universidad Nacional Autónoma de México, Editorial Oceano de México, 2004. 13 vols. 970-32-0805+3 (obra completa), $9.25 each [*Críticas*, August 2005]

Czarnowsky, Christyne A. and Michael H. Williams. *Managing Your Wired Workforce: A Practical Guide.* Denver, Colo.: Bradford Pub., 2003. 1-883726-79-4, $24.95 [*Colorado Libraries,* 2004]

Abraham Lincoln. Colección Grandes Biografías. Madrid: Edimat Libros, 2003. 84-8403-858-0, €4.95 [*Críticas*, 2004]

Alponte, Juan María. *Colón: el Hombre, el Navegante, la Leyenda.* México, D.F.: Aguilar, 2003. 968-19-1260-8, $16.95 [*Críticas*, 2004]

Olcese Salvatecci, Alfieri. *Cómo Estudiar con Èxito: Téchnicas yHhábitos Para Aprender Major.* México, D.F.: Alfaomega Grupo Editor, 2002. 970-15-0764-9 [*Críticas*, 2003]

Mujeres Como Islas: Antología de Narradoras Cubanas, Dominicanas, Puertoriqueñas. Edición: Olga Marta Pérez, Thelma Jiménez, Andrés Blanco D., eds. Santo Domingo, República Dominicana: Ediciones Ferilibro, 2002. 959-209-419-5 [*Críticas*, 2003]

Tibol, Raquel. *Los Murales de Diego Rivera: Universidad Autónoma Chapingo.* México, D.F.: Editorial RM, Universidad Autónoma Chapingo, 2002. 968-5208-08-5 [*Críticas*, 2003]

Lindsay-Poland, John. *Emperors in the Jungle: the Hidden History of the U.S. in Panama.* Durham, N.C.: Duke University Press, 2003. 0-8223-3098-9, $18.95 [*Críticas*, 2003]

Kaplan, Allison G. and Ann Marlowe Riedling. *Catalog It! A Guide to Cataloging School Library Materials.* Worthington, Ohio: Linworth Pub., 2002. 1-58683-014-7, $44.95 [*Colorado Libraries,* 2002]

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Bardach, Ann Louise. *Cuba Confidential: Love and Vengeance in Miami and Havana.* New York: Random, 2002. 0-375-50489-3, $25.95 [*Library Journal*, 2002]

Swan, James. *Fundraising for Libraries: 25 Proven Ways to Get More Money for Your Library.* New York: Neal Schuman, 2002. 1-55570-433-6, $69.95 [*Colorado Libraries,* 2002]

Puíg de Lange, Victoria. *Sol Con Agua.* Nashville, Tenn.: Editorial Vistazo/Ediciones Reio Negro, 2002. 0-9724506-0-2, $17.75 [*Críticas*, 2002]

The Encyclopedia of Latin American Politics. Edited by Diana Kapiszewski; assistant editor, Alexander Kazan. Westport, Conn.: Oryx Press, 2002. 1-57356-306-4, $74.95 [*Library Journal*, 2002]

Vargas Lizano, Isabel. *Y Si Quieres Saber de Mi Pasado.* Con la colaboración de J.C. Vales. Madrid: Santillana Ediciones Generales, S.L., 2002. 84-03-09278-4, $18.95 [*Críticas*, 2002]

Ruy Sánchez, Alberto. *Los Jardines Secretos de Mogador: Voces de Tierra.* México, D.F.: Alfaguara, S.A., 2001. 968-19-0879-1, $16.95 [*Críticas*, 2002]

Chávez, Ricardo and Celso Santajuliana. *El Final de las Nubes.* Barcelona: RBA Libros, S.A., 2001. 84-7901-760-0, $11.95 [*Críticas*, 2002]

The Power of Language / El Poder de la Palabra: Selected Papers from the Second REFORMA National Conference. Edited by Lillian Castillo-Speed and the REFORMA National Conference Publications Committee. Englewood, Colo.: Libraries Unlimited, 2001. 1-563089459, $35.00 [*Colorado Libraries,* 2001]

Martínez, Rubén. *Crossing Over: A Mexican Family on the Migrant Trail.* Metropolitan: Holt, 2001. 0-8050-4908-8, $26.00 [*Library Journal*, 2001]

Guevara, Ernesto "Che." *The African Dream: the Diaries of the Revolutionary War in the Congo.* Translated from the Spanish by Patrick Camiller. With an introduction by Richard Gott and a foreword by Aleida Guevara March. New York: Grove Press, 2001. 0-8021-3834-9, $13.00 [*Library Journal*, 2001]

Cooper, Gail and Garry Cooper. *New Virtual Field Trips.* Englewood, Colo.: Libraries Unlimited, 2001. 1-56308-887-8, $27.50 [*Colorado Libraries,* 2001]

NATIONAL SERVICE & PROFESSIONAL AFFILIATIONS

American Library Association
Association for Library Collections & Technical Services
Cataloging, Classification, and Metadata Section
ALCTS Editorial Board, Member, 2015-
Committee on Cataloging: Description and Access, Member, 2008-2012
Test Site for RDA, Manager, 2009-2011
Nominating Committee, Member, 2007-2008
Committee for Education and Training of Catalogers, Chair, 2006-2007, Member, 2003-2007
Competencies & Education for a Career in Cataloging Interest Group, Chair, 2010-2012; Member, 2010-
President's Program Committee, 2015-2016
Education Committee, Member, 2005-2007
Task Force on Competencies and Education for a Career in Cataloging, Chair, 2007-2009
2007 Annual Meeting Pre-conference, "What They Don't Teach in Library School: Competencies, Education and Employer Expectations for a Career in Cataloging," Steering Committee Chair
Fundraising Committee, Member, 2004-2006
Office of Diversity
Committee on Diversity, Chair, 2010-2011
Diversity Research Advisory Committee, Member, 2009-2010
Spectrum Scholar Mentor, 2009
Diversity Grants Review Committee, Member, 2007, 2010, 2012
Office of Statistics and Research
Research and Statistics Committee, Member, 2005-2007; Intern, 2003-2005
Library Research Round Table
Board of Directors, Member At-Large, 2009-2012
Member, 2003-
Office of Accreditation
Accreditation Panel Member (training completed 2004)
Accreditation Review Panel Member (training completed 2004)

REFORMA
National Board of Directors, 2005-2013
National Fundraising Chair, 2005-2013
National Recruiting and Mentoring Committee, 2008-2010
Colorado Chapter, Secretary, 2004-2005
Colorado Chapter Liaison to National Board of Directors, 2004-2013

Online Audiovisual Catalogers Association (OLAC)
American Association of Law Libraries (AALL)
Colorado Association of Law Librarians (CoALL)

Association for Library and Information Science Education (ALISE)
University of Denver ALISE Representative, 2003-2008; 2010-2011
Membership Advisory Committee, 2007-2010
Technical Services Education Special Interest Group, 2003-
Garfield Doctoral Dissertation Award Reviewer, 2012
Garfield Doctoral Dissertation Scholarship Reviewer, 2014
American Association of University Professors (AAUP), 2006-
American Grant Writers Association, 2014-
Grant Professionals Institute, 2016-
National Grants Management Association, 2014-

Grant Reviewer (National and Regional Team Leader), U.S. Department of Education, 1998-
Grant Reviewer, Broadband Technologies Opportunity Program, U.S. Department of Commerce, 2009

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Grant Reviewer, Institute of Museum and Library Services, 1998-2000
Grant Reviewer, Colorado Department of Education, 2014-
Grant Reviewer, Colorado State Library, 1998-
Grant Reviewer, American Association of Community Colleges *Working Connections* program, 1999
Peer Reviewer, *Journal for Library and Information Science Education,* 2005-
Peer Reviewer, *Journal of Library Metadata,* 2009
Peer Reviewer, *International Journal of Library and Information Science,* 2011
Regular Columnist, *The Bottom Line*, 2013-2016
Book Reviewer, *Library Journal*, 2001
Book Reviewer, *Críticas*, 2002-2009
Book Reviewer, *Colorado Libraries,* 2000-2012

REGIONAL SERVICE & PROFESSIONAL AFFILIATIONS

Mountain Plains Library Association
Professional Development Grants Committee, Member, 2005-2006
Professional Development Policy and Guidelines Sub-committee Chair, 2006

Colorado Association of Libraries
"Student Voices" Column Editor, *Colorado Libraries,* 2005-2006
Conference Planning Committee, Member, 2002
Technical Services and Automation Division, Chair, 2002-2003; Member, 2000-
Academic Libraries Division, Peer Review Conference Papers Committee, Member, 2007-2009
Education Committee, Member, 1988-1993
Diverse Populations Committee, Member, 2009-2013

SERVICE TO THE UNIVERSITY OF DENVER
Center for Teaching and Learning Faculty Advisory Board, 2007-2008; 2010-2012
Center for Community Engagement and Service Learning Advisory Board, 2007-2012
Faculty Senate
Executive Committee, 2008-2013
Nominations, Rules & Credentials Committee, Chair, 2008-2013; Member 2007-2013
Appointment, Promotion, and Tenure Revision Committee, 2010-2012
Grievance Policy Committee Member, 2007-2010
Law Library Director Search Committee Chair, 2012-2013
PROF Grant Review, College Representative to the University Review Team, 2006, 2008
Project Homeless Connect Evaluations, Principal Investigator, 2006-2009
University Technology Council, 2007-2009
University of Denver Hyde Interviews for Incoming Freshmen, 2003-2012

SERVICE TO THE MORGRIDGE COLLEGE OF EDUCATION
Appointment, Tenure & Review Committee
Member, voting, 2003-2005; 2007- 2009
Chair, Clinical Faculty Promotion & Tenure Policy Subcommittee, 2008-2009
Member, Community Engagement Subcommittee, 2007-2009
Member, Tenure Review Panel, 2003
Advancement and Alumni Relations Committee, Chair, 2003-2007; Member, 2002-2007
College Building Committee Member, 2004-2010
College of Education Student Association, Faculty Advisor, 2004-2007; 2009-2010
Faculty Senator, 2007-2013
Research and Scholarship Committee, Chair, 2008-2009; Member, 2002-2003, 2008-2009
Research and Grant Mentoring Committee, Chair, 2009-2010
Research Task Force Member, 2010-2012
Search Committee Member, Assistant Professor for Curriculum & Instruction, 2010-2011
Workload Task Force Member, 2010-2011

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SERVICE TO THE LIBRARY & INFORMATION SCIENCE PROGRAM
Library and Information Science Student and Alumni Association, Faculty Advisor, 2002-2008
ALA Student Chapter, Faculty Advisor, 2005-2008
Beta Phi Mu Phi Chapter, Faculty Advisor, 2004-2014
Steering Committee Member, Accreditation by the American Library Association, 2001-2004
Search Committee Member, Associate Professor for LIS, 2006
Search Committee Chair, Assistant Professors for LIS, 2003, 2005, 2006, 2007
Search Committee Ex-Officio Member, Director for LIS, 2004

SERVICE TO SAM HOUSTON STATE UNIVERSITY
Rio Roundup: South Texas Literature Conference, Conference Coordinator, 1993
External Relations, Fund Raising, Grants Committee, Chair, 1993-1995
Advisory Council Committee, Chair, 1993-1995
Students, Admissions, and Advisement Committee, Chair, 1994
Institutional Effectiveness Committee, Member, 1993-1995

SERVICE TO THE COLLEGE OF EDUCATION AND APPLIED SCIENCE
Faculty Affairs Committee, Member, 1993-1995
Curriculum Committee, Member, 1993-1995
Continuing Education Committee, Member, 1993-1995

SERVICE TO THE COMMUNITY
Denver/Boulder Games 2022, Board of Directors, Secretary-Treasurer, 2015-
United Way Campaign Committee, College of Education, 2006
Arapahoe County, Election Judge for the County Clerk and Recorder, 2000-2005
Arthritis Foundation, Rocky Mountain Chapter, Certified Educator & Trainer, 1999-2008
Bonfils Blood Center, Silver Level Donor, 2000-
Denver Museum of Natural History, Docent, 1992
Tech Prep of the Lower Rio Grande Valley, Inc. (Harlingen, Texas) Board of Directors, 1995-1997
Executive Committee, 1996-1997; Chair, Development Committee, 1995-1997; Chair, Fiscal Agency Committee, 1995-1996; Chair, Colleges and Universities Committee, 1996-1997
Gilpin County (Colorado) Public Library Board of Trustees, 1986-1989; Vice President, 1987-1989
City of Central (Colorado) Economic Development Committee, 1987-1989
Columbine Family Health Centers, Inc. (Nederland and Black Hawk, Colorado) Board of Directors, 1988-1989

CERTIFICATION
Permanent Public Librarian Certificate - Pennsylvania, New York, Texas
Westlaw Expert Witness, 2008-
Certified Grant Writer®, 2016-

AWARDS AND HONORS
Advanced Practitioner for Service Learning and Community Engagement, University of Denver, 2011
Platinum Star Alumnae, College of Information, Library Science & Technologies, University of North Texas, 2009
Commendation for Integration of Technologies in Teaching & Learning Environment, University of Denver, 2006
Outstanding Adjunct Faculty Member Award, College of Education, University of Denver, 2002
Beta Phi Mu, Pi, University of Pittsburgh, 1985
Alpha Lambda Sigma, University of North Texas, 1972

Albert Nelson Marquis Lifetime Achievement Award, Who's Who in America; Who's Who in American Women; Who's Who of Women Executives; Dictionary of International Biography; Who's Who in the East; Who's Who in the South and Southwest; Who's Who in the World; Who's Who of Online Professionals; Who's Who in Library and Information Science; 2,000 Notable Women; Who's Who of Emerging Leaders; Who's Who in Professional and Executive Women; Who's Who in American Education; International Who's Who of Professional and Business Women; International Leaders in Achievement; International Educator of the Year; Who's Who in Finance and Industry; Who's Who in Finance and Business

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Invited International and National Conference Presentations

Hall-Ellis, Sylvia D. *Invest in Me -- I'm Your Future: Succession Planning for Libraries.* Keynote presentation delivered at the ALCTS President's Symposium, Boston, Mass., January 8, 2016.

Seidel, Kent E. and Sylvia D. Hall-Ellis. *Making Grants Work for You: Strategies for Doctoral Students and Early Career Scholars.* Presentation delivered at the University Council for Educational Administration, Early Career Scholars Session, Indianapolis, Ind., November 9, 2013.

Hall-Ellis, Sylvia D. *So You Want to be a Manager; Leadership Skills and Competencies for Technical Services Managers and Administrators.* Presentation delivered at the 138th Annual Conference, American Library Association, Chicago, Ill., June 29, 2013.

Seidel, Kent E., Karen S. Riley, Lyndsay Agans, Susan Korach, and Sylvia D. Hall-Ellis. *Making Grants Work for You (Instead of Just Working for Grants).* A panel discussion delivered at the University Council for Educational Administration, Early Career Scholars Session, Denver, Colo., November 17, 2012.

Hall-Ellis, Sylvia D. *After the Great TS Reorganization: The Westminster Law Library.* Presentation delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 23, 2012.

Hall-Ellis, Sylvia D. *Conversations with Catalogers in the 21st Century.* A panel discussion sponsored by the ALCTS Competencies for a Career in Cataloging Interest Group, delivered at the 137th Annual Conference, American Library Association, Anaheim, Calif., June 22, 2012.

Hall-Ellis, Sylvia D., moderator. *Mid-Career Leaders Program.* A panel discussion sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 26, 2011.

Hall-Ellis, Sylvia D., moderator. *Diversity Town Hall.* A community conversation sponsored by the ALA Committee on Diversity delivered at the 136th Annual Conference, American Library Association, New Orleans, La., June 24, 2011.

LaBarre, Kathryn, Sylvia D. Hall-Ellis, Karen Anderson, Rick Hasenyager, Christopher Cronin, and Penny Baker. *Briefings from RDA Test Participants.* A panel discussion delivered at the Midwinter Conference, American Library Association, San Diego, Calif., January 7, 2011.

Miksa, Shawne, Marjorie Bloss, and Sylvia D. Hall-Ellis. *Educating the Next Generation of Catalogers: Teaching RDA.* A panel discussion delivered at the 97th Annual Conference, Association for Library and Information Science Education, San Diego, Calif., January 7, 2011.

Hall-Ellis, Sylvia D., Robert Maxwell, John Hostage, and George Prager. *RDA Panel: What Cataloging Managers Need to Know.* Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 12, 2010.

Hall-Ellis, Sylvia D. and Stacey L. Bowers. *Catalogers in the RDA Environment: Skill Sets, Expectations and Challenges.* Presentation delivered at the 103rd Annual Conference, American Association of Law Librarians, Denver, Colo., July 11, 2010.

Hall-Ellis, Sylvia D. *Comfortable in Your Cataloging and Metadata Specialist Skin? Or, So You Want to Hire a Cataloger.* Presentation delivered to the ALCTS Research Group at the 134th Annual Conference, American Library Association, Chicago, Ill., July 11, 2009.

Perez, Megan, Sylvia D. Hall-Ellis, and Denise Anthony. *From Novice to Expert: Collaboration for Succession Planning.* A "hot topic" presentation delivered at the 14th ACRL Conference, Seattle, Wash., March 13, 2009.

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Hall-Ellis, Sylvia D. *Cataloging in the RDA Environment: Skill Sets, Expectations and Challenges.* Presentation delivered to the ALCTS Research and Publications Committee at the Midwinter Conference, American Library Association, Denver, Colo., January 24, 2009.

Hall-Ellis, Sylvia D. *LIS Cataloging Education for the 21st Century: Expectations and Challenges.* A panel discussion held at the 95th Annual Conference, Association for Library and Information Science Education, Denver, Colo., January 23, 2009.

Chu, Clara, Sylvia D. Hall-Ellis, and Mark Winston. *The Doctoral Degree & Building a Career.* A panel discussion delivered at the ALA Office of Diversity Spectrum Doctoral Fellows E.J. Josey Leadership Institute, Midwinter Conference, American Library Association, Denver, Colo., January 20, 2009.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Fundamentals of Cataloging Course: An Overview of the ALCTS Online Course.* Presentation delivered to the ALCTS Big Heads Group, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 30, 2008.

Hall-Ellis, Sylvia D. *Employers' Expectations for Technical Services Librarians: What We Don't Know.* Presentation delivered to the ALCTS Research and Publications Committee Program, 133rd Annual Conference, American Library Association, Anaheim, Calif., June 28, 2008.

Hall-Ellis, Sylvia D., Virginia R. Maloney, and Mary Stansbury. *Institutional Responses to Engaged Scholarship: The Carnegie Foundation Engaged University Classification at Two Universities.* Presentation delivered to the 94th Annual Conference, Association for Library and Information Science Education, Philadelphia, Pa., January 11, 2008.

Hall-Ellis, Sylvia D. *Puzzles, Problems, and Predicaments.* Presentation delivered to the ALCTS Research Discussion Group, 132nd Annual Conference, American Library Association, Washington, D.C., June 23, 2007.

Hall-Ellis, Sylvia D. *Cataloging Education: A New Emphasis for the Library and Information Science Curriculum.* Presentation delivered to the ALCTS Pre-conference, 132nd Annual Conference, American Library Association, Washington, D.C., June 22, 2007. http://www.loc.gov/catdir/cpso/careercat.html

Ellett, Jr., Robert O. and Sylvia D. Hall-Ellis. *Copy Cataloging Done Smarter.* Presentation delivered to the International Conference on Interdisciplinary Information Sciences and Technologies (InSciT2006), October 25-28, 2006.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Challenges and Opportunities for Defense Libraries.* Presentation delivered to the 1st Annual Conference of Defense Libraries, Spanish Ministry of Defense, Madrid, Spain, July 7, 2006.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation delivered to the ALCTS CCS Heads of Cataloging Discussion Group, 131st Annual Conference, American Library Association, New Orleans, La., June 26, 2006.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *From Research to Practice: The Scholarship of Teaching and Learning in LIS Education.* Presentation delivered to the at the 92nd Annual Conference, Association for Library and Information Science Education, San Antonio, Tex., January 18, 2006.

Hall-Ellis, Sylvia D. *Employers' Expectations for Entry-Level Catalogers: What Position Announcement Data Indicate.* Research paper delivered to the Technical Services Special Interests Group, 91st Annual Conference, Association for Library and Information Science Education, Boston, Mass., January 12, 2005. http://dlist.sir.arizona.edu/

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Hall-Ellis, Sylvia D. *Common Errors in MARC Records Prepared by LIS Students: What Does It Mean?* Research paper delivered to the ALCTS CCS Cataloging Norms Discussion Group, Mid-Winter Conference, 90th American Library Association, San Diego, Calif., January 10, 2004.

Hall-Ellis, Sylvia D. *Visual Arts as Foundation for Successful Library Automation: The Rocky Mountain College of Art & Design Experience.* Paper delivered at the 6th Annual Conference of Higher Education, Charleston, S. C., 1993.

Hall, Sylvia D. *Design Elements for Bibliographic Databases: An Overview.* Paper delivered at the 14th Online National Conference, New York, 1983.

Invited Regional Conference Presentations

Hall-Ellis, Sylvia D., Hudson, Christopher D., Brittany Cronin, and Kathryn Michaels. "The Colorado Law Project: Meeting the Public's Need for Legal Information." Panel discussion delivered at the Mountain Plains Library Association Conference, Billings, Mont., April 9, 2011.

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Education for Information Professionals in New Mexico: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the New Mexico Library Education Summit, Las Vegas, N.M., September 26, 2005.

Hall-Ellis, Sylvia D. *Public Library-School Library Partnerships.* Presentation delivered at the 3rd Annual Colorado Association of Libraries Conference with the Mountain Plains Library Association, Denver, Colo., October 22, 2004.

Hall-Ellis, Sylvia D. *Learn All You Can – Educational Partnership Opportunities for the Lewis and Clark Bicentennial Commemoration.* Paper delivered at the 3rd Annual Lewis and Clark Bicentennial Council National Planning Conference, Bismarck, N.D., April 26, 1998.

Invited State Conference Presentations

Grealy, Deborah S. and Sylvia D. Hall-Ellis. *Academic Library Leadership Changes: Using Succession Planning and Mentoring*. Presentation delivered at the Minnesota Library Education Conference, St. Cloud, Minn., October 10, 2013.

Hall-Ellis, Sylvia D., Merrie Valliant, and Melissa Powell. *RDA: What Is It and What Do You Need To Do With It At Your Library?* Presentation delivered at the Colorado Library Consortium Spring Conference, Ft. Morgan, Colo., April 26, 2013.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 4th LEADS Scholars Orientation, Denver, Colo., August 5, 2009.

Hall-Ellis, Sylvia D. *Service Learning: Enhancement to Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 3rd LEADS Scholars Orientation, Denver, Colo., June 2008.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation.* Sponsored by the Colorado Association of Law Libraries. Paper delivered at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. *Opportunities and Challenges in Law Librarianship: A Community Conversation.* Presentation delivered at the Sturm College of Law, Denver, Colo., November 7, 2007.

Hall-Ellis, Sylvia D. *Grant Writing Resources for Nursing Professionals.* Presentation delivered at the Presbyterian / St. Luke's Health One Medical Center 1st Annual Research Symposium, Denver, Colo., October 17, 2007.

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Hall-Ellis, Sylvia D. *Project Homeless Connect 4 Event Evaluation – Insights and Lessons Learned.* Presentation delivered at the Homelessness Research Symposium: What is DU Doing about Homelessness in Denver, Denver, Colo., September 14, 2007.

Hall-Ellis, Sylvia D. *Service Learning and the Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 2nd LEADS Scholars Orientation, Denver, Colo., August 10, 2007.

Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 15th Spring Mountains and Plains Parapros Conference, Denver, Colo., February 24, 2007.

Hall-Ellis, Sylvia D. *Public Library Service to Spanish-Speaking and Latino Residents in Denver: A Case Study.* Presentation delivered at the 4th Annual Colorado Association of Libraries Conference, Denver, Colo., November 10, 2005.

Hall-Ellis, Sylvia D. *Education for Information Professionals in a Digital Environment: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 14th Annual Mountains and Plains Parapros Conference, Aurora, Colo., July 29, 2005.

Hall-Ellis, Sylvia D. *Educational Opportunities: Library & Information Science Graduate Education at the University of Denver.* Presentation delivered at the 13th Annual Mountains and Plains Parapros Conference, Centennial, Colo., August 6, 2004.

Hall-Ellis, Sylvia D. *Library Education & Training: Focus on the West: An LIS Faculty Member's Personal Response*. Presentation delivered at the 1st Annual Colorado Association of Libraries Conference, Keystone, Colo., October 18, 2002.

Hall-Ellis, Sylvia D. *Grant Writing for School Librarians.* Presentation delivered at the 2002 Annual Colorado Education Media Association Conference, Colorado Springs, Colo., February 15, 2002.

Hall-Ellis, Sylvia D. *Grants – Opportunities for the Future.* Paper delivered at the Southeast Regional Accountability Annual Conference, Lamar, Colo., November 12, 1998.

Hall-Ellis, Sylvia D. *The Texas Library Connection and Interlibrary Loan: An Experiment in Resource Sharing.* Paper delivered at the Texas Computer Educators' Association Annual Conference, Austin, Tex., February 6, 1997.

Hall-Ellis, Sylvia D. *Finding Grant Sources on the Internet: A Guide for Librarians.* Paper delivered at the 2nd Annual Institute for School Library Personnel, Pharr-San Juan-Alamo North High School, Pharr, Tex., July 29, 1996**.**

Hall-Ellis, Sylvia D. *Mathematical and Logical Thinking: A Critical Intelligence.* Paper delivered at the 3rd Annual Paraprofessional Conference at the University of Texas - Pan American, Edinburg, Tex., March 8, 1996.

Hall-Ellis, Sylvia D. *Cataloging Trends and Issues: Update Session.* Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 19, 1995.

Hall-Ellis, Sylvia D. *Grant Writing: Tips and Encouragement for School Librarians.* Paper delivered at the 1st Annual Institute for School Library Personnel, South Texas Community College, McAllen, Tex., July 18 and 19, 1995.

Hall-Ellis, Sylvia D. *How to Become an Expert Grant Writer.* Paper delivered at the 3rd Annual High School Principals' Academy, South Padre Island, Port Isabel, Tex., June 19, 1995.

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Hall-Ellis, Sylvia D. *Texas Library Study: Results from Regions I and II.* Paper delivered at the 3rd Annual Technology Conference, Texas A&M University, College Station, Tex., November 18, 1994.

Hall-Ellis, Sylvia D. *Academic Achievement and Middle School Students.* Paper delivered at the 8th Annual Young Adult Conference, Sam Houston State University, Huntsville, Tex., November 5, 1994.

Hall-Ellis, Sylvia D. *Multimedia Resources for Library Leaders.* Paper delivered at the Institute for Librarians in A Multicultural Environment, Sam Houston State University, Huntsville, Tex., June 10, 1994.

Hall-Ellis, Sylvia D. *Finding the Resource: Empowering the User, or, the Case for Curriculum Based Subject Access to Learning Resource Center Collections.* Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.

Hall-Ellis, Sylvia D. and William H. Pichette. *Sam Houston State University Makes Use of OCLC/AMIGOS Collection Analysis CD.* Paper delivered at the 81st Annual Texas Library Association Conference, Corpus Christi, Tex., April 12-16, 1994.

Hall, Sylvia D. *Funding and Library Development in Pennsylvania: A Symbiotic Relationship.* Paper delivered at the Annual Graduate Student Colloquia, University of Pittsburgh, School of Library and Information Science, 1982.

Hall, Sylvia D. *Leadership for Public Library Trustees.* Paper delivered for the Trustees Division, Pennsylvania Library Association Annual Conference, Lancaster, Penn., 1981.

Seminar and Professional Development Presentations

Taylor, Meredith, and Sylvia D. Hall-Ellis. *Talent Management and Succession Planning.* ALCTS eForum, held March 22, 2017.

Hirsh, Sandra, Heather O'Brien, Michelle Holschuh Simmons, Michael Krasulski, and Sylvia D. Hall-Ellis. *Information Services Today: An Introduction. Part 3: Information Services: Roles in the Digital Age*. Rowan and Littlefield in partnership with Library Journal webinar, recorded February 5, 2015.

Hall-Ellis, Sylvia D. and Jennifer Sweda. *Copy Cataloging in an RDA Environment.* ALCTS eForum, held May 14 and 15, 2013.

Hall-Ellis, Sylvia D. *Law Librarianship: A Community Conversation.* Sponsored by the Colorado Association of Law Libraries, presented at the Colorado Supreme Court Library, Denver, Colo., May 14, 2008.

Hall-Ellis, Sylvia D. and Beatrice Z. Gerrish. *Reading and Libraries: Recent Research in Reading.* Presentation at the Ricks Center for Gifted Education, Denver, Colo., March 4, 2008.

Hall-Ellis, Sylvia D. *Cataloger Competencies: Do the Employers Require What the Professors Teach?* Presentation for the School of Library and Information Science, San José State University, February 12, 2008.

Hall-Ellis, Sylvia D. and Robert O. Ellett, Jr. *Cooperative Cataloging: Rules, Tools, and Conventions for Building a Multi-institutional Catalog.* Sponsored for the Spanish Ministry of Defense, Madrid, Spain, July 10, 2006.

Hall-Ellis, Sylvia D. *Cash for Kids: Grant Writing Opportunities for Youth Services Librarians.* Sponsored by the Colorado Young Adult Librarians; presented at Bemis Memorial Library, Littleton, Colo., November 13, 2002.

Hall-Ellis, Sylvia D. *MARC Records and Authority Control: Planning for Bibliographic Database Migration.* Sponsored and held at the Douglas County Public Library, Castle Rock, Colo., May 28, 2002.

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Hall-Ellis, Sylvia D. *Grant Writing: A Refresher for Librarians.* Sponsored by Library and Information Science Program, College of Education, University of Denver; presented at University Center at Chaparral, August 12, 2000.

Hall-Ellis, Sylvia D. *Shaking the Money Tree – Basic Grant Writing for Colorado Educators.* Sponsored by the Office of Educational Telecommunications of the Colorado Department of Education.
Pikes Peak Community College, Colorado Springs, Colo., November 16, 1998.
Pueblo School District 60, Pueblo, Colo., November 12, 1998.
University of Northern Colorado, Greeley, Colo., November 10, 1998.
United Technology Educational Partnership, Grand Junction, Colo., November 9, 1998.

Hall-Ellis, Sylvia D. *Cataloging Multimedia, Kits, Globes and Map Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 24, 1997 and December 12, 1996.

Hall-Ellis, Sylvia D. *New Standards for School Library Media Centers.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 15, 1997.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., April 4, 1997.

Hall-Ellis, Sylvia D. *Cataloging Sound Recordings and Audio Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 20, 1997 and November 21, 1996.

Hall-Ellis, Sylvia D. *Evaluating and Selecting CD-ROMS for School Library Media Collections.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., March 18, 1997.

Hall-Ellis, Sylvia D. *Cataloging Audiovisual Materials in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 27, 1997, November 7, 1996 and October 24, 1996.

Hall-Ellis, Sylvia D. *Introduction to Dialog: Basic Searching Strategies.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., February 14, 1997.

Hall-Ellis, Sylvia D. *Cataloging Books in USMARC.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 30, 1997, October 10, 1996, September 26, 1996 and August 8, 1996.

Hall-Ellis, Sylvia D. *Advanced Internet Searching Techniques for Librarians.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., January 21, 1997.

Hall-Ellis, Sylvia D. *Texas Library Connection Full-Text Searching.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 13, 1996 and October 25, 1996.

Hall-Ellis, Sylvia D. *Developing Evaluation Strategies for Grants and Proposals.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., December 10, 1996.

Hall-Ellis, Sylvia D. *Developing Needs Assessment for Grants and Proposals.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 12, 1996.

Hall-Ellis, Sylvia D. *Texas Library Connection Union Catalog Searching.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., November 8, 1996 and September 6, 1996.

Hall-Ellis, Sylvia D. *Grant Resources on the Internet.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 23, 1996.

Hall-Ellis, Sylvia D. *Preparing a Response to the Telecommunications Infrastructure Fund Board: Needs Assessment, Professional Development Framework, and Evaluation Strategies.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., October 16, 1996.

Hall-Ellis, Sylvia D. *Texas Library Connection: Building the Districtwide Bibliographic Database.* Sponsored and hosted by Mercedes Independent School District, Mercedes, Tex., September 13, 1996 and August 8, 1996. Sponsored and hosted by Los Fresnos Consolidated Independent School District, Los Fresnos, Tex., August 12, 1996.

Hall-Ellis, Sylvia D. *School-to-Work and Special Education: An Inclusive Partnership for Success.* Sponsored and hosted by the Office of Special Education, Region One Education Service Center, Edinburg, Tex., September 11, 1996.

Hall-Ellis, Sylvia D. *Telecommunications Infrastructure Fund Board: An Overview of Funding for Secondary Schools.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., August 31, 1996.

Hall-Ellis, Sylvia D. *Cataloging Books, Multimedia, and Realia in USMARC.* Sponsored and hosted by Edinburg Consolidated Independent School District, Edinburg, Tex., August 6, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers.* Sponsored and hosted by Region One Education Service Center, Edinburg, Tex., April 20, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills for Mathematics Educators: Writing Skills for Campus Teams.* Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 22, 1996.

Hall-Ellis, Sylvia D. *Internet Resources for Grant Writers.* Sponsored and hosted by the College of Education and Applied Science, Sam Houston State University, Huntsville, Tex., March 9, 1996.

Hall-Ellis, Sylvia D. *Grant Writing for Mathematics Educators: A Development Process for Campus Teams.* Sponsored and hosted by the Office of General Education, Region One Education Service Center, Edinburg, Tex., March 4, 1996.

Hall-Ellis, Sylvia D. *Shaking the Money Tree: Preparing Successful Technology Grant Applications.* Sponsored and hosted by the Office of Technology and Media Services, Region One Education Service Center, Edinburg, Tex., February 29, 1996 and April 29, 1996.

Hall-Ellis, Sylvia D. *District-wide Technology Planning: Technical Assistance for the Texas Education Agency Initiative.* Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., February 2, 1996.

Hall-Ellis, Sylvia D. *Enhanced Grant Writing Skills.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 27, 1996.

Hall-Ellis, Sylvia D. *United States Copyright Act of 1976, Video Transmissions, Computer Software and the Internet.* Sponsored and hosted by the Office of Technology and Media, Region One Education Service Center, Edinburg, Tex., January 24, 1996.

Hall-Ellis, Sylvia D. *The Grant Writing Development Process.* Sponsored and hosted by Pharr-San Juan-Alamo Independent School District, Pharr, Tex., January 20, 1996.

Hall-Ellis, Sylvia D. *MARC Cataloging of Materials for Library Media Centers.* Sponsored and hosted by the Office of Media Services, Region One Education Service Center for the Donna Independent School District, Donna, Tex., August 17, 1995.

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Hall-Ellis, Sylvia D. *Classification.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 10, 1995.

Hall-Ellis, Sylvia D. *Library Technical Services.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., April 26, 1995.

Hall-Ellis, Sylvia D. *Grant Writing: An Introduction for Public School Administrators.* Sponsored and hosted by the Office of Administrative Services, Region One Education Service Center, Edinburg, Tex., April 19, 1995.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by the United Independent School District, Laredo, Tex., March 31, 1995.

Hall-Ellis, Sylvia D. *Using USMARC.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 29, 1995.

Hall-Ellis, Sylvia D. *Library Media Center Policies and Guidelines: How to Prepare for School Board Adoption.* Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., March 10, 1995.

Hall-Ellis, Sylvia D. *Developing District-wide Policies and Guidelines for Library Media Centers.* Sponsored and hosted by the Office of Technology and Media Services, La Joya Independent School District, La Joya, Tex., January 10, 1995.

Hall-Ellis, Sylvia D. *MARC Cataloging of Audiovisual Materials for Library Media Centers.* Sponsored and hosted by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., December 1, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by United Independent School District, Laredo, Tex., October 14, 1994.

Hall-Ellis, Sylvia D. *The School Library Media Specialist in the 21st Century: Visions for the Future.* Sponsored and hosted by the Laredo Independent School District, Laredo, Tex., October 7, 1994.

Hall-Ellis, Sylvia D. *MARC Cataloging for Library Media Centers.* Sponsored by the Office of Library Media and Technology Services, Cypress-Fairbanks Independent School District, Houston, Tex., October 5, 1994.

Hall-Ellis, Sylvia D. *Jump to the Head of the Class: Undergraduate Library Resources Available at Sam Houston State University.* Sponsored by the Office of the Associate Vice President for Student Services, Sam Houston State University, Huntsville, Tex., October 4, 1994.

Hall-Ellis, Sylvia D. *CD-ROMs - 1994's Newest and the Best for Secondary Level Media Centers.* Sponsored and hosted by Clear Lake Independent School District, Houston, Tex., June 3, 1994.

Hall-Ellis, Sylvia D. *Introduction to Classification.* Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., May 18, 1994.

Hall-Ellis, Sylvia D. *Basic Descriptive Cataloging.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., May 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part II: Writing Successful Grant Applications.* Sponsored by Donna Independent School District, Donna, Texas, and Region One Education Service Center Edinburg, Texas; presented at South Texas Community College Library, McAllen, Tex., April 29, 1994.

Hall-Ellis, Sylvia D. *Using MARC.* Sponsored by AJ Seminars, Rockville, Maryland; presented at Holiday Inn, Market Center, Dallas, Tex., April 6, 1994.

Hall-Ellis, Sylvia D. *Automated Authority Control.* Sponsored by AJ Seminars, Rockville, Maryland; presented at University Hilton Hotel, Houston, Tex., March 23, 1994.

Hall-Ellis, Sylvia D. *Automating the District School Library Media Centers: Choices and Opportunities.* Sponsored and hosted by the Office of Technology and Library Media Services, Fort Bend Independent School District, Sugar Land, Tex., March 4, 1994.

Hall-Ellis, Sylvia D. *Shaking the Money Tree - Part I: Preparing Successful Grant Applications.* Sponsored and hosted by the Office of Library Media Services, Donna Independent School District, Donna, Tex., February 4, 1994.

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GRADUATE COURSES TAUGHT

San José State University, School of Library and Information Science
INFO 249 – Advanced Cataloging and Classification (Fall 2015, 2016; Summer 2016)
INFO 287 – Special Topics in Cataloging and Classification (Spring 2017, 2018)
LIBR 248 – Beginning Cataloging and Classification (Summer 2002, 2003, 2004, 2005, 2006)
LIBR 249 – Advanced Cataloging and Classification (Summer 2003; Fall 2014; Summer 2015)

University of Denver, Morgridge College of Education
HED 5991 – Grant Writing in Higher Education (Spring 2011)
LIS 4010 – Organization of Information (Fall 2002, 2003, 2004, 2005, 2006, 2009; Winter 2005; Spring 2004, 2005, 2006)
LIS 4020 – Professional Principles and Ethics (Summer 2000)
LIS 4040 – Management of Libraries and Information Centers (Fall 2010; Spring 2003, 2009 (DS); Winter 2005)
LIS 4070 – Cataloging and Classification (Winter 2008, 2009, 2010, 2011, 2012; Fall 2009 (DS))
LIS 4321 – Collection Management (Spring 2005)
LIS 4326 – LIS Research (Winter 2009 (DS); Spring 2009 (DS))
LIS 4350 – Adult Materials and Services (Summer 2006, 2009)
LIS 4379 – Social Sciences Resources (Spring 2009)
LIS 4400 – Cataloging and Classification (Spring 2000, 2001; Winter 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Summer 2005, 2006 – course renumbered LIS 4070, September 2007)
LIS 4401 – Descriptive Cataloging (Winter 2001; Spring 2002, 2003, 2006, 2007, 2008, 2009; Summer 2005)
LIS 4402 – Subject Cataloging (Spring 2001, 2009; Summer 2005, 2006, 2007, 2008)
LIS 4403 – Classification Schemes (Fall 2007, 2008, 2009 (DS))
LIS 4405 – Authority Control (Winter 2009)
LIS 4510 – Materials and Services for Children (Winter 2004; Summer 2005)
LIS 4620 – Grant Writing and Fundraising (Summer 2000, 2002, 2004, 2010; Winter 2006; Fall 2006, 2007, 2008, 2009)
LIS 4700 – Seminar in Technical Services (Fall 2001)
LIS 4700 – Seminar in Public Libraries (Summer 2002)
LIS 4804 – Management of Electronic Records (Spring 2004; Fall 2005)
LIS 4902 – Capstone Projects (Winter 2003, Spring 2008, 2009, 2011)
LIS 4910 – Independent Study (every quarter Winter 2000 through Spring 2011)
LIS 4920 – Service Learning (every quarter Summer 2004 through Spring 2011)
RMS 4954 – Grant Writing (Summer 2013, 2014)
RMS 4959 – Content Analysis Methodology (Spring 2015)
QRM 4978 – Grant Writing (Summer 2011, 2012)

Rutgers University, School of Communication and Information
SC&I 522 – Cataloging and Classification (Summer 2013)

University of Arizona, College of Behavioral and Social Sciences
LIS 602 – Cataloging and Classification (Summer 1995)
LIS 612 – Advanced Online Search and Retrieval (Summer 1995)

Sam Houston State University, College of Education & Applied Science
LIS 532 - Cataloging and Classification (Fall 1993, 1994, 1995)
LIS 563 - Advanced Cataloging and Classification (Summer 1994)
LIS 567 - Research Methods (Spring 1994, Spring 1995)
LIS 591 - Educational Technology (Spring 1994, 1995)
LIS 596 - Networking and Computer Technologies in Education (Fall 1993, Summer 1994, Fall 1995)

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Dissertations at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale.* Chair, May 5, 2010.

Fattor, Melissa M. *Student Engagement Differences by Ethnicity and Scale for Ninth Grade Students.* Chair, November 1, 2010.

Fulton, Roseanne. *A Case Study of Culturally Responsive Teaching in Middle School Mathematics.* Kent Seidel, Chair, June 18, 2009, Outside Chair.

Grealy, Deborah S. *Tribes and Territories in Library and Information Studies Education.* Bruce Uhrmacher, Chair, June 10, 2008, Committee Member.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice.* Chair, April 15, 2011.

Priebe, Sarah J. *Distinguishing Effects of Domain and General Knowledge on Passage Fluency and Comprehension.* Jan Keenan, Chair. July 21, 2011, Outside Chair.

Snyder-Mondragon, Sandra M. *Institutional Factors that Impact the Retention of Graduate Students of Color in Schools of Library and Information Science: A Metaregression of Accredited Library School Statistics on Student Retention and Graduation Rates.* Kathy Green, Chair, July 24, 2009, Committee Member.

Taylor, Karen Pickles. *Effective Teaching.* Elinor Katz, Chair, July 15, 2009, Outside Chair.

Thompson, Jennifer. *Distinguishing a Western Women's College: A History of the Curriculum and Student Experience at Colorado Women's College.* Edith W. King, Chair, July 16, 2010, Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions.* Chair, April 29, 2010.

Dissertation Proposals at the University of Denver

Bowers, Stacey L. *Library Anxiety of Law School Students: A Study Utilizing the Multidimensional Library Anxiety Scale.* Chair, November 5, 2009.

McCord, J. Michael. *Developing a Standard of Care for Educational Malpractice.* Edith W. King, Chair. April 23, 2010.

Thompson, Jennifer. *History of Colorado Women's College.* Edith W. King, Chair, October 30, 2008. Committee Member.

Walker, Emelda. *Influence of Organizational Factors on Job Satisfaction of Disability Service Providers at Postsecondary Institutions.* Chair, July 21, 2009.

Dissertations at Other Institutions

Rodríguez-Mori, Howard. *The Information Behavior of Puerto Rican Immigrants to Central Florida, 2003-2009: Grounded Analysis of Six Case Studies Use of Social Networks during the Migration Process.* Kathleen Burnett, Chair, April 10, 2009, Florida State University, Committee Member.

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools.* D. Mirah Dow, Chair, July 18, 2017. Emporia State University, Committee Member.

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Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers.* Shawne D. Miksa, Chair, August 1, 2011. University of North Texas, Committee Member.

Dissertation Proposals at Other Institutions

Schwartz, Brian *More than a Look-up Skill: Medical Information Literacy Education in Osteopathic Medical Schools.* D. Mirah Dow, Chair, December 4, 2015. Emporia State University, Committee Member.

Snow, Karen. *A Study of the Perception of Cataloging Quality among Catalogers.* Shawne D. Miksa, Chair, May 11, 2010. University of North Texas, Committee Member.

Master's Thesis at the University of Denver

Hemingson, Jeff. *Recital Paper*. Lamont School of Music, February 2010, Outside Chair.

Capstones at the University of Denver

Anthony, Alisa. *Correlation of Library and Information Science Program outcomes and Vacant Position Qualifications Listed on the Colorado State Library Jobline by Employers During the Period September 1, 2000 through August 31, 2002.* Chair, Winter Quarter, 2003.

Borden, Donna M. *Improving Emergency Communications Systems: Is a Radio Communications Network the Answer?* Fall Quarter, 2014.

Bowden, Heather L.M. *Exploring Biological Models for Long-term Data Preservation.* Chair, Spring Quarter, 2008.

Casenada, Cassandra Y. *Challenges to the Recruitment, Education, and Retention of Librarians of Color*. Chair, Spring Quarter, 2008.

Chang, Jennifer C. *Legal Research Practice and Preference: A Law Firm Perspective.* Chair, Spring Quarter 2011.

Ellis, Megan S. Fitzgerald. *Design of a Public Library Adult Volunteer Recruitment Program and Training Curriculum.* Chair, Winter Quarter, 2003.

Kircher, Kathy. *Development of a Library Pathfinder for Exobiology and Posting it on the Internet.* Chair, Winter Quarter, 2003.

Melhado, Loretta. *Design of St. John's Episcopal Church Library.* Chair, Spring Quarter, 2008.

Radcliff, Kathy. *Original Cataloging of Archival materials in the HERS Collection in Penrose Library.* Chair, Winter Quarter, 2003.

Sass, Carol Ann. *ACT Periodical Index: Access to Catholic Thinking Periodical Index: Web Index to Select Catholic Periodicals.* Spring Quarter 2000.

Stone, Sergio D. *Conducting Community Analysis for the Bemis Public Library (Littleton, Colorado) Using 2002 U.S. Census Data and the Online Outcome-Based Evaluation Toolkit.* Chair, Winter Quarter, 2003.

Tureson, Tamara. *Design and Use of an Information Audit Tool for Use in a Law Library.* Chair, Winter Quarter, 2003.

Tweed, Beth. *Evaluation of Email Reference Service in a Consumer Health Library Environment.* Chair, Winter Quarter, 2003.

GRANTS AND CONTRACTS

Student Learning in Agriculture STEM through Teacher Professional Development. Research team: Stanton Gartin (PI) and Cyndi Hofmeister, Northeast Junior College; Jeff Cash, Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Jack Wiley, Kerry Gabrielson, Trinidad State Junior College; Michael J. Miller, Colorado State University; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Agriculture and Food Research Initiative, Food, Agriculture, Natural Resources and Human Sciences Education and Literacy Initiative, $404,460 (2017-2020)

Leading and Achieving: the Colorado Agriculture Regional Consortium. Research team: Jack Wiley (PI), Kerry Gabrielson, Trinidad State Junior College; Jeff Cash (PI), Cheryl Sánchez, Anne-Marie Crampton, Lamar Community College; Suzanna Spears, Morgan Community College; Cyndi Hofmeister, Northeast Junior College; Michael Womochil (Co-PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Agriculture, Hispanic Serving Institutions Education Grants Program, $504,414 (2017-2020)

Cyber Prep Program Planning Grant. Research team: Debbie Sagen (PI), Brenda Lauer, Pikes Peak Community College; Gretchen Martin, Koiosa Insights; and, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Commerce, Regional Alliances and Multi-stakeholder Partnerships to Stimulate (RAMPS) Cybersecurity Education and Workforce Development, $199,681 (2016-2018)

Career and Technical Education in Colorado: Pathways to Education and Employment. Research team: Heather McKay (PI), Rutgers University; Sarah Heath, Casey Sacks, Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, Institute of Education Sciences, $1,400,000 (2017-2021)

Pre-Alliance Planning Grant Colorado Community College Alliance. Research team: Victor Vialpondo (PI) and Janel Highfill, Community College of Aurora; Heidi Loshbaugh (Co-PI), Community College of Denver; Rick Reeves, Bill McGreevy, Liz Cox, and Kristin Aslin, Red Rocks Community College; Cathy Pellish, Front Range Community College; Samuel DeVries, Arapahoe Community College; Sylvia D. Hall-Ellis, Colorado Community College System. National Science Foundation, Louis Stokes Alliance for Minority Participation (LSAMP), $86,817 (2016-2017)

Towards Scalable Differentiated Instruction Using Technology-enabled, Competency-based, Dynamic Scaffolding. Research team: Karen Wilcox (PI) and Vijay Kumar, Center for Computational Engineering, Massachusetts Institute of Technology; Flora McMartin, Broad-based Knowledge; Quinsigamond Community College; and, Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Education, First in the World Developmental Grant, $2,891,882 (2015-2019)

Colorado Strategic Partnerships Emergency Grant. Research team: Elise Lowe-Vaughn (PI), Amy Hodson, Celia Hardin, Barbara McBride, James Newby, Christopher Dewhurst, Nina Holland, Kate Anderson, MaryAnn Roe, Chrystalynn Chrystalynn, Elaine Edon, Mona Barnes, Tom Morgan, Rob Hanni, and Marie Valenzuela, Colorado Department of Labor and Employment; Steve Anton, Joelle Brouner, and, Katie Griego, Colorado Department of Human Services; Rebecca Holmes, Judith Martinez, and Jennifer Jirous, Colorado Department of Education; Emily Templin Lesh, Colorado Workforce Development Council; Cory Everett, Colorado Department of Regulatory Agencies; and, Casey Sacks and Sylvia D. Hall-Ellis, Colorado Community College System. U.S. Department of Labor, Strategic Partnerships Emergency Grant, $5,000,000 (2015-2017)

CAEL Jump Start Program: Competency-Based Education. Research team: Jerry Migler (PI), Casey Sacks, Debra Cohn, Thomas Hartman, and Sylvia D. Hall-Ellis, Colorado Community College System; Matt Jamison, Front Range Community College; Mike Coste, Red Rocks Community College; Amanda Corum, Pueblo Community College; Janet Colvin, Pikes Peak Community College; and, MaryAnn Matheny, Community College of Denver. Council for Adult and Experiential Learning, $15,000 (2015)

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Summit on the Redesign of Developmental Education. Research team: Jerry Migler (PI), Casey Sacks, and Sylvia D. Hall-Ellis, Colorado Community College System; Chip Nava, Pueblo Community College; Kim Moultney, Arapahoe Community College; Debbie Ulibarri, Trinidad State Junior College; and, Kris Bernard, Front Range Community College. American Association of Community Colleges, $15,000 (2015-2016)

Equity in Excellence at Colorado Community Colleges. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Estela Mata Bensimon, Center for Urban Education, University of Southern California; and Kerry Gabrielson, Trinidad State Junior College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $150,000 (2015-2016)

MBA High School of Business in Colorado. Research team: Laurie Urich (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Rudolph Sumpter and Beatrice Gerrish, Boulder Valley Schools; Keith Curry Lance, RSL Research Group. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $501,295 (2015-2016)

Fullbridge Program in Colorado. Research team: Keith Howard (PI) and Sylvia D. Hall-Ellis, Colorado Community College System; Suzanna Spears, Fort Morgan Community College; and, Cheryl Sánchez and Anne-Marie Compton, Lamar Community College. Colorado Department of Higher Education, Colorado Opportunity Scholarship Program, $300,000 (2015-2017)

Colorado Community College System Alternative Credit Program. Research team: Jerry Migler (PI), Keith Howard, and Sylvia D. Hall-Ellis, Colorado Community College System. American Council on Education, $13,000 (2015)

Internationalization in Higher Education. Researcher: Samuel D. Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $8,000 (2014-2015)

International Perspectives on Bilingual Education. Researcher: Sharolyn Pollard-Durodola. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $3,700 (2014-2015)

Cultivating Culturally Relevant and Responsive Curriculum and Pedagogy in College. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, iRise Grant, $5,000 (2014-2015)

Project EMERGE (Educational Model for Evaluation and Replicability in Gifted Environments). Research team: Norma Hafenstein (PI) and Bruce Uhrmacher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Lynde and Harry Bradley Foundation, $235,000 (2014-2015)

Collecting Asian American Refugee Stories. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. American Educational Research Association, Research Grant, $5,000 (2014-2015)

Developing Expertise in Teaching K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas H. Clements (Co-PI), in partnership with the School of Education at the University of Michigan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $130,344 (2013-2015)

Investigation of the Long-Term Outcomes for Special Education Students. Researcher: Antonio Olmos-Gallos. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Jefferson County School District, Office of Assessment, $40,000 (2014)

Refugee Community Collaboration. Researcher: Vicki Tomlin (PI) in partnership with the African Community Center and Jewish Family Service. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $14,854 (2014-2015)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Access to Mathematics for All. Research team: Richard S. Kitchen (PI), Nicole M. Russell (Co-PI), and Terrence Blackman (Co-PI), Curriculum Studies and Teaching Program, Morgridge College of Education; Álvaro Árias (Co-PI, Department of Mathematics); and, James Gray (Co-PI), Department of Mathematics, Community College of Aurora. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, The Robert Noyce Scholarship Program, Capacity Building Project, $349,926 (2014-2016)

Cognitive Test Battery for Intellectual Disabilities. Research team: Karen Riley (PI), Lyndsay Agans, Jessica Lerner, and Karin Dittrick-Nathan in partnership with David Hessl (PI), The MIND Institute at the University of California – Davis, and Elizabeth Berry-Kravis, Rush University Medical Center. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Institutes of Health, Outcome Measures for Use in Treatment Trials for Individuals with Intellectual and Developmental Disabilities (R01), $2,499,996 ($588,672 at DU) (2014-2019)

Broadening Participation in Engineering among Women and Latino/as: A Longitudinal, Multi-Site Study. Researcher: Patton Garriott (PI) in partnership with the University of North Dakota and the University of Missouri. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, HER Core Research, $677,390 ($69,992 at DU) (2014-2019)

Designing a Teacher Evaluation System to Improve Teacher Effectiveness for Culturally and Linguistically Diverse Learners. Research team: María del Carmen Sálazar (PI), Jessica Lerner, and Kathy Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $29,988 (2014-2016)

Developing a College-Going Culture in Latina/O Families: Exploring the Influence of Funds of Knowledge on Family Outreach Programs. Researcher: Judy Marquez Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $18,720 (2014-2016)

Assessment of Quality of Life in Neutral Implantation Surgery for the Treatment of Parkinson's Disease. Researcher: Cynthia McRae. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $3,967 (2014-2015)

Pura Vida: Cloud Forest, Curriculum and Cross-Cultural Study. Research team: Norma Hafenstein (PI) and Bruce Uhrmacher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $8,000 (2014-2015)

Online Course Development for Curriculum and Instruction. Researcher: Ruth Chao. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: María del Carmen Sálazar. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Jessica Lerner. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

Online Course Development for Curriculum and Instruction. Researcher: Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2014)

The Mathematics Education of African Americans, 1866 – 1954. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, $55,000 (2014-2016)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Early Childhood Care and Education Study. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota, Department of Public Instruction, $73,500 (2013-2014)

Graduate Level Specialty in Addiction Counselor Training with Emphasis on Integration of Native American Specific Content. Research team: Ruth Chao (PI) and Michael J. Faragher (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Galena Foundation, $289,732 (2013-2016)

The Collecting Asian American and Pacific Islander Refugee Stories (CARS) Project. Researcher: Samuel Museus. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $15,000 (2014)

Parents in Transition: A Multiple Case Study of Parent and Family Orientation Programs. Researcher: Judy Marquéz Kiyama. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $1,500 (2014-2015)

The Sistah Network: Black Women Graduate Students Supporting and Retaining Each Other. Researcher; Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,708 (2014-2015)

Evaluation of the Northeast Denver Babies Ready for College Program. Research team: Carrie Germeroth (PI), Melissa Mincic, and Douglas H. Clements. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High Montessori, $9,922 (2013-2014)

Developing Teaching Expertise in K-5 Mathematics. Research team: Julie Sarama (PI) and Douglas Clements (University of Denver), in partnership with Timothy Boerst (PI), Meghan Shaughnessy, Deborah Ball, Hyman Bass (School of Education at the University of Michigan). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $449,827 ($130,344 at the University of Denver (2013-2015)

Early Learning Care and Education Study Program Grant for the State of North Dakota. Research team: Carrie Germeroth (PI), Melissa Mincic, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. State of North Dakota Department of Public Instruction, $73,500 (2013-2014)

Local Professional Learning Community for School Leaders. Research team: Susan Korach (PI), Kristina Hesbol, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Education Development Center, $10,950 (2013)

Healthy Eaters, Lifelong Movers 2: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado. Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $3,103,108 (2013-2017)

Hughes Rare Books Library Room Renovation in the Sturm College of Law. Project team: Patti H. Marks, Sylvia D. Hall-Ellis, and Leigh Elliott. Mabel T. Hughes Charitable Trust, $34,000 (2013-2014)

The Promise Center Partnership with the Marsico Institute for Early Learning and Literacy and the City and County of Denver. Research team: Karen Riley (PI), Douglas H. Clements (Co-PI), and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. The Piton Foundation, $223,468 (2013-2014)

Center of Excellence for Problem Gambling. Research team: Ruth Chao (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $68,021 (2012-2013)

United Way Implementation and Validation Review. Research team: Douglas H. Clements (PI), Amanda Moreno, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, $19,737 (2013)

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Math/Science Partnership in Rural Districts. Research team: Kristen Bunn (PI, Eagle County Schools), Paul Michalec (Co-PI), and Alegra Reiber. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Colorado's Mathematics and Science Partnership Program, $750,000 (2013-2014)

Mathematics and Science Education of African Americans. Research team: Nicole Russell (PI), Sylvia D. Hall-Ellis, Steve Fisher (Penrose Library). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $29,994 (2013-2015)

Online Course Development for Curriculum and Instruction. Researcher: Nicole Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $3,000 (2013)

Discourse and Opportunity: Undocumented Students and Higher Education Policy. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Academy of Education, Spencer Foundation Postdoctoral Fellowship, $55,000 (2012-2014)

An Anthropological Study of the Latino Graduation Ceremony. Researcher: Ryan Gildersleeve. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Spencer Foundation, $39,900 (2012-2013)

Fragile-X and Pharmaceutical Company: Clinical Trial of AFQ056. University of California – Davis Children's Hospital MIND Institute (Sacramento), Children's Hospital Denver, and Rush Children's Hospital at Rush University Medical Center (Chicago). Karen Riley, PI. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Novartis Pharmaceuticals Corporation, $394,206 (2012-2014)

Project Engage, Phase 2, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University. Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, $60,000 (2011-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $14,951 (2012-2013)

Online Course Development for Curriculum and Instruction. Research team: Bruce Uhrmacher (PI) and Norma Hafenstein (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Teaching and Learning, $18,193 (2012-2014)

Writers in the Schools. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI).Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Humanities, $4,965 (2012-2013)

Learning Ecosystem Validation Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, $315,000 (2012-2013)

Project Words of Oral Reading and Language Development (WORLD). Research team: Jorge E. Gonzalez (PI), Texas A&M University; Laura Saenz (Co-PI), University of Texas – Pan American; and, Sharolyn Pollard-Durodola (Co-PI), University of Denver. Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $53,354 (2012-2015); award $640,718, transfer from Texas A&M University

Increasing the Efficacy of an Early Mathematics Curriculum with Scaffolding Designed to Promote Self-Regulation. Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $1,445,315 (2008-2014); award $4,541,975, transfer from University at Buffalo, The State University of New York

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US PATENT NO. 6,557,540

Using Rule Space and Poset-based Adaptive Testing Methodologies to Identify Ability Patterns in Early Mathematics and Create a Comprehensive Mathematics Ability Test. Research team: Douglas H. Clements (PI) and Julie Sarama (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $323,791 (2010-2014); award $1,194,944, transfer from University at Buffalo, The State University of New York

Comprehensive Postdoctoral Training in Scientific Education Research. Researcher: Julie Sarama (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Education, Institute of Education Sciences, $133,458 (2010-2014); award $613,353, transfer from University at Buffalo, The State University of New York

Longitudinal Study of a Successful Scaling Up Project: Extending TRIAD. Research team: Douglas H. Clements (PI), Julie Sarama (Co-PI), and Abt Associates (Carolyn Layzer, Fatih Unlu, Laurie Bozzi, Lily Fesler, Alina Martinez, Cristofer Price, James van Orden). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, $384,940 (2011-2015; award $1,250,286, transfer from University at Buffalo, The State University of New York

Early Childhood Education in the Context of Mathematics, Science, and Literacy. Research team: Julie Sarama (PI), Douglas H. Clements (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. National Science Foundation, $990,020 (2010-2014; award $2,285,228, transfer from University at Buffalo, The State University of New York

Early Childhood Clearinghouse Information Center Redesign. Research team: Karen Riley (PI) and Amanda Moreno (Co-PI).Technical reviewer for MCE: Sylvia D. Hall-Ellis. Office of the Lt. Governor of Colorado, $12,000 (2012-2013)

Morgridge Rural Educational Leadership Initiative. Research team: Lyndsay Agans (PI), Linda Brookhart (Co-PI), Susan Korach, and Rebecca McClure. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, $100,000 (2012-2014)

Center of Excellence for Problem Gambling. Research team: Patrick Sherry (PI) and J. Mike Faragher. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $55,000 (2012-2013)

Intermodal Transportation Institute Research Initiatives. Researcher: Patrick Sherry. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University Transportation Centers Program, Research and Innovative Technology Administration, U.S. Department of Transportation. $600,000 (2012-2014)

Mile High United Way Social Innovation Fund Early Literacy Initiative. Gloria L. Miller, PI, Amanda Moreano, Kim Hartnett-Edwards, and Sheridan Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Mile High United Way, $89,992 (2012-2013)

International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, $1,000 (2012-2013)

Refugee Student Art Outreach. Researcher: Karin Dittrick-Nathan. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $3,000 (2012-2013)

Resistance, Resilience, and Reciprocity: Centering the Voices of Black Doctoral Women with Faculty Aspirations. Researcher: Nicole M. Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,965 (2012-2013)

Assessing Learning through Student Notebooks. Research team: Keith Miller, Nancy Sasaki, and Kathy Green. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Professional Research Opportunities for Faculty, $30,000 (2012-2014)

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International School Psychology Practicum Exchange. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $2,000 (2012-2013)

ELO in Colorado. Research team: Cynthia Hazel and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Legacy Foundation, $150,000 (2012-2013)

Creating Online LIS Courses. Research team: Mary C. Stansbury (PI), Shimelis Assefa, Denise Anthony, Xiao Hu, and Krystyna Matusiak. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $15,000 (2011-2013)

Maritime Piracy Seminar. Researcher: Ved Nanda, The Nanda Center, Sturm College of Law. Technical reviewer for Sturm College of Law: Sylvia D. Hall-Ellis. Arsenault Family Foundation, $15,000 (2012-2013).

Early Childhood Librarianship: An Interdisciplinary, Experiential Learning MLIS. Researcher: Mary C. Stansbury (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, $249,066 (2012-2014)

Learning Ecosystem Planning Grant. Research team: Karen Riley (PI), Lyndsay Agans, Kent Seidel, and Shimelis Assefa. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Bill & Melinda Gates Foundation, $281,217 (2011-2012)

Advanced Service Learning Practitioner Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Community Engagement and Service Learning, $400 (2011)

Evaluating and Enhancing the EspeciallyMe Program. Research team: Lori D. Patton and Nicole Russell. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Fellowship Grant, $24,780 (2012)

Choosing Excellence: Let Every Child Bloom. Research team: Shimelis Assefa (PI) and Mary C. Stansbury (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Community Engagement and Service Learning, Public Good Grant, $7,657 (2012)

K-8 STEM Content Specific Professional Development to Improve Elementary Student Achievement. Research team: Kent Seidel (PI), Nicole Russell (Co-PI), Kimberly Hartnett-Edwards, Paul Michalec, Jeff Farmer, Keith Miller, Alegra Reiber, and Nancy Sasaki. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Education, Improving Teacher Quality Grant, (Title II ESEA), $307,299 (2011-2012)

Building a Better Principal Pipeline to Boost Student Achievement. Researcher: Susan Korach. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Denver Public Schools; a subcontract from the Wallace Foundation Grant, $170,000 (2011-2017)

Center of Excellence for Problem Gambling. Research team: J. Mike Faragher (Co-PI) and Bobbie Vollmer (PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Department of Behavioral Health, $79,999 (2011-2012)

An Exploration of Novice Teachers' Core Competencies: Impacts on Student Achievement, and Effectiveness of Preparation. Research team: Kent Seidel (PI), Kathy Green (Co-PI), Kimberly Hartnett-Edwards, and Duan Zhang. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Institute of Education Sciences, Effective Teachers and Effective Teaching, $990,987 (2012-2015)

Project Engage, a DAPRA Grant in partnership with Total Immersion Systems, Inc., and Texas A&M University. Research team: Karen Riley (PI) and Lyndsay Agans (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. U.S. Department of Defense, $49,964 (2011-2014)

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User-centered Evaluation of Music Search Engines. Researcher: Xiao Hu. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Faculty Research Fund, $2,931 (2011-2012)

Educational Practicum in Vietnam and China to Promote the Inclusion of Young Children with Disabilities. Researcher: Gloria L. Miller. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Office of Internationalization, $5,000 (2011-2012)

Evaluation of Colorado's Enhancing Quality in Infant-Toddler (EQIT) Initiative. Research team: Virginia R. Maloney and Amanda Moreno. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Buell Foundation, $395,884 (2011-2013)

Creating Engaging Environments to Teach Pre-Algebra Mathematics to Elementary Students. Research team: Álvaro Arias, Mario López, María del Carmen Salazar, and Lyndsay Agans. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver Interdisciplinary Grant, $60,000 (2011-2012)

Morgridge Education Technology Accessible (META) Resource Project. Research team: Lyndsay Agans (PI) and Shimelis Assefa (Co-PI). Technical reviewer for MCE: Sylvia D. Hall-Ellis. Morgridge Family Foundation, $36,000 (2011)

MCE Connect: A 21st Century Framework for Faculty Development. Research team: Bruce Uhrmacher (PI), Shimelis Assefa (Co-PI), Lyndsay Agans (Co-PI), Kimberly Hartnett-Edwards, Norma Hafenstein, Xiao Hu, Paul Michalec (Co-PI), María del Carmen Salazar (Co-PI), and Sandra Snyder-Mondragon. Technical reviewer for MCE: Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $22,355 (2011-2012)

Parent Education and Parent Leadership and Advocacy. Research team: Virginia Maloney (PI) and Amanda Moreno, Marsico Institute for Early Learning and Literacy. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $27,358 (2010-2011)

Intentional School Culture. Researcher: Cynthia Hazel. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Denver Public Schools, $38,040 (2010-2011)

Healthy Eaters, Lifelong Movers: Implementing Evidence-Based School Environment, Policy, and Curricular Changes to Increase Opportunities for Healthy Eating and Physical Activity in Low Income, Rural Colorado. Research team: Elaine Berlansky, University of Colorado at Denver (PI), Nicholas Cutforth, University of Denver (Co-PI), and Allison Reeds. Technical reviewer for MCE: Sylvia D. Hall-Ellis. Colorado Health Foundation, $1,683,277 (2011-2014)

Second Life Learning Community. Research team: Don McCubbrey (PI), Sylvia D. Hall-Ellis (Co-PI), Walter LaMendola, and Paul Novak. University of Denver, Center for Teaching and Learning, $13,000 (2010-2011)

Reintroducing the Value of Law Librarians to Academic and Public Librarians in Colorado through the Identification and Use of Emerging Technologies. Research team: Sylvia D. Hall-Ellis (Co-PI), Stacey L. Bowers (PI), and Christopher Hudson, in partnership with Denver Public Library, Arapahoe Library District, and the Colorado State Supreme Court Library. University of Denver, Center for Community Engagement and Service Learning, $5,773 (2010-11)

Reintroducing the Value of Law Librarians to Public Librarians through the Identification and Use of Emerging Technologies and Resources. Research team: Stacey Bowers (PI) and Sylvia D. Hall-Ellis (Co-PI). American Association of Libraries, Wolters Kluwer Law & Business Grant Program, $2,725 (2010-2011)

Faculty Service Learning Pod. Research team: María del Carmen Salazar and Nicholas Cutforth (Curriculum and Instruction Program), Frank Tuitt (Higher Education Program), Cynthia Hazel and Gloria Miller (Child, Family, and School Psychology Program), and Sylvia D. Hall-Ellis (Library and Information Science Program). University of Denver, Center for Community Engagement and Service Learning, $8,000 (2010-2011)

Lincoln Collaborative. Research team: Antonio Esquibel (Principal, Lincoln High School), María del Carmen Salazar (Curriculum and Instruction Program), and. Sylvia D. Hall-Ellis. School Improvement Grant, Denver Public Schools, $375,000 (2010-2012)

Future LEADers of America: Leaders III. Research team: Denver Public Library (Kristen Svendson, PI), the University of Denver (Sylvia D. Hall-Ellis), the Colorado Chapter of REFORMA (Orlando Archibeque), and the Colorado Association of Libraries (Martin Garnar). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $988,366 (2009-2012)

Teaching for Success in the Library Environment: LIS 4030 in Library 2.0. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis (Co-PI). University of Denver, Center for Teaching and Learning, $ 9,350 (2009-10)

Writing Group Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Community Engagement and Service Learning, $750 (2008-2009)

Collaborative Learning Faculty Grant, Sylvia D. Hall-Ellis, University of Denver, Center for Teaching and Learning, $1,500 (2008)

Connecting Information Literacy to Learning. Research team: Lori Micho, Merrie Valliant, Amanda Samland, and Sylvia D. Hall-Ellis. Colorado State Library, LSTA Discretionary Grant Program, $19,548 (2008-2009)

Law Librarianship Fellows Program. Research team: Sylvia D. Hall-Ellis (PI), Stacey Bowers (Co-PI), and Christopher Hudson, Westminster Law Library. Laura Bush's 21st Century Librarians Program, Institute for Museums and Library Services, $999,370 (2008-2012)

Grant Writing in a Cooperative Learning Environment. Sylvia D. Hall-Ellis. University of Denver, Center for Teaching and Learning, $2,000 (2008-2009)

Project Homeless Connect 6 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $9,785 (2008)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $600 (2007)

Project Ecuador: International Learning Service Libraries – A Faculty Development Experience in Ecuador. Sylvia D. Hall-Ellis, International Service Learning Office, University of Denver, $400 (2007)

Project Homeless Connect 5 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $1,000 (2007)

Project Homeless Connect 4 Event Evaluation. Research team: Sylvia D. Hall-Ellis and Duan Zhang. University of Denver Center for Community Engagement and Service Learning, $4,595 (2007)

Future LEADers of America: Leaders II. Research team: Denver Public Library (Kristen Svendson, PI), the University of Denver (Sylvia D. Hall-Ellis), and the Colorado Chapter of REFORMA (Orlando Archibeque). Laura Bush's Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $988,518 (2007-2010)

Strategic Planning Assistance for the Denver Medical Library. Sylvia D. Hall-Ellis. Denver Medical Library, Inc., $30,000 (2006-2007)

Destiny Software for JMAC Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, $10,000 (2006)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in France. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $800 (2005)

Denver Public Library: Opportunities for Change. Sylvia D. Hall-Ellis, Colorado Community Based Research Network, $2,000 (2005)

Future LEADers of America. Research team: Denver Public Library (Letty Icolari and Steve Taylor, PIs), Emporia State University (Jim Agee), and the University of Denver (Sylvia D. Hall-Ellis). Recruiting Librarians for the 21st Century Program, Institute for Museums and Library Services, $670,315 (2005-2008)

American Association of University Professors Summer Institute Professional Development Grant. Sylvia D. Hall-Ellis, American Association of University Professors, $300 (2005)

Beta Phi Mu Alumni Tea. Sylvia D. Hall-Ellis, gift from the Office of Alumni and Parent and Relations, University of Denver, $2,000 (2005)

Spectrum Software for LIS Student Lab. Sylvia D. Hall-Ellis, gift from the Sagebrush Corporation, Minneapolis, Minnesota, $5,000 (2005)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Nicholas J. Cutforth (PI) and Sylvia D. Hall-Ellis. Piton Foundation, $25,000 (2005-2006)

Libraries: Tools for Education and Development Worldwide: A Faculty Development Experience in Argentina. Sylvia D. Hall-Ellis, Office of Internationalization, University of Denver, $500 (2004)

Developing Research Capacity in Community Organizations and Residents through Training and Technical Assistance. Research team: Nicholas J. Cutforth (PI), Gary Lichtenstein and Sylvia D. Hall-Ellis, Piton Foundation, $25,000 (2003-2004)

Increasing Spanish-Speaking and Hispanic Diversity among Library and Information Science Students at the University of Denver: Development of a Student Recruitment Model. Researcher: Sylvia D. Hall-Ellis (PI), Office of Multicultural Excellence, University of Denver, $2,750 (2003-2004)

Collection Development Enrichment to Support the Cataloging & Classification Specialization and School Librarianship within the Library & Information Science Program at the University of Denver. Research team: Sylvia D. Hall-Ellis (PI) and Deborah S. Grealy. Women's Library Association, University of Denver, $4,000 (2003)

Collection Development Enrichment to Support the Library & Information Science Program at the University of Denver. Research team: Deborah S. Grealy (PI) and Sylvia D. Hall-Ellis. Women's Library Association, University of Denver, $4,000 (2001)

Wireless LAN for Library Education. Research team: Deborah S. Grealy (PI) and Sylvia Hall-Ellis. University of Denver, Center for Teaching and Learning, $24,000 (2001-2002)

Upward Bound – A Program for South Texas Youth. Research team: Monte Churchill, Executive Director of Community Relations; Gary R. Sauceda, Outreach Coordinator; Raymond Hernandez, (PI) Associate Dean for Student Success; and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). U.S. Department of Education, Office of Postsecondary Education, $2,672,003 (1999-2003)

Write Now! Improving Elementary Students' Writing Skills. Research team: Caryl G. Thomason, Assistant Superintendent (PI); Karen Tankersley, Principal; and, Hal Anderson, Director of Technology, Cheyenne Mountain School District 12 (Colorado Springs, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, $189,453 (1999-2001)

PETITIONER'S EXHIBIT 1002
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Operation Quick Start -- Distance Learning in Rural Colorado. Research team: Randal Weigum, Technology Coordinator (PI); Bonnie Barns, Director of Federal Programs and Staff Development; and, Adam "Joe" Raskop, Executive Director, Southeastern Board of Cooperative Educational Services (Lamar, Colorado); and Sylvia D. Hall-Ellis. Colorado Department of Education, Educational Telecommunications Unit, $400,000 (1999-2001)

Advanced Technological Training for Information Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Phi Delta Kappa and the National Science Foundation, $250,000 (1999-2001)

Working Connections – Training Information Technologies Professionals for the 21st Century. Research team: Mario Reyna, Division of Business Director (PI) and Sylvia D. Hall-Ellis, South Texas Community College (McAllen, Texas). Microsoft Corporation and the American Association of Community Colleges, $1,147,775 (1999-2001)

The ROAD (Research Oriented Amplification of Development to Literacy) Program. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Foundation, $25,000 (1998-1999)

Press to Literacy. Research team: Deborah J. Leong (PI), Metropolitan State University; Elena Bodrova, Metropolitan State University; Dmitri Semenov, Robert J. Marzano, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). The Denver Post and the Robert S. McCormick Foundation, $49,818 (1998-1999)

International Telementor Center. Research team: David Neils, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Philanthropy, $100,000 (1998-1999)

America Reads: Providing Tutor Training for the America Reads Challenge. Research team: Louis F. Cicchinelli (PI) and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, $306,000 (1998-1999)

Comprehensive School Reform. Research team: Louis F. Cicchinelli (PI), J. Timothy Waters, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Department of Education, Office of Educational Research and Improvement, $285,000 (1998-1999)

Sustainable Energy Education (SEE) Program for Grades 4-8: Preparing Today's Youth for Lifelong Learning and Responsible Actions in Energy Conservation. Research team: Mary Gromko, Colorado Department of Education; Gene McCarthy, Rocky Flats Field Office, U.S. Department of Energy; Gina Kissell, National Renewable Energy Laboratory; and Barbara L. McCombs (PI), Janet L. Bishop, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). State of Colorado Governor's Office for Energy Conservation, $499,936 (1997-1999)

Review of Kansas Curriculum Standards in Mathematics and Language Arts. Research team: Robert J. Marzano (PI), John S. Kendall, David B. Frost, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Submitted to the Kansas State Department of Education, $25,903 (1998)

International Telementor Center. Research team: David Neils, John Kuglin, Chris Rapp, David B. Frost (PI), and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). Hewlett-Packard Company, $54,752 (1998)

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Genesis Mission: Education Public Outreach. Developed in partnership by the Jet Propulsion Laboratory, California Institute of Technology, Los Alamos National Laboratory, Lockheed Martin Astronautics, and the Mid-continent Regional Educational Laboratory (Aurora, Colorado). Research team: John T. Sutton (PI), Alice Krueger, Martha Henry, Greg Rawls, Shae Isaacs, Jeff Johnson, Deb Jordan, Arlene Mitchell, David B. Frost, Jana Caldwell, J. Timothy Waters, and Sylvia D. Hall-Ellis. National Aeronautics and Space Administration, $139,700,000; subcontract award, $4,750,000 (1997-2007)

North Dakota Mathematics Assessment Project. Developed in partnership by the North Dakota Department of Education and Mid-continent Regional Educational Laboratory (Mid-continent Regional Educational Laboratory). Research team: Ann Clapper, Clarence Bina, Greg Gallagher, North Dakota Department of Education; Don Burger (PI), Hillary Michaels, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, $1,618,214; subcontract award, $389,076 (1997-2001)

Pacific Resources for Education and Learning Distance Education: Project Evaluation. Developed in partnership by the Pacific Educational Community, the Pacific Resources for Education and Learning (PREL), and Mid-continent Regional Educational Laboratory (McREL). Research team: John W. Kofel (PI), Executive Director, PREL; J. Timothy Waters, Executive Director; Joan Buttram, Robert Keller, and Sylvia D. Hall-Ellis, Mid-continent Regional Educational Laboratory (Aurora, Colorado). U.S. Office of Education, Star Schools Program, $10,000,000; subcontract award, $500,000 (1997-2002)

Identification of Bilingual Gifted and Talented Children: A Comprehensive School Grants for Bilingual Education. Developed in partnership by Hidalgo (Texas) ISD, Los Fresnos (Texas) CISD, Progreso (Texas) ISD, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Hilda Medrano, Dean, College of Education, University of Texas – Pan American; Linda Phemister (PI), Janie Navarro, and Sylvia D. Hall-Ellis, Education Service Center, Region One. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, $1,670,633 (1997-2002)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Jim Hogg (Hebbronville, Texas) County ISD, Mirando City (Texas) ISD, and San Isidro (Texas) ISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg, Texas); Angie Lehmann, Amy Mares, Ellen Gonzalez (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg, Texas). Texas Education Agency, $339,987 (1997-2000)

Southwestern Bell's Learning Communities Initiative. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen, Texas); the Center for Professional Teacher Development, University of Texas – Brownsville; Teach for America – Rio Grande Valley (McAllen, Texas); and Education Service Center, Region One (Edinburg, Texas). Research team: Patricia G. Bubb, Executive Director (PI), Tech Prep of the Rio Grande Valley; Martin Winchester, Executive Director, Teach for America – Rio Grande Valley; Aileen Johnson, Director, School of Education, University of Texas – Brownsville; and Sylvia D. Hall-Ellis. Southwestern Bell Foundation, $100,000 (1997-1998)

Texas School to Work: Regional Implementation. Developed for Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), Texas State Technical College (Harlingen), Texas Southmost College (Brownsville), Empowerment Zone of the Rio Grande Valley (Mercedes), Project VIDA (Weslaco), Youth Fair Chance (McAllen), and Education Service Center, Region One (Edinburg). Research team: Patricia G. Bubb (PI), Tech Prep of the Rio Grande Valley; Stephen Vassberg, Texas State Technical College; Ellen Trevino, Youth Fair Chance; Wanda Garza, Project VIDA; Leonardo Olivares, University of Texas – Pan American; Michael Bell, South Texas Community College; and Sylvia D. Hall-Ellis. Texas Workforce Commission, $4,250,000 (1997-2002).

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Comprehensive Bilingual Education Grant for Hidalgo ISD and Roma ISD. Developed for Hidalgo (Texas) ISD, Roma (Texas) ISD, College of Education, University of Texas – Pan American (Edinburg, Texas), and Education Service Center, Region One (Edinburg, Texas). Research team: Tomas Thomas (PI), Director, Office of Bilingual Education and Sylvia D. Hall-Ellis. U.S. Department of Education, Office of Bilingual Education and Minority Languages Affairs, $1,531,361 (1997-2002)

Lopez High School, Porter High School, Rivera High School, Central Middle School, and Perkins Middle School, Brownsville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $1,473,611 (1997-1998)

Donna High School, Todd Middle School, and Solis Middle School, Donna (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $704,052 (1997-1998)

Memorial Middle School and Nellie Schunior Middle School, La Joya Independent School District (Texas). Telecommunications Infrastructure Fund Board, $293,641 (1997-1998)

Martin High School, Christen Middle School, Cigarroa Middle School, Lamar Middle School, Laredo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $1,200,000 (1997-1998).

Lasara Middle School, Lasara (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $246,210 (1997-1998)

Los Fresnos High School and Resaca Middle School, Los Fresnos (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, $500,000 (1997-1998)

Lyford Junior High School, Lyford (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $354,997 (1997-1998)

Travis Middle School, McAllen (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $269,139 (1997-1998)

Mission High School, Mission (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $297,010 (1997-1998)

Progreso High School, Progreso (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $300,000 (1997-1998)

San Perlita High School, San Perlita (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $293,490 (1997-1998)

Myra Green Junior High School, Raymondville (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $225,000 (1997-1998)

Rio Grande City High School, Ringgold Middle School, Gruella Middle School, Rio Grande City (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $809,934 (1997-1998)

Rio Hondo Junior High School, Rio Hondo (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $297,024 (1997-1998)

Roma High School, Roma (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $333,178 (1997-1998)

San Benito High School, Miller Jordan Junior High School, San Benito (Texas) Consolidated Independent School District. Telecommunications Infrastructure Fund Board, $547,000 (1997-1998)

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Santa Maria High School and Santa Maria Middle School, Santa Maria (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $400,000 (1997-1998)

Salvador High School, United Independent School District (Laredo, Texas). Telecommunications Infrastructure Fund Board, $250,879 (1997-1998)

Weslaco High School, Cabaza Middle School, Cuellar Middle School, Weslaco (Texas) Independent School District. Telecommunications Infrastructure Fund Board, $874,242 (1997-1998)

Principals' Assessment and Training Center. Developed for Education Service Center, Region One (Edinburg, Texas). Research team: Roberto Zamora, Leonel Barrera, William H. Parry, and Sylvia D. Hall-Ellis. Texas Principals' Leadership Initiative, Texas Association of Secondary School Principals, Texas Association of Elementary School Principals, and the Sid Richardson Foundation. $461,439 (1996-1998)

The Texas Library Connection -- Integrating and Sharing Resources. Developed for Hidalgo County Library System (McAllen), Cameron County Library System (Brownsville), South Texas Community College (McAllen), the University of Texas - Pan American (Edinburg), University of Texas – Brownsville, and Education Service Center, Region One (Edinburg). Research team: William R. McGee, Coordinator, Hidalgo County Library System; Joe Garcia, Director, Cameron County Library System; Michael D. Bell, Library Director, South Texas Community College; Eleanor Folger Foster, University Library, University of Texas - Pan American; Jaime Vela (PI), Director of Instructional Technology and Media Services, Ron Pontius, Instructional Technology, and Fabiola Fuentes, Media Services, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Office of Library Media Services, Technology Services, Texas Education Agency. $8,000 (1996-1997)

Developing Leadership Communities for Improving Algebra I for All Students. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Noel Villarreal (PI), Eduardo Cancino, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin. $25,000 (1996-1997)

Academics 2000: First Things First -- The Texas Goals 2000. Developed for Edinburg (Texas) CISD. Research team: Hilda Medrano, Dean, College of Education, University of Texas - Pan American (Edinburg); Helen Jones, Director (PI), Gifted and Talented Education, Edinburg CISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $750,000 (1996-2001)

Texas Teachers Empowered for Achievement in Mathematics (TEXTEAM) Institute for Algebra I. Developed for Hidalgo ISD, Jim Hogg (Hebbronville) County ISD, La Joya ISD, La Villa ISD, Lyford ISD, Mission CISD, Pharr-San Juan-Alamo ISD, Rio Hondo ISD, San Isidro ISD, San Perlita ISD, Santa Maria ISD, Santa Rosa, Sharyland ISD, Valley View ISD, Webb (Laredo) CISD, Weslaco ISD, and Zapata County (Zapata) ISD. Research team: Noel Villarreal (PI), Chuck McInteer, Ellen M. Gonzalez, Education Service Center, Region One (Edinburg); and Sylvia D. Hall-Ellis. Charles A. Dana Center for Mathematics and Science Education, University of Texas - Austin, $15,975 (1996)

Community Learning Center for La Villa, Texas. Developed for Edcouch-Elsa Independent School District. Research team: Noe Gonzalez (PI), Assistant Superintendent, Edcouch-Elsa Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $325,000 (1996-1997)

Monte Alto (Texas) Community Learning Center. Developed for Monte Alto Independent School District. Research team: Homero A. Diaz (PI), Superintendent, Monte Alto Independent School District, and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $300,000 (1996-1997)

Community Learning Center for La Villa, Texas. Developed for La Villa Independent School District. Research team: Sam Gonzalez (PI), Assistant Superintendent, La Villa Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $325,000 (1996-1997)

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Building Project for Taylor Elementary. Developed for Mercedes (Texas) Independent School District. Research team: Mrs. Denise Rivera, Librarian, and Eduardo Infante, Principal, Taylor Elementary School; Ismael S. Cantu (PI), Federal Programs Director, Mercedes Independent School District; and Sylvia D. Hall-Ellis. Delta Region Subzone, Rio Grande Valley (Texas) Rural Empowerment Zone, $375,000 (1996-1997)

Border Education Network (BEN) - Distance Education through Cable Television. Developed for Edinburg (Texas) Consolidated Independent School District. Research team: Noe Torres (PI), Library Media Specialist, Magdalena Rosas, Library Media and Technology Coordinator, Edinburg Consolidated Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Edinburg (Texas) Consolidated School District, $250,000 (1996-1997)

Multiservice One-Stop Open Enrollment Charter School. Developed for the Information Referral Resource Assistance, Inc. (McAllen, Texas). Research team: Pablo Perez and Aguie Pena (PI), Executive Director, Information Referral Resource Assistance, Inc.; Roberto Zamora and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $3,066,000 (1996-2001)

Project OK: A Community Youth Opportunities Grant for Summer, 1996. Developed for McAllen (Texas) Independent School District, St. Joseph the Worker Catholic Church, and the Office of Adult Education, Education Service Center, Region One. Research team: Father Bart Flatt, St. Joseph the Worker Catholic Church; Noe Calvillo (PI), Office of Adult Education; Maria Louisa Garcia, McAllen Independent School District; and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Protective and Regulatory Agency through the Office of the Mayor, City of McAllen, $350,000 (1996-2001).

Early Childhood: a Time of Discovery. Developed for a partnership of Lasara ISD, Rio Hondo ISD, San Perlita ISD, the School of Education, University of Texas - Brownsville, and Education Service Center, Region One (Edinburg). Research team: Hugo Rodriguez, Dean, School of Education, University of Texas - Pan American; Leonel Barrera and Jack Damron, Field Service Agents, Ellen M. Gonzalez (PI), Administrator for Student Instructional Services, Ruth Solis, Education Specialist in Special Education, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $722,090 (1996-2001)

Innovative Gifted and Talented Programs for Early Childhood and Elementary Education Students. Developed for a partnership of Edinburg (Texas) CISD, the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Helen de la Garza (PI), Director of Elementary Curriculum and Instruction, Edinburg CISD; and Sylvia D. Hall-Ellis. Texas Education Agency, $750,000 (1996-2001)

Reading Recovery in Early Elementary Grades. Developed for a partnership of La Villa (Texas) ISD the School of Education, University of Texas - Pan American (Edinburg), and Education Service Center, Region One (Edinburg). Research team: Hilda Medrano, Dean, School of Education, University of Texas - Pan American; Marcario Salinas (PI), Supervisor of Elementary Curriculum and Instruction, La Villa ISD; and Sylvia D. Hall-Ellis, Education Service Center, Region One. Texas Education Agency, $750,000 (1996-2001)

Connected Mathematics Project for Middle and Junior High Students. Developed for a partnership of Michigan State University, The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin and Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). National Science Foundation through Michigan State University to the Charles A. Dana Center at the University of Texas - Austin, $539,610 (1996-1999)

Sharing Resources: Testing the Interlibrary Loan Potential of the Texas Library Connection -- Integrating Media Resources. Developed under the sponsorship of the Hidalgo County Library System (McAllen) and Education Service Center, Region One (Edinburg). Research team: William H. McGee, Hidalgo County System Coordinator; Fabiola Fuentes, Library Media; Ronald Pontius (PI), Instructional Technology, Education Service Center, Region One; and Sylvia D. Hall-Ellis. Library Media Services Program, Office of Technology Services, Texas Education Agency, $25,000 (1996-1997)

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State and Federal Adult Education JOBS Program. Developed for Education Service Center, Region One (Edinburg). Research team: Noe Calvillo (PI), Director, Adult Education Program, and Sylvia D. Hall-Ellis. Adult Education Program, Texas Education Agency, $532,846 (1995-1996)

Creating Safe and Drug-Free Schools and Communities. Developed for a partnership of the Region One Consortium for Safe and Drug-Free Education Environments. Research team: Clara Contreras (PI), Health Specialist, and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Education Agency, $150,000 (1995-1996)

Developing Leadership Communities for Improving Mathematics Performance for All Students on Title I Campuses. Developed for a partnership of the Region One Statewide Systemic Initiative Team. Research team: Jack Damron, Chuck McInteer, Noel Villarreal (PI), and Sylvia D. Hall-Ellis, Education Service Center, Region One (Edinburg). Texas Statewide Systemic Initiative for Reform in Mathematics, Science and Technology Education to The Charles A. Dana Center for Mathematics and Science Education, The University of Texas at Austin, $50,669 (1995-1996)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Texas Association of School Librarians, Children's Services Round Table, and Young Adults Round Table (Austin, Texas), $2,500 (1995)

School Library Media Specialists Fellowship Program. Sylvia D. Hall-Ellis (PI). Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville, Texas). U.S. Department of Education, HEA Title II-B, Library Education and Human Resource Development Program, $44,000 (1995-1996)

Planning for Educational Technology. Research team: Ruth Ann Riggins (PI), Director of Library Media and Technology Services, Donna (Texas) Independent School District; Noe Torres, Education Service Center, Region One; Patricia G. Bubb, Tech Prep of the Rio Grande Calley, Inc; Michael D. Bell, South Texas Community College; and Sylvia D. Hall-Ellis, Sam Houston State University. Developed under the sponsorship of Donna (Texas) Independent School District, Education Service Center, Region One (Edinburg), Tech Prep of the Rio Grande Valley, Inc. (Harlingen), South Texas Community College (McAllen), and the Department of Library Science, Sam Houston State University (Huntsville). Funded through Infusion of Educational Technology Planning Grant Program (H.B. 18: Models). Texas Education Agency, $18,000 (1993-1994)

The Impact of Library Resource Centers on Academic Achievement in Selected Public Schools in South Texas. Sylvia D. Hall-Ellis (PI) and Mary Ann Berry. Developed under the sponsorship of the Department of Library Science, College of Education and Applied Science, Sam Houston State University (Huntsville). Sam Houston State University Research Enhancement Fund, $7,500 (1993-1994)

Electronic Mail Resource Sharing System: Management and Operation of the Iowa Computer-Assisted Network. State Library of Iowa, $294,000 (1986-1993)

The Iowa Locator: A CD-ROM Resource Sharing Tool. State Library of Iowa, $567,000 (1986-1992)

Statewide Database Development: An OCLC Tape Analysis To Determine Feasibility. State Library of South Dakota, $15,000 (1987)

The Iowa Locator: A Feasibility Study. State Library of Iowa, $50,000 (1986)

Electronic Mail Resource Sharing System: A Feasibility Study for Libraries in the State of Iowa. State Library of Iowa, $5,000 (1985)

Access Pennsylvania: A Feasibility Study. State Library of Pennsylvania, $50,000 (1984)

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Automating Library Administrative and Management Tasks: Procurement and Distribution of Microcomputer Systems for District Library Centers in the Commonwealth of Pennsylvania. State Library of Pennsylvania, $495,000 (1982)

Sharing Serial Titles Resources: Procurement and Distribution of Microfiche Readers for 550 Libraries in the Commonwealth of Pennsylvania. State Library of Pennsylvania, $500,000 (1982)

Electronic Mail System: A Pilot Project for Libraries throughout the Commonwealth of Pennsylvania. State Library of Pennsylvania, $125,000 (1982)

Literacy Program for Adults in Rural Upstate New York State: Program Outreach and Evaluation - Phase 3. Appalachian Regional Commission, $50,000 (1981)

Database Building: A Cooperative Project of the Finger Lakes Library System (Ithaca), Four County Library System (Binghamton), and the Southern Tier Library System (Corning). New York State Library, $450,000 (1980-1985)

Faces of the Southern Tier: A Professional Photographer-in-Residence. New York State National Endowment for the Humanities, $25,000 (1980)

Literacy Program for Adults in Rural Upstate New York State: Program Implementation - Phase 2. Appalachian Regional Commission, $50,000 (1980)

Small Business Resources Center: A Pilot Project for Rural Public Libraries. New York State Library, $50,000 (1980)

Media Programming: A Professional Development Program for Public Librarians in Upstate New York: A Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $35,000 (1979)

Information and Library Resources for Inmates and Prisoners in Selected Upstate New York Facilities: A Cooperative Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $25,000 (1979)

Library Resources for Homebound Adults in Upstate New York: An Outreach Program in Allegheny, Chemung, Schuyler, Steuben, and Yates Counties. New York State Library, $40,000 (1979)

Literacy Program for Adults in Rural Upstate New York State: Program Initiation and Establishment - Phase 1. Funded by the Appalachian Regional Commission. Awarded to the Corning (New York) Public Library, $50,000 (1979)

Information Reference Services to Homebound Adults. New York State Library, $31,000 (1978)

Books-By-Mail Services to Homebound Adults. New York State Library, $31,000 (1978)

System Headquarters Services and Programs for Public Libraries in District 10. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, $880,000 (1976)

County Library Development Grant for Atascosita County. Funded through Library Services and Construction Act Title I. Texas State Library and Historical Commission, $15,000 (1976)

Spanish Language Materials Collection Development Program. Texas State Library and Historical Commission, $40,000 (1975)

Establishment of System Headquarters for Alamo Regional Library System (District 10) Headquartered at the San Antonio (Texas) Public Library. Texas State Library and Historical Commission, $800,000 (1975)

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SELECTED CONSULTANTSHIPS

Project Strategic Planning & Funding Proposal Development

Walden University, 2015.

Pikes Peak Library District, 2014.

Douglas County Public Libraries, 2011-2012.

Denver School for Science and Technology, 2008-2011.

Johnson & Wales University, Denver Campus, 2007-2009.

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Bemis Public Library (Littleton), Ergonomic Design and Facilities Enhancement Consultant, 2003.

Curtis Park Community Center (Denver), Community Technology Center Evaluation and Proposal Development Consultant, 2003.

Colorado Community Based Research Network (Denver), Funding Research Associate, 2002-

Our Lady of the Rosary Academy (Edgewater), Learning Resource Center Development Project Consultant, 2001-

University of Southern Colorado (Pueblo). Technology Integration and Curriculum Enhancement into Higher Education Learning Environment. Proposal Development Consultant, 2000.

Jefferson County Library System (Lakewood), 1999-2000.

Southeastern BOCES (Lamar, CO). Distance Learning Curriculum Content Development Project. Proposal Development Consultant, 1998-2004.

Cheyenne Mountain School District 12 (Colorado Springs, CO). Technology Integration into Elementary Writing Curriculum Project. Proposal Development Consultant, 1998.

Telecommunications Infrastructure Fund Board Round #2 Application, 1997. Technical assistance to the following: La Villa (Texas) Independent School District; Mirando City (Texas) Independent School District; Monte Alto (Texas) Independent School District; San Isidro (Texas) Independent School District.

Telecommunications Infrastructure Fund Board Round #1, 1996. Technical assistance to the following: Brownsville (Texas) Independent School District; Donna (Texas) Independent School District; Edinburg (Texas) Consolidated Independent School District; Harlingen (Texas) Consolidated Independent School District; Jim Hogg County Independent School District (Hebbronville, Texas); La Feria (Texas) Independent School District; La Joya (Texas) Independent School District; La Villa (Texas) Independent School District; Los Fresnos (Texas) Consolidated Independent School District; Progreso (Texas) Independent School District; Raymondville (Texas) Independent School District; Rio Hondo (Texas) Independent School District; San Benito (Texas) Independent School District; Sharyland Independent School District (Mission, Texas); Weslaco (Texas) Independent School District; Zapata (Texas) County Independent School District.

South Texas Community College (McAllen). Strategy Development to Meet the Technology Instructional Needs for Vocational, School-To-Work and Academic Programs, 1994-2000. Development Consultant.

Donna (Texas) Independent School District. Planning for the Infusion of Technology in Middle Schools Serving High At-Risk Students, 1994-1995. Research Associate.

Pettus (Texas) Independent School District. Planning for District-wide Automation in School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994. Principal Investigator.

Fort Bend Independent School District (Sugar Land, TX). Planning for District-wide Automation in School Library Media Centers, Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1994-1995. Principal Investigator.

Northern Waters Library Services (Ashland, WI). Professional Consulting Services to Make Recommendations on the Development of System-Wide Efforts of the Northern Waters Library Service, 1988-1989. Research Associate.

State Library of Iowa (Des Moines). The Iowa Locator Compact Disc to Support Multi-Type Libraries Resource Sharing including Database Design, Building, Production, and Distribution, 1986-1991. Project Director.

State Library of Iowa (Des Moines). Iowa Computer-Assisted Network Development, Enhancement, and Operation, 1985-1992. Technical Director.

State Library of South Dakota (Pierre). Statistical Sampling and Analysis of Multi-Institutional OCLC Archive Tape for Statewide Online Database Building, 1985-1986. Research Associate.

District of Columbia Public Library (Washington, DC). Planning Document for the Retrospective Conversion of Bibliographic Records and Automation Issues in the 1990's, 1984-1985. Research Associate.

State Library of Pennsylvania (Harrisburg). Database Development for High School Libraries, 1984-1985. Research Associate.

MINITEX (Minneapolis, MN). Workshops for Retrospective Conversion, Bar Coding, Library Statistics, and OCLC Serials Format, 1985. Presenter and Research Associate.

ABC Film Consortium (Altoona, Bellefonte, Johnstown, PA). Database Building, System Design, and Implementation of Online Film Booking System, 1983-1985. Database Manager.

Library Automation -- System Design & Implementation

Douglas County Library District (Castle Rock, CO). Library Automation Technical and System Performance Specifications, 2001.

Pharr-San Juan-Alamo Independent School District (Pharr, TX). Library Automation Technical and System Performance Specifications, 1997. Project Development Consultant.

Harlingen (Texas) Independent School District. Planning for District-wide Automation in Junior High School Library Media Centers: Preparation of Data, and CD-ROM Hardware/Software Configuration Evaluation, 1996. Principal Investigator.

Sharyland (Texas) Independent School District. Design and Construction of New Elementary School Library and Technology Resources Center, 1995-1996. Principal Investigator.

South Texas Independent School District (Mercedes, TX). Design and Construction of a New High School Library and Technology Resources Center, 1995-1996. Principal Investigator.

Citizens' Library (Washington, PA). Online Community Resources Files: Design and Implementation, 1984. Research Associate.

Altoona (Pennsylvania) Hospital. Integrated Online System Upgrade Study, 1984. Research Associate.

State Library of South Dakota (Pierre). Automation Plan and State Database Development, 1982-1983. Principal Investigator.

State Library of Pennsylvania (Harrisburg). COM Production and Preparation of the Technical Specifications Document, Procurement, and Distribution of Microcomputers in the Commonwealth of Pennsylvania, 1983-1984. Research Associate.

Altoona (Pennsylvania) Area Public Library. Integrated System (Circulation/Online Catalog) Study, 1982-1983. Principal Investigator.

COPSCAULD (Council of Pennsylvania State College and University Library Directors, Edinboro, PA). Design of Online Media Catalog, 1982. Principal Investigator.

Erie (Pennsylvania) County Library System. Operations Research and Design for Automated Circulation, Hardware Upgrade and Re-Retrospective Conversion, 1982. Research Associate.

Michigan Library Consortium (Lansing, MI). Tape Management System Design and Implementation, 1982-1984. Research Associate.

State Library of Pennsylvania (Harrisburg). Preparation of the Technical Specifications Document, Procurement and Distribution of Microfiche Readers in the Commonwealth of Pennsylvania, 1982. Research Associate.

Community College of Allegheny County, Allegheny Campus (Pittsburgh, PA). Integrated Systems Study, 1981. Principal Investigator.

Community College of Allegheny County, South Campus (West Mifflin, PA). Retrospective Conversion Training Program for Handicapped Students, 1981. Technical Director.

Southern Tier Library System (Corning, NY). OCLC Acquisitions Subsystem Evaluation, 1981. Principal Investigator.

South Central Reference and Research Council (Ithaca, NY). South Central Regional Delivery System, 1980. Principal Investigator.

Southern Tier Library System (Corning, NY). Newspapers on Microfilm in the Chemung-Southern Tier Library System, 1979-1981. Principal Investigator.

Cataloging & Bibliographic Database Building

Challenges, Choices, and Images K-12 Charter School, Denver Public Schools, 2007.

Denver Medical Library, Inc., 2006-2010.

Ricks Gifted and Talented School Library, 2005-

American Humane Society (Englewood), 2004-2006.

Fisher Early Learning Center Library, 2004-

**PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540**

Colorado Community Based Research Network (Denver), 2004-

Boulder Valley School District (Boulder), 2002-2003.

Douglas Public Library District (Castle Rock), 2001-2002.

Bibliographic Center for Research, Inc. (Denver). Original Cataloging, 2001-2003 & 1992-1993. Professional Cataloger. Libraries include Arapahoe Library District (Centennial); Clarke College (Clarke, IA); Kaiser Permanente Center for Health Research (Portland, KS); Douglas County Library System (Carson City, NV); Grinnell College (Grinnell, IA); Kansas State University (Manhattan, KS); Kansas State Library (Topeka, KS); McPherson College (McPherson, KS); Newman University (Wichita, KS); Montana Technical University (Helena, MT); Montana State Library (Helena, MT); University of Texas Southwest Medical Center Library (Dallas, TX); Community College of Southern Nevada (Las Vegas, NV); Pikes Peak Library District (Colorado Springs); Mesa Community College (Grand Junction); Coe College (Cedar Rapids, IA); Briar Cliff College (Sioux City, IA); Tri-Care Health Systems (Aurora); The Penrose-St. Francis Healthcare System (Colorado Springs); Westminster Public Library (Westminster); Lutheran Medical Center Medical Library (Wheat Ridge); American Heritage Center, University of Wyoming (Laramie, WY); National Wildlife Research Center Library (Lakewood); University of Colorado Health Sciences Center, Denison Memorial Library (Denver); Water Resources Library, Denver District Office, Bureau of Land Management (Lakewood); Mesa State Community College Learning Resources Center (Pueblo); Front Range Community College Learning Resources Center (Westminster).

Colorado Historical Society Library (Denver). Original Cataloging of Serials for Multi-Institutional Union Listing Project, 1993. Technical Services Associate. Institutional partners: Denver Art Museum, Denver Museum of Natural History Library, and Denver Botanical Gardens Library.

Arapahoe Library District (Centennial). Original Cataloging of Major Media, 1991.

Original Cataloging Projects: Davis and Elkins College (Elkins, WV), 1989-1990; Waldorf College (Forest City, IA), 1989-1990; Kennametal Corporation (Latrobe, PA), 1984-1985; Pennsylvania Public Libraries Film Center (Harrisburg), 1982-1985.

Retrospective Conversion Projects: North Central Regional Library Service (Mason City, IA), 1987-1988; Southeastern Library Services (Davenport, IA), 1986-1987; Virginia Theological Seminary (Alexandria), 1984-1985; California University of Pennsylvania (California, PA), 1984-1985; Kennametal Corporation (Latrobe, PA), 1984-1985;West Virginia University (Morgantown), 1983-1985; Altoona Area Public Library (Altoona, PA), 1983-1984; George Washington University (Washington, DC), 1983-1984; Indiana University of Pennsylvania (Indiana, PA), 1983-1985; Health Education Center (Pittsburgh), 1983-1984; Central Pennsylvania District Library Center (Bellefonte, PA), 1982-1985; Duquesne University Law School Library (Pittsburgh), 1982-1983; Allegheny County Law Library (Pittsburgh), 1982-1984;Calgon Technical Information Center (Pittsburgh), 1982; Dow Corning Corporation, Technical Information Center (Midland, MI), 1982-1983; Tri-System Public Library Retrospective Conversion Project (Binghamton, Corning, and Ithaca, NY), 1978-1981, Technical Project Director.

Updated December 2017

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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- 0011598658
- 00520170802085719.0
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- 906__ |**a** 7 |**b** cbc |**c** orignew |**d** 1 |**e** ocip |**f** 19 |**g** y-gencatlg
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- 010__ |**a** 94039724
- 020__ |**a** 0070331898 (acid-free paper) : |**c** $89.50
- 035__ |**9** (DLC) 94039724
- 040__ |**a** DLC |**c** DLC |**d** DLC
- 05000 |**a** TL272.5 |**b** .A982 1995
- 08200 |**a** 629.25/49 |**2** 20
- 24500 |**a** Automotive electronics handbook / |**c** Ronald Jurgen, editor in chief.
- 260__ |**a** New York : |**b** McGraw-Hill, |**c** c1995.
- 300__ |**a** 1 v. (various pagings) : |**b** ill. ; |**c** 25 cm.
- 504__ |**a** Includes bibliographical references and index.
- 650_0 |**a** Automobiles |**x** Electronic equipment.
- 7001_ |**a** Jurgen, Ronald K.
- 920__ |**a** ** LC HAS REQ'D # OF SHELF COPIES **
- 991__ |**b** c-GenColl |**h** TL272.5 |**i** .A982 1995 |**t** Copy 1 |**w** BOOKS

HMC EXHIBIT 1017

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 31375278 **No holdings in XXX - 255 other holdings**

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082	00	629.25/49 ‡2 20
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245	00	Automotive electronics handbook / ‡c Ronald Jurgen, editor in chief.
260		New York : ‡b McGraw-Hill, ‡c ©1995.
300		1 volume (various pagings) : ‡b illustrations ; ‡c 25 cm
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
504		Includes bibliographical references and index.
650	_0	Automobiles ‡x Electronic equipment.
650	_7	Automobiles ‡x Electronic equipment. ‡2 fast ‡0 (OCoLC)fst00823428
653	_0	Automobiles ‡a Electronic equipment
700	1_	Jurgen, Ronald K.
776	08	‡i Online version: ‡t Automotive electronics handbook. ‡d New York : McGraw-Hill, ©1995 ‡w (OCoLC)747304641
856	41	‡3 Table of contents ‡u http://www.gbv.de/dms/ilmenau/toc/171940121.PDF

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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- 00520140130085805.0
- 008 890526s1989 maua 001 0 eng
- 906__ |**a** 7 |**b** cbc |**c** orignew |**d** 3 |**e** opcn |**f** 19 |**g** y-gencatlg
- 955__ |**a** by34 to bc00 11-13-89; fg04 08-13-90; fg03 08-30-90; fp28 09-21-90
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- 035__ |**9** (DLC) 89061946
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- 05000 |**a** TL214.F78 |**b** P76 1989
- 08200 |**a** 629.25/3 |**2** 20
- 1001_ |**a** Probst, Charles O.
- 24510 |**a** Bosch fuel injection & engine management : |**b** theory of operation, troubleshooting and service ... / |**c** by Charles O. Probst.
- 260__ |**a** Cambridge, Mass. : |**b** R. Bentley, |**c** c1989.
- 300__ |**a** 1 v. (various pagings) : |**b** ill. ; |**c** 28 cm.
- 500__ |**a** Includes index.
- 500__ |**a** "Bentley stock no. GFIB"--T.p. verso.
- 650_0 |**a** Automobiles |**x** Motors |**x** Fuel injection systems.
- 650_0 |**a** Automobiles |**x** Motors |**x** Fuel injection systems |**x** Maintenance and repair.
- 61020 |**a** Robert Bosch GmbH.
- 7400_ |**a** Bosch fuel injection and engine management.
- 85642 |**3** Publisher description |**u** http://www.loc.gov/catdir/enhancements/fy1401/89061946-d.html
- 922__ |**a** ad
- 991__ |**b** c-GenColl |**h** TL214.F78 |**i** P76 1989 |**p** 0001511857A |**t** Copy 1 |**w** BOOKS

HMC EXHIBIT 1019

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 21265250 **No holdings in XXX - 96 other holdings**

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		Cont		**GPub**		**LitF**	0	**Indx**	1		
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050	00	TL214.F78 ‡b P76 1989
082	00	629.25/3 ‡2 20
100	1_	Probst, Charles O.
245	10	Bosch fuel in ection engine management : ‡b theor of operation, troubleshooting and service ... / ‡c b Charles O. Probst.
260		Cambridge, Mass. : ‡b R. Bentle , ‡c ©1989.
300		1 volume (various pagings) : ‡b illustrations ; ‡c 28 cm
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
500		Includes index.
500		Bentle stock no. GFIB --Title page verso.
505	00	‡t Introduction to fuel In ection and engine management -- ‡t Air-fuel mixtures -- ‡t Fuel deliver -- ‡t Carburetors vs. fuel In ection -- ‡t T pes of Bosch fuel in ection -- ‡t What is engine management -- ‡t The Bosch Jetronic famil -- ‡t Listing of cars equipped with Bosch s stems covered in this book -- ‡t Engine Management Fundamentals -- ‡t Basic factors: Air-fuel mixture, stoichiometric ratio, Lambda -- ‡t Operating conditions and driveabilit : Warm and cold start-up, warm-up, cruising and accelerating -- ‡t Effects of altitude and other external factors -- ‡t Emission controls: EGR, AIR, catal tic converters -- ‡t Control s stems -- ‡t Pulsed In ection-- Theor -- ‡t Pulsed in ection identification and applications -- ‡t L-Jetronic: Design and operation, componentr , circuitr -- ‡t LH-Jetronic: Design and operation, s stem

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

		signals, stabili ation and ad ustment -- ‡t Motronic: Data mapping, Drive-b -wire electronic throttle -- ‡t D-Jetronic -- ‡t Digifant II -- ‡t Pulsed In ection-- Troubleshooting ervice -- ‡t Troubleshooting the s stem -- ‡t Checking the fuel deliver s stem from tank to in ector tip -- ‡tTesting during starting and warm-up -- ‡t Air-flow measurement: Air-flow sensor, air-mass sensor, throttle switches -- ‡t Idle speed testing and ad ustment -- ‡t Idle mixture (CO) and Lambda control -- ‡t Motronic timing and dwell -- ‡t Continuous In ection--Theor -- ‡t CI identification and applications -- ‡t Air-flow s stem: Control plunger; backfire protection -- ‡t Fuel s stem: Accumulation and distribution, regulating s stem pressure -- ‡t Fuel metering: governing differential pressure.
610	20	Robert Bosch GmbH.
650	_0	Automobiles ‡x Motors ‡x Fuel in ection s stems.
650	_0	Automobiles ‡x Motors ‡x Fuel in ection s stems ‡x Maintenance and repair.
610	27	Robert Bosch GmbH. ‡2 fast ‡0 (OCoLC)fst00629751
650	_7	Automobiles ‡x Motors ‡x Fuel in ection s stems. ‡2 fast ‡0 (OCoLC)fst00823676
650	_7	Automobiles ‡x Motors ‡x Fuel in ection s stems ‡x Maintenance and repair. ‡2 fast ‡0 (OCoLC)fst00823677
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653	_0	Robert Bosch GmbH
740	0_	Bosch fuel in ection and engine management.
856	41	‡3 Table of contents ‡u http://www.gbv.de/dms/bowker/toc/9780837603001.pdf
856	42	‡3 Publisher description ‡u http://catdir.loc.gov/catdir/enhancements/f 1401/89061946-d.html

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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- 010__ |**a** 2002512185
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- 035__ |**a** (OCoLC)ocm47389322
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- 042__ |**a** lccopycat
- 05000 |**a** TL214.F78 |**b** A47 2001
- 1001_ |**a** Aird, Forbes, |**d** 1944-
- 24510 |**a** Bosch fuel injection systems / |**c** Forbes Aird.
- 250__ |**a** 1st ed.
- 260__ |**a** New York, N.Y. : |**b** HP Books, |**c** c2001.
- 300__ |**a** 138 p. : |**b** ill. ; |**c** 28 cm.
- 650_0 |**a** Automobiles |**x** Motors |**x** Fuel injection systems.
- 7400_ |**a** Fuel injection systems.
- 906__ |**a** 7 |**b** cbc |**c** copycat |**d** 2 |**e** ncip |**f** 20 |**g** y-gencatlg
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- 9251_ |**a** acquire |**b** 2 shelf copy |**x** policy default
- 955__ |**a** ps16 2002-09-19 to ASCD |**a** jg00 2002-10-03; |**c** jg02 2003-04-17 to subj. |**d** jg12 2003-05-07 |**e** jg08 2003-05-10 to Dewey |**a** jg07 2003-07-08 copy 2 added
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HMC EXHIBIT 1021

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 47389322 **No holdings in XXX - 33 other holdings**

Books **Rec Stat** c **Entered** 20020919 **Replaced** 20170928085319.9

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082	04	629.253
049		DGSL
100	1_	Aird, Forbes, ‡d 1944-
245	10	Bosch fuel injection systems / ‡c Forbes Aird.
250		1st ed.
260		New York, N.Y. : ‡b HP Books, ‡c ©2001.
300		138 pages : ‡b illustrations ; ‡c 28 cm
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
650	_0	Automobiles ‡x Motors ‡x Fuel injection systems.
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740	0_	Fuel injection systems.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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- 042__ |**a** nsdp |**a** pcc
- 05000 |**a** TL151 |**b** .M658
- 08200 |**a** 629.222/05 |**2** 20
- 2100_ |**a** Goodheart-Willcox automot. encycl.
- 222_0 |**a** Goodheart-Willcox automotive encyclopedia
- 24500 |**a** Goodheart-Willcox automotive encyclopedia.
- 24618 |**a** Automotive encyclopedia
- 260__ |**a** South Holland, Ill. : |**b** Goodheart-Willcox Co., |**c** c1975-
- 265__ |**a** Goodheart-Willcox Co., 123 W. Taft Drive, S. Holland, IL 60473
- 300__ |**a** v. : |**b** ill. ; |**c** 28 cm.
- 310__ |**a** Irregular
- 3621_ |**a** [1975 ed.]-
- 500__ |**a** "Fundamental principles, operation, construction, service, repair."
- 590__ |**a** SERBIB/SERLOC merged record
- 650_0 |**a** Automobiles.
- 650_0 |**a** Automobiles |**x** Maintenance and repair.
- 78000 |**t** Motor Service's automotive encyclopedia |**w** (DLC) 95644991 |**w** (OCoLC)7428534
- 850__ |**a** DLC
- 890__ |**a** Goodheart-Willcox automotive encyclopedia. |**i** 95-644988
- 906__ |**a** 7 |**b** cbc |**c** serials |**d** u |**e** ncip |**f** 19 |**g** n-oclcserc
- 920__ |**a** Keep 1
- 936__ |**a** 1995 ed. (surrogate) LIC
- 991__ |**b** c-GenColl |**h** TL151 |**i** .M658 |**w** SERIALS
- 991__ |**b** r-MRR |**h** TL151 |**i** .M658 |**t** X-Copy 2 |**m** Alc |**z** Latest edition |**w** GenBib bi 95-018560
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PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 4593063 **No holdings in XXX - 97 other holdings**

Books	**Rec Stat**	c	**Entered**	19781220	**Replaced**	20140730033101.8			
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050	10	TL205 ‡b .G66 1979
082	00	629.22/22
245	00	Goodheart-Willcox automotive encyclopedia : ‡b fundamental principles, operation, construction, service, repair / ‡c [edited by] William K. Toboldt, Larry Johnson.
246	3_	Automotive encyclopedia
260		South Holland, Ill. : ‡b Goodheart-Willcox Co., ‡c ©1979.
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337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
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700	1_	Toboldt, William King, ‡d 1895-
700	1_	Johnson, Larry, ‡d 1920-

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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049    SFRA
092    629.2872|bAu825 2000
245 00 Automotive handbook /|c[editor in chief, Horst Bauer;
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       Folkhart Dinkler].
246 18 Bosch automotive handbook
250    5th ed.,rev. and extended ed.
260    Stuttgart :|bRobert Bosch GmbH ;|aWarrendale, PA. :
       |bDistributed by SAE, Society of Automotive Engineers,
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337    unmediated|bn|2rdamedia
338    volume|bnc|2rdacarrier
500    Includes index.
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650  0 Automobiles|xMaintenance and repair|vHandbooks, manuals,
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650  0 Automobiles|xDesign and construction|vHandbooks, manuals,
       etc.
700 1  Bauer, H.,|cDipl.-Ing.
710 2  Robert Bosch GmbH.
730 0  Kraftfahrtechnisches Taschenbuch.|lEnglish.|f2000.
907    .b18809030|b05-23-07|c04-27-04
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OCLC	1001864331	**No holdings in XXX - 296 other holdings**

Books	**Rec Stat**	c	**Entered**	20010115	**Replaced**	20180409013503.6					
Type	a	**ELvl**	M	**Srce**	d	**Audn**		**Ctrl**		**Lang**	eng
BLvl	m	**Form**		**Conf**	0	**Biog**		**MRec**		**Ctry**	gw
		Cont	f	**GPub**		**LitF**	0	**Indx**	1		
Desc	a	**Ills**	a	**Fest**	0	**DtSt**	s	**Dates**	2000,		

040		SFR ‡b eng ‡c SFR ‡d A7U ‡d WOM ‡d OCLCF ‡d OCLCO ‡d OCL ‡d OCLCQ
019		798290588 ‡a 1030656243
020		0768006694
020		9780768006698
041	1_	eng ‡h ger
050	_4	TL151 ‡b .A98 2000
082	14	629.2872 ‡b Au825 2000
245	00	Automotive handbook / ‡c [editor in chief, Horst Bauer ; edictorial staff, Karl-Heinz Dietsche, Jurgen Cripin, Folkhart Dinkler].
246	18	Bosch automotive handbook
250		5th ed., rev. and extended ed.
260		Stuttgart : ‡b Robert Bosch GmbH ; ‡a Warrendale, PA. : ‡b Distributed by SAE, Society of Automotive Engineers, ‡c 2000.
300		962 pages : ‡b illustrations ; ‡c 18 cm
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
500		Includes index.
500		"Translation: editorin-in-chief Peter Girling. Translated by: Star Deutschaland GmbH"--Title page verso.
500		Translation of: Kraftfahrtechnisches Taschenbuch.
650	_0	Automobiles ‡x Maintenance and repair ‡v Handbooks, manuals, etc.
650	_0	Automobiles ‡x Design and construction ‡v Handbooks, manuals, etc.
650	_7	Automobiles ‡x Maintenance and repair. ‡2 fast ‡0 (OCoLC)fst00823551
650	_7	Automobiles ‡x Design and construction. ‡2 fast ‡0 (OCoLC)fst00823374
655	_7	Handbooks and manuals. ‡2 fast ‡0 (OCoLC)fst01423877

700	1_	Bauer, H., ‡c Dipl.-Ing.
710	2_	Robert Bosch GmbH.
730	0_	Kraftfahrtechnisches Taschenbuch. ‡l English.

HMC EXHIBIT 1026

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

- 001708229
- 00520160907064725.0
- 008 970414s1997 nyua d 001 0 eng
- 035__ |**9** (DLC) 97016168
- 010__ |**a** 97016168
- 020__ |**a** 0070578370
- 040__ |**a** DLC |**c** DLC |**d** DLC
- 05000 |**a** TK7804 |**b** .M354 1997
- 08200 |**a** 621.38/03 |**2** 21
- 1001_ |**a** Sclater, Neil.
- 24510 |**a** McGraw-Hill electronics dictionary / |**c** Neil Sclater, John Markus.
- 250__ |**a** 6th ed.
- 260__ |**a** New York : |**b** McGraw-Hill, |**c** c1997.
- 300__ |**a** x, 527 p. : |**b** ill. ; |**c** 24 cm.
- 500__ |**a** Markus' name appears first on the earlier edition.
- 500__ |**a** Includes index.
- 650_0 |**a** Electronics |**x** Dictionaries.
- 7001_ |**a** Markus, John, |**d** 1911-
- 906__ |**a** 7 |**b** cbc |**c** orignew |**d** 1 |**e** ocip |**f** 19 |**g** y-gencatlg
- 9250_ |**a** acquire |**b** 2 shelf copies |**x** KW, 2016-09-07
- 955__ |**a** pc14 to ja00 04-14-97; jf04 (desc.) to subj. 04-14-97; jf08 04-15-97 to SL; je05 to DDC 04-17-97; CIP ver. pv04 03-26-98
- 920__ |**a** ** LC HAS REQ'D # OF SHELF COPIES **
- 991__ |**b** c-GenColl |**h** TK7804 |**i** .M354 1997 |**t** Copy 1 |**w** BOOKS
- 991__ |**b** r-SciRR |**h** TK7804 |**i** .M354 1997 |**t** Copy 1 |**m** Dict |**w** GenBib bi 98-008696

HMC EXHIBIT 1027

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC	36767742	**No holdings in XXX - 399 other holdings**

Books	**Rec Stat**	c	**Entered**	19970414	**Replaced**	20171208003016.1					
Type	a	**ELvl**		**Srce**		**Audn**		**Ctrl**		**Lang**	eng
BLvl	m	**Form**		**Conf**	0	**Biog**		**MRec**		**Ctry**	nyu
		Cont	d	**GPub**		**LitF**	0	**Indx**	1		
Desc	a	**Ills**	a	**Fest**	0	**DtSt**	s	**Dates**	1997,		

010		97016168
040		DLC ‡b eng ‡c DLC ‡d C#P ‡d UKM ‡d BAKER ‡d BTCTA ‡d YDXCP ‡d ZWZ ‡d A7U ‡d OCLCF ‡d OCLCO ‡d OCLCQ ‡d OCLCO
015		GB9761081 ‡2 bnb
019		37726214
020		0070578370
020		9780070578371
050	00	TK7804 ‡b .M354 1997
082	00	621.38/03 ‡2 21
100	1_	Sclater, Neil.
245	10	McGraw-Hill electronics dictionary / ‡c Neil Sclater, John Markus.
250		6th ed.
260		New York : ‡b McGraw-Hill, ‡c ©1997.
300		x, 527 pages : ‡b illustrations ; ‡c 24 cm
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
500		Markus' name appears first on the earlier edition.
500		Includes index.
520		First published more than half a century ago, the McGraw-Hill Electronics Dictionary has long held a position as the world's standard authority on the language of electronics. This completely updated and revised Sixth Edition enhances the established position of the dictionary. During the four years since the Fifth Edition was published, many new terms have entered the language of electronics. The authenticity of each definition has been checked against present usage in the leading professional engineering books and magazines. All entries - words, phrases,

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

acronyms, and abbreviations - are in consistent, easy-to-read alphabetical order. Enhanced cross-referencing and the highlighting of related terms simplifies the search for additional information and any commonly accepted synonyms for the desired term. As another reader benefit, all scientific and technical measurements are in standard international (SI) units.

650 _0 Electronics ‡v Dictionaries.

650 _7 Electronics. ‡2 fast ‡0 (OCoLC)fst00907538

650 _7 Électronique ‡x Dictionnaires. ‡2 ram

655 _7 Dictionaries. ‡2 fast ‡0 (OCoLC)fst01423826

700 1_ Markus, John, ‡d 1911-

HMC EXHIBIT 1028

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

- 0012063118
- 00520060727185516.0
- 008 931117s1993 enk d 000 0 eng d
- 035__ |**9** (DLC) 93232719
- 010__ |**a** 93232719
- 020__ |**a** 0198612710 (thumb index ed.) : |**c** $99.95
- 020__ |**a** 019861134X (plain ed.)
- 035__ |**a** (OCoLC)28877591
- 040__ |**a** OCo |**c** OCo |**d** KyLxCB |**d** DLC
- 042__ |**a** lccopycat
- 05000 |**a** PE1625 |**b** .N539 1993
- 08200 |**a** 423 |**2** 20
- 24504 |**a** The New shorter Oxford English dictionary on historical principles / |**c** edited by Lesley Brown.
- 250__ |**a** Thumb index ed.
- 260__ |**a** Oxford : |**b** Clarendon Press, |**c** 1993.
- 300__ |**a** 2 v. (xxvi, 3801 p.) ; |**c** 29 cm.
- 500__ |**a** Rev. ed. of: The shorter Oxford English dictionary on historical principles edited by William Little. 3rd ed. 1955.
- 650_0 |**a** English language |**x** Dictionaries.
- 650_0 |**a** English language |**x** Etymology |**x** Dictionaries.
- 7001_ |**a** Brown, Lesley.
- 7001_ |**a** Little, William, |**d** 1848-1922. |**t** Shorter Oxford English dictionary on historical principles.
- 85642 |**3** Publisher description |**u** http://www.loc.gov/catdir/enhancements/fy0638/93232719-d.html
- 906__ |**a** 7 |**b** cbc |**c** copycat |**d** 2 |**e** ncip |**f** 19 |**g** y-gencatlg
- 922__ |**a** ad
- 952__ |**a** Previous ed. entered under editor.
- 955__ |**a** pb18 11-01-93; pb09 11-17-93 to HLCD; lh04 12-02-93; lk19 04-25-94; lh05 05-02-94; lk46 05-12-94
- 991__ |**b** c-GenColl |**h** PE1625 |**i** .N539 1993 |**t** Copy 1 |**w** BOOKS

HMC EXHIBIT 1029

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 29470987 **No holdings in XXX - 1653 other holdings**

Books	**Rec Stat**	c	**Entered**	19941020	**Replaced**	20180420153603.2			
Type	a	**ELvl**		**Srce**	d	**Audn**		**Ctrl**		**Lang**	eng
BLvl	m	**Form**		**Conf**	0	**Biog**		**MRec**		**Ctry**	enk
		Cont	d	**GPub**		**LitF**	0	**Indx**	0		
Desc	a	**Ills**		**Fest**	0	**DtSt**	s	**Dates**	1993,		

010		93232719
040		OCo ‡b eng ‡c NLM ‡d OCO ‡d DLC ‡d UKM ‡d KLF ‡d BOS ‡d AGL ‡d NLGGC ‡d MNU ‡d EL$ ‡d UKV3G ‡d BAKER ‡d BTCTA ‡d LVB ‡d YDXCP ‡d HUV ‡d SXC ‡d ZWZ ‡d OCLCF ‡dBEDGE ‡d CNTAB ‡d OCLCQ ‡d MNA ‡d OCLCO ‡d OCL ‡d OCLCA ‡d ILM ‡d OCLCQ ‡d KJ6 ‡d OCLCQ ‡d RB#
015		GB9355945 ‡2 bnb
015		GB9359680 ‡2 bnb
016	7_	9438874 ‡2 DNLM
019		28877591 ‡a 28902184 ‡a 30064520 ‡a 30139741 ‡a 59907215 ‡a 228665629 ‡a 613801436
020		9780198612711 ‡q (thumb index ed.)
020		0198612710 ‡q (thumb index ed.)
020		9780198611349 ‡q (plain ed.)
020		019861134X ‡q (plain ed.)
020		0191958042
020		9780191958045
050	00	PE1625 ‡b .N539 1993
060	00	PE 1625 ‡b N532 1993
070	0_	PE1625.N39 ‡b 1993
072	_0	X000
082	00	423 ‡2 20
084		18.04 ‡2 bcl
245	04	The new shorter Oxford English dictionary on historical principles / ‡c edited by Lesley Brown.
250		Thumb index ed.
260		Oxford : ‡b Clarendon Press ; ‡a New York : ‡b Oxford University Press, ‡c 1993.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

300		2 volumes (xxvi, 3801 pages)
336		text ‡b txt ‡2 rdacontent
337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
505	0_	v. 1. A-M -- v. 2. N-Z.
520		Includes the history and etymology of thousands of words, 500,000 definitions, 25,250 variant spellings, and 83,000 illustrative quotations.
650	_0	English language ‡v Dictionaries.
650	_0	English language ‡x Etymology ‡v Dictionaries.
650	12	Dictionaries as Topic. ‡0 (DNLM)D004014
650	_5	English language ‡v Dictionaries.
650	_6	Anglais (Langue) ‡v Dictionnaires.
650	_7	Dictionnaires. ‡2 eclas
650	_7	English language. ‡2 fast ‡0 (OCoLC)fst00910920
650	_7	English language ‡x Etymology. ‡2 fast ‡0 (OCoLC)fst00911149
650	17	Engels. ‡2 gtt
650	_7	Anglais (langue) ‡x Étymologie ‡x Dictionnaires. ‡2 ram
650	_7	Anglais (langue) ‡x Dictionnaires. ‡2 ram
650	_7	English language ‡x Dictionaries. ‡2 sears
650	_4	Inglés ‡x Etimología ‡x Diccionarios.
653	0_	English language ‡a Dictionaries.
655	_2	Dictionary. ‡0 (DNLM)D016437
655	_7	Reference works. ‡2 fast ‡0 (OCoLC)fst01919963
655	_7	Dictionaries. ‡2 fast ‡0 (OCoLC)fst01423826
655	_7	Reference works. ‡2 lcgft
700	1_	Brown, Lesley.
776	08	‡i Online version: ‡t New shorter Oxford English dictionary on historical principles. ‡b Thumb index ed. ‡d Oxford : Clarendon Press ; New York : Oxford University Press, 1993 ‡w(OCoLC)777915936
856	42	‡3 Publisher description ‡u http://catdir.loc.gov/catdir/enhancements/fy0638/93232719-d.html

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

001			003934853
003			MiU
005			20140313124050.0
006			m d
007			cr bn ---auaua
008			960627s1996||||miu|||||||||||| ||eng|d
035			**|a** (UMI)09624736
035			**|a** (OCoLC)ocm49862211
040			**|a** MiU **|c** MiU
099			**|a** MiU diss
100	1		**|a** Stefanopoulou, Anna G.
245	1	0	**|a** Modeling and control of advanced technology engines.
260			**|c** 1996.
300			**|a** 1 v.
502			**|a** Dissertation (Ph.D.)--University of Michigan
538			**|a** Mode of access: Internet.
650		4	**|a** Electrical engineering: Systems.
852	4		**|a** MiU **|b** BUHR **|c** GRAD **|j** DISS 26440
852	4		**|a** MiU **|b** BUHR **|c** GLMR **|j** DISS FILM 31710 **|z** Microfilm copy
970			**|a** BK **|b** Book
971			**|a** MiU
972			**|c** 20040625
973			**|a** HT **|b** avail_ht
973			**|a** AC **|b** avail_circ
974			**|a** B1682455 **|b** BUHR **|c** GLMR **|f** 01
974			**|u** mdp.39015037450023 **|r** ic **|d** 20140320 **|a** 39015037450023 **|b** BUHR **|c** GRAD **|f** 01
997			**|a** MARS
999			**|a** MDP **|b** 20 **|c** 20110419 **|l** MIU01 **|h** 0000

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC 49862211	No holdings in XXX - 2 other holdings

Books	Rec Stat c	Entered 20020524	Replaced 20150422181733.0				
Type t	ELvl I	Srce d	Audn	Ctrl	Lang eng		
BLvl m	Form 5	Conf 0	Biog	MRec	Ctry xxu		
	Cont bm	GPub	LitF 0	Indx 0			
Desc i	Ills a	Fest 0	DtSt s	Dates 1996,			

040		AD# ‡b eng ‡c AD# ‡d OCLCQ ‡d OCLCF ‡d OCLCO ‡d OCLCQ
050	14	TJ250 ‡b .S74 1996
100	1_	Stefanopoulou, Anna G.
245	10	Modeling and control of advanced technology engines / ‡c by Anna Stefanopoulou.
246	30	Advanced technology systems
260		‡c 1996.
300		x, 131 pages ; ‡b illustrations
500		Copyright by the author.
502		Univ. of Michigan, Ph. D. Thesis--Ann Arbor, 1996.
504		Includes bibliographical references (p. 126-131).
533		Photocopy. ‡b Ann Arbor, Mich. : ‡c UMI Dissertation Services, ‡d 2002. ‡e 23 cm.
650		Engines.

HMC EXHIBIT 1032

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

- 00111251778
- 00520171205082442.0
- 008 811228d19811984nyuqr p 0 a0eng
- 010__ |**a** 81649117
- 0220_ |**a** 0272-1708 |**l** 0272-1708 |**z** 0730-6598 |**2** 1
- 030__ |**a** ISMAD7
- 035__ |**a** (OCoLC)ocm08022749
- 040__ |**a** DLC |**b** eng |**c** DLC |**d** NSD |**d** NST |**d** DLC |**d** NSD |**d** NST |**d** NSD |**d** NST |**d** NSD |**d** NST |**d** AIP |**d** NST |**d** AIP |**d** NST |**d** NSD |**d** AIP |**d** NST |**d** NSD |**d** DLC |**d** NYG |**d** DLC |**d** NST |**d** NSD |**d** WAU |**d** MYG |**d** NST |**d** NSD |**d** NST |**d** IEEEX |**d** OCLCQ |**d** HNK |**d** NSD |**d** CRU |**d** OCLCQ |**d** O CLCO |**d** DLC |**d** OCLCF |**d** OCLCO |**d** IUL
- 042__ |**a** pcc |**a** nsdp
- 05000 |**a** TJ212 |**b** .C69
- 05014 |**a** TA168 |**b** .C66
- 082_4 |**a** 629.8/05
- 1300_ |**a** Control systems magazine (New York, N.Y. : 1981)
- 2100_ |**a** IEEE control syst. mag.
- 222_0 |**a** IEEE control systems magazine
- 24500 |**a** Control systems magazine.
- 24616 |**a** IEEE control systems magazine
- 260__ |**a** [New York, NY : |**b** Control Systems Society, Institute of Electrical and Electronics Engineers], |**c** c1981-c1984.
- 300__ |**a** 4 v. : |**b** ill. ; |**c** 28 cm.
- 310__ |**a** Quarterly
- 3620_ |**a** Vol. 1, no. 1 (Mar. 1981)-v. 4, no. 4 (Nov. 1984).
- 500__ |**a** Title from cover.
- 590__ |**a** SERBIB/SERLOC merged record
- 650_0 |**a** Automatic control |**v** Periodicals.
- 650_7 |**a** Automatic control. |**2** fast |**0** (OCoLC)fst00822702
- 655_7 |**a** Periodicals. |**2** fast |**0** (OCoLC)fst01411641
- 7102_ |**a** IEEE Control Systems Society.
- 77608 |**t** Control systems magazine (New York, N.Y. : 1981 : Online) |**x** 2374-9385 |**w** (OCoLC)52185677
- 77608 |**i** Microfiche version: |**t** Control systems magazine (New York, N.Y. : 1981) |**w** (DLC)sc 86007064 |**w** (OCoLC)9361490
- 78000 |**t** Control systems magazine |**x** 0272-1708 |**w** (DLC)sn 80002341 |**w** (OCoLC)6794997
- 78500 |**t** IEEE control systems magazine |**x** 0272-1708 |**w** (DLC) 87640286 |**w** (OCoLC)12098840
- 850__ |**a** AAP |**a** AU |**a** ArU |**a** AzU |**a** CCC |**a** CLU-P |**a** CNoS |**a** CPT |**a** CSt |**a** CU |**a** CU-A |**a** CU-RivA |**a** CU-S |**a** CU-SB |**a** CaAEU |**a** CaBVaS |**a** CaMWU |**a** CaOKR |**a** CaOPAL |**a** CaOTDT |**a** CaOTU |**a** CaOWA |**a** Ca OWtU |**a** CaSSU |**a** CtU |**a** CtY-KS |**a** DLC |**a** DeU |**a** FU |**a** GAT |**a** ICIU |**a** ICU |**a** ICarbS |**a** IU |**a** InLP |**a** KMK |**a** KyU |**a** LU |**a** MBU |**a** MCM |**a** MMeT |**a** MiD |**a** MiDW |**a** MiEM |**a** MiU |**a** MnU |**a** MoKL |**a** MoU |**a** MsSM |**a** MsU |**a** MtBC

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

|**a** N |**a** NBuU |**a** NIC |**a** NN |**a** NNC |**a** NRU |**a** NSyU |**a** NcD |**a** NcRS |**a** NjP |**a** NjR |**a** NhU |**a** OCU |**a** OU |**a** OkU |**a** PBL |**a** PPD |**a** PSt |**a** PPiC |**a** PPiU |**a** PU |**a** ScCleU |**a** TU |**a** TxArU |**a** TxCM |**a** TxDaM |**a** TxLT |**a** TxU |**a** ULA |**a** UPB |**a** UU |**a** ViBlbV |**a** WM |**a** WaU |**a** WvU |**a** WyU

- 85941 |**u** http://ieeexplore.ieee.org/servlet/opac?punumber=37
- 890__ |**a** Control systems magazine. New York, N.Y. 1981- . |**i** 81-649117
- 906__ |**a** 7 |**b** cbc |**c** serials |**d** 3 |**e** ncip |**f** 19 |**g** n-oclcserc
- 920__ |**a** Keep 1
- 985__ |**e** eserial 200406
- 991__ |**b** c-GenColl |**h** TJ212 |**i** .C69 |**w** SERIALS
- 992__ |**b** Ser |**w** SERLOC

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OCLC	26522522	No holdings in XXX - 268 other holdings									
Continuing Resources		Rec Stat	c	Entere d	19920902		Replace	20170411234616.3			
Type	a	ELvl		Srce	c	GPub		Ctrl		Lang	eng
BLvl	s	Form		Conf	0	Freq	b	MRec		Ctry	nyu
S/L	0	Orig		EntW		Regl	r	Alph	a		
Desc	a	SrTp	p	Cont		DtSt	c	Dates	1991,9999		

010		sn 92034772
040		NYG ‡b eng ‡c NYG ‡d NSD ‡d NST ‡d WAU ‡d MYG ‡d OCL ‡d MYG ‡d DLC ‡d NSD ‡d CUS ‡d IEEEX ‡d OCLCQ ‡d TJC ‡d DLC ‡d NSD ‡d OCLCQ ‡d NSD ‡d DLC ‡d SERSO ‡d CRU ‡dOCLCQ ‡d OCLCF ‡d OCLCO ‡d IUL ‡d TFW ‡d OCLCQ
012		‡i 9209 ‡l y
019		45157814 ‡a 221020249 ‡a 811407906
022	0_	1066-033X ‡l 1066-033X ‡y 0272-1708 ‡2 1
037		‡b Institute of Electrical and Electronics Engineers, Inc., 345 East 47th St., New York, N.Y. 10017-2394
042		pcc ‡a nsdp
050	00	TJ212 ‡b .C69
050	14	TA168 ‡b .C663
082	00	629 ‡2 19
210	0_	IEEE control syst.
222	_0	IEEE control systems
245	00	IEEE control systems / ‡c IEEE Control Systems Society.
246	3_	Institute of Electrical and Electronics Engineers control systems
246	1_	‡i Issues for <June 2002-> have title: ‡a IEEE control systems magazine
246	30	Control systems
260		New York, N.Y. : ‡b Institute of Electrical and Electronics Engineers, ‡c 1990-
300		volumes : ‡b illustrations ; ‡c 28 cm
310		Bimonthly, ‡b 1994-
321		Seven times a year, ‡b 1991
321		Six times a year, ‡b 1992-1993
336		text ‡b txt ‡2 rdacontent

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

337		unmediated ‡b n ‡2 rdamedia
338		volume ‡b nc ‡2 rdacarrier
362	0_	Vol. 11, no. 1 (Jan. 1991)-
500		Title from cover.
588		Latest issue consulted: Vol. 22, no. 3 (June 2002).
650	_0	Automatic control ‡v Periodicals.
650	_7	Automatic control. ‡2 fast ‡0 (OCoLC)fst00822702
655	_7	Periodicals. ‡2 fast ‡0 (OCoLC)fst01411641
655	_7	Electronic journals. ‡2 lcgft
710	2_	IEEE Control Systems Society.
776	08	‡i Online version: ‡t IEEE control systems (Online) ‡x 1941-000X ‡w (DLC) 2008212901 ‡w (OCoLC)44506918
780	00	‡t IEEE control systems magazine (New York, N.Y. : 1985) ‡x 0272-1708 ‡w (DLC) 87640286 ‡w (OCoLC)12098840
850		DLC ‡a InLP ‡a N ‡a WaU
856	41	‡u http://ieeexplore.ieee.org/servlet/opac?punumber=37

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Transaction History Date 2018-05-23
Date information retrieved from USPTO Patent Application Information Retrieval (PAIR) system records at www.uspto.gov

Trials@uspto.gov
571-272-7822

Paper No. 3

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,
Petitioner,

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,
Patent Owner.

Case IPR2018-01061
Patent 6,557,540

Mailed: May 23, 2018

Before Cathy Underwood, *Trial Paralegal*

NOTICE OF FILING DATE ACCORDED TO PETITION AND TIME FOR FILING PATENT OWNER PRELIMINARY RESPONSE

The petition for *inter partes* review, filed in the above proceeding has been accorded the filing date of May 14, 2018.

Patent Owner may file a preliminary response to the petition no later than three months from the date of this notice. The preliminary response is limited to setting forth the reasons why the requested review should not be instituted. Patent Owner may also file an election to waive the preliminary

response to expedite the proceeding. For more information, please consult the Office Patent Trial Practice Guide, 77 Fed. Reg. 48756 (Aug. 14, 2012), which is available on the Board Web site at http://www.uspto.gov/PTAB.

Patent Owner is advised of the requirement to submit mandatory notice information under 37 C.F.R. § 42.8(a)(2) within 21 days of service of the petition.

The parties are encouraged to use the heading on the first page of this Notice for all future filings in the proceeding.

The parties are advised that under 37 C.F.R. § 42.10(c), recognition of counsel *pro hac vice* requires a showing of good cause. The parties are authorized to file motions for *pro hac vice* admission under 37 C.F.R. § 42.10(c). Such motions shall be filed in accordance with the "Order -- Authorizing Motion *for Pro Hac Vice* Admission" in Case IPR2013-00639, Paper 7, a copy of which is available on the Board Web site under "Representative Orders, Decisions, and Notices."

The parties are reminded that unless otherwise permitted by 37 C.F.R. § 42.6(b)(2), all filings in this proceeding must be made electronically in Patent Trial and Appeal Board End to End (PTAB E2E), accessible from the Board Web site at http://www.uspto.gov/PTAB. To file documents, users must register with PTAB E2E. Information regarding how to register with and use PTAB E2E is available at the Board Web site.

If there are any questions pertaining to this notice, please contact Cathy Underwood at 571-272-8358 or the Patent Trial and Appeal Board at 571-272-7822.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Case IPR2018-01061
Patent No. 6,557,540

PETITIONER:

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HMC-MMT-IPR@BakerMcKenzie.com

PATENT OWNER:

VISTEON GLOBAL TECHNOLOGIES INC
Intellectual Property Department
One Village Center Drive
Van Buren Township, MI 48111

and

Timothy Devlin
DEVLIN LAW FIRM LLC
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

NOTICE CONCERNING ALTERNATIVE DISPUTE RESOLUTION (ADR)

The Patent Trial and Appeal Board (PTAB) strongly encourages parties who are considering settlement to consider alternative dispute resolution as a means of settling the issues that may be raised in an AIA trial proceeding. Many AIA trials are settled prior to a Final Written Decision. Those considering settlement may wish to consider alternative dispute resolution techniques early in a proceeding to produce a quicker, mutually agreeable resolution of a dispute or to at least narrow the scope of matters in dispute. Alternative dispute resolution has the potential to save parties time and money.

Many non-profit organizations, both inside and outside the intellectual property field, offer alternative dispute resolution services. Listed below are the names and addresses of several such organizations. The listings are provided for the convenience of parties involved in cases before the PTAB; the PTAB does not sponsor or endorse any particular organization's alternative dispute resolution services. In addition, consideration may be given to utilizing independent alternative dispute resolution firms. Such firms may be located through a standard keyword Internet search.

CPR INSTITUTE FOR DISPUTE RESOLUTION	AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION (AIPLA)	AMERICAN ARBITRATION ASSOCIATION (AAA)	WORLD INTELLECTUAL PROPERTY ORGANIZATION (WIPO)	AMERICAN BAR ASSOCIATION (ABA)
Telephone: (212) 949-6490	Telephone: (703) 415-0780	Telephone: (212) 484-3266	Telephone: 41 22 338 9111	Telephone : (202) 662-1000
Fax: (212) 949-8859	Fax: (703) 415-0786	Fax: (212) 307-4387	Fax: 41 22 733 5428	N/A
575 Lexington Ave	241 18th Street, South, Suite 700	140 West 51st Street	34, chemin des Colombettes	1050 Connecticut Ave, NW
New York, NY 10022	Arlington, VA 22202	New York, NY 10020	CH-1211 Geneva 20, Switzerland	Washington D.C. 20036
www.cpradr.org	www.aipla.org	www.adr.org	www.wipo.int	www.americanbar.org

If parties to an AIA trial proceeding consider using alternative dispute resolution, the PTAB would like to know whether the parties ultimately decided to engage in alternative dispute resolution and the reasons why or why not. If the parties actually engage in alternative dispute resolution, the PTAB would be interested to learn what mechanism (e.g., arbitration,

mediation, etc.) was used and the general result. Such a statement from the parties is not required but would be helpful to the PTAB in assessing the value of alternative dispute resolution to parties involved in AIA trial proceedings. To report an experience with ADR, please forward a summary of the particulars to the following email address: PTAB_ADR_Comments@uspto.gov

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,
Petitioner,

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,
Patent Owner

IPR2018-01061
Patent 6,557,540

PATENT OWNER'S MANDATORY NOTICES

Mail Stop PATENT BOARD
Patent Trial and Appeal Board
US Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Through the undersigned Counsel, Patent Owner, Michigan Motor Technologies LLC, is submitting the following Mandatory Notice pursuant to 37 C.F.R. § 42.9(a)(2).

REAL PARTY-IN-INTEREST

Michigan Motor Technologies LLC certifies that it is the real party-in-interest as it is the owner of the Patent No. 6,557,540.

RELATED MATTERS:

The Patent Owner identifies the following judicial and/or administrative matters that may affect, or may be affected by, a decision in the *Inter Partes* Review:

Michigan Motor Technologies LLC v. Hyundai Motor Company, et al., Case No. 2:17-cv-12901-BAF-RSW (ED MI).

LEAD COUNSEL:

Pursuant to 37 C.F.R. §§ 42.8(b)(3) and 42.01(a), Michigan Motor Technologies LLC designated the following:

Lead Counsel:
Timothy Devlin, Reg. No. 41706
Devlin Law Firm LLC
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806
Phone: (302) 449-9010
Fax: (302) 353-4251
tdevlin@devlinlawfirm.com

SERVICE INFORMATION:

Service information is as follows: DEVLIN LAW FIRM LLC, 1306 N. Broom Street, 1st Floor, Wilmington, DE 19806; Phone: (302) 449-9010; Fax: (302) 353-4251; Michigan Motor Technologies LLC consents to service by electronic mail at tdevlin@devlinlawfirm.com; rwilliams@devlinlawfirm.com, mmcclain@devlinlawfirm.com and fxu@devlinlawfirm.com

Michigan Motor Technologies LLC believes this submission fulfills the requirements of 37 C.F.R. § 42.8. If additional information is required, please contact the undersigned counsel at the address shown below.

Should the Board require any further information, the Board is encouraged to contact the Patent Owner's undersigned representative at the telephone number listed below.

Respectfully submitted,

Dated: June 4, 2018

DEVLIN LAW FIRM LLC

By: */s/ Timothy Devlin*
Timothy Devlin
Reg. No. 41706
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806
Phone: (302) 449-9010
tdevlin@devlinlawfirm.com

Attorney for Patent Owner

CERTIFICATE OF SERVICE

I hereby certify that on June 4, 2018, I caused a true and correct copy of this Mandatory Notice to be served via email on Brian C. McCormack, Baker & McKenzie LLP at brian.mccormack@bakermckenzie.com

/s/ Timothy Devlin
Timothy Devlin

Transaction History Date 2018-09-26
Date information retrieved from USPTO Patent Application Information Retrieval (PAIR) system records at www.uspto.gov

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,

Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,

Patent Owner

Case IPR2018-01061

Patent No. 6,557,540

JOINT MOTION OF PETITIONER AND PATENT OWNER TO TERMINATE PROCEEDING PURSUANT TO 35 U.S.C. § 317

STATEMENT OF PRECISE RELIEF REQUESTED

Pursuant to 35 U.S.C. § 317, 37 C.F.R. § 42.74, and the Board's September 24, 2018 email granting the Parties permission to file this motion, Petitioner Hyundai Motor Company ("Hyundai") and Patent Owner Michigan Motor Technologies LLC ("MMT") (collectively the "Parties") jointly request termination of this *Inter Partes* Review, Case No. IPR2018-01061. As there are no other petitioners in this proceeding and the proceeding is still at an early stage, the Parties respectfully submit that termination of the proceeding is appropriate.

STATEMENT OF FACTS

MMT sued Hyundai in *Michigan Motor Technologies LLC v. Hyundai Motor Company et al*, No. 2:17-cv-12901 (E.D. Mich), alleging infringement of U.S. Patent No. 6,557,540 ("the '540 patent").

Hyundai filed a Petition for *Inter Partes* Review of the '540 patent on May 14, 2018. A Patent Owner Preliminary Response has not been filed nor has an Institution Decision been issued in this case.

The Parties have reached an agreement to end the present actions between them. Filed herewith is a true copy of the Parties agreement (Exhibit 1035). A "Joint Request to File Settlement Agreement as Business Confidential Information Under 35 U.S.C. § 317(b)" is being filed concurrently with this Joint Motion to Terminate to keep the settlement agreement confidential.

ARGUMENT

A joint motion to terminate generally "must (1) include a brief explanation as to why termination is appropriate; (2) identify all parties in any related litigation involving the patents at issue; (3) identify any related proceedings currently before the Office, and (4) discuss specifically the current status of each such related litigation or proceeding with respect to each party to the litigation or proceeding." *Heartland Tanning, Inc. v. Sunless, Inc.*, IPR2014-00018, Paper 26 at 2 (PTAB Jul. 28, 2014).

The Board should terminate this case as the Parties jointly request, for the following reasons.

1. Brief Explanation As To Why Termination is Appropriate

The Parties have met the statutory requirement that they file a "joint request" to terminate this proceeding before the office "has decided the merits of the proceeding." 35 U.S.C. § 317(a). A decision on institution of this case is still many weeks away. No prior motions are pending.

The Parties have reached a settlement in the related litigation as to the '540 patent and to end this dispute. A copy of the confidential settlement is filed concurrently herewith. *See* Ex. 1035. The Parties further jointly certify that there is no other agreement or understanding between them, including any collateral agreements, made in connection with, or in contemplation of, the termination of

the instant proceeding as set forth in 35 U.S.C. § 317(b).

The Parties respectfully submit that termination of this proceeding is appropriate because (a) this proceeding is at an early stage and no motions are outstanding; (b) the Parties have reached agreement to end their dispute concerning U.S. Patent No. 6,557,540; (c) the Parties have agreed to dismiss the related district court litigation with respect to U.S. Patent No. 6,557,540; (d) the Parties agree that this *Inter Partes* Review should be terminated; and (e) termination of this proceeding will preserve the Board's resources and obviate the need for any more Board involvement in this matter.

2. Identity of All Parties in Related Litigations Involving the Patent-At-Issue

The parties in *Michigan Motor Technologies LLC v. Hyundai Motor Company et al*, Case No. 2:17-cv-12901 (E.D. Mich) are Patent Owner, MMT, Petitioner, Hyundai, and Hyundai America Technical Center, Inc.

3. Identity of Any Related Proceedings Currently Before the Office

There are no other pending proceedings before the Office related to the '540 patent.

4. Current Status of Each Related Litigation and Proceeding

The joint stipulation filed in Case No. 2:17-cv-12901 requests dismissal with prejudice of all of Patent Owner's claims relating to the '540 patent.

CONCLUSION

For at least the foregoing reasons, Petitioner Hyundai Motor Company and Patent Owner Michigan Motor Technologies LLC respectfully request termination of this *Inter Partes* Review.

Dated: September 26, 2018

Respectfully submitted,

/*Brian C. McCormack*/
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Baker & McKenzie LLP
1900 North Pearl Street, Suite 1500
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Tel: (214) 978-3007
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Counsel for Petitioner

/*Timothy Devlin*/
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Wilmington, DE 19806
Tel: (302) 449-9010
Fax: (302) 353-4251
tdevlin@devlinlawfirm.com

Counsel for Patent Owner

CERTIFICATE OF SERVICE

I certify that on September 26, 2018 I am causing a copy of this Joint Motion to Terminate, including all attachments, exhibits, and documents therewith, to be served upon the Patent Owner by filing this document as well as by delivering a copy via email to the following attorneys of record for the Patent Owner:

Timothy Devlin
tdevlin@devlinlawfirm.com
DEVLIN LAW FIRM LLC
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806

Dated: September 26, 2018

Respectfully submitted,

/Brian C. McCormack/
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Counsel for Petitioner

Transaction History Date 2018-09-26
Date information retrieved from USPTO Patent Application Information Retrieval (PAIR) system records at www.uspto.gov

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,

Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,

Patent Owner

Case IPR2018-01061

Patent No. 6,557,540

JOINT REQUEST TO FILE SETTLEMENT AGREEMENT AS BUSINESS CONFIDENTIAL INFORMATION UNDER 35 U.S.C. § 317(b)

Pursuant to 35 U.S.C. § 317(b), and 37 C.F.R. § 42.74(c), Petitioner Hyundai Motor Company and Patent Owner Michigan Motor Technologies LLC (collectively the "Parties") jointly request that the Parties' written agreement, attached as Exhibit 1035, (a) be treated as business confidential information, (b) be kept separate from the file of the involved patent, and (c) be made available only as permitted pursuant to the provisions of 35 C.F.R. § 317(b) and 37 C.F.R. § 42.74(c). This joint request is filed contemporaneous with the Parties' written agreement (Exhibit 1035) and the Parties' Joint Motion to Terminate *Inter Partes* Review of U.S. Patent No. 6,557,540 Case No. IPR2018-01061.

Dated: September 26, 2018

Respectfully Submitted,

/Brian C. McCormack/
Brian C. McCormack, Reg. No. 36,601
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Counsel for Petitioner

/Timothy Devlin/
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Tel: (302) 449-9010
tdevlin@devlinlawfirm.com

Counsel for Patent Owner

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

CERTIFICATE OF SERVICE

I certify that on September 26, 2018 I am causing a copy of this Joint Request to File Settlement Agreement as Business Confidential Information, including all attachments, exhibits, and documents therewith, to be served upon the Patent Owner by filing this document as well as by delivering a copy via email to the following attorneys of record for the Patent Owner:

Timothy Devlin
tdevlin@devlinlawfirm.com
DEVLIN LAW FIRM LLC
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806

Dated: September 26, 2018

Respectfully submitted,

/*Brian C. McCormack*/
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Counsel for Petitioner

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Transaction History Date 2018-10-02
Date information retrieved from USPTO Patent Application Information Retrieval (PAIR) system records at www.uspto.gov

UNITED STATES PATENT AND TRADEMARK OFFICE

_____

BEFORE THE PATENT TRIAL AND APPEAL BOARD

_____

HYUNDAI MOTOR COMPANY,

Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,

Patent Owner

Case IPR2018-01061

Patent No. 6,557,540

PETITIONER'S REQUEST FOR REFUND

On May 14, 2018, Petitioner Hyundai Motor Company ("Petitioner") filed a Petition for *Inter Partes* review of U.S. Patent 6,557,540. Paper 2. On September 26, 2018, Petitioner and Patent Owner Michigan Motor Technologies LLC filed a joint motion to terminate the instant proceeding per a settlement agreement. Paper 5. On October 2, 2018, the Board issued a decision terminating the proceeding. Paper 7. The instant proceeding was still at a preliminary stage and the Board had not yet instituted any trial.

The *Inter Partes* Post-Institution fee of $15,000 specified in 37 C.F.R. § 42.15(a)(2) was charged to Deposit Account No. 130480 with the filing of the Petition. Petitioner hereby requests that the Post-Institution fee in the amount of $15,000 be refunded to Deposit Account No. 130480.

Dated: October 02, 2018

Respectfully Submitted,

/Brian C. McCormack/

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brian.mccormack@bakermckenzie.com

Counsel for Petitioner

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

CERTIFICATE OF SERVICE

I certify that on October 02, 2018, I caused a true and correct copy of this Petitioner's Request for Refund to be served upon the Patent Owner by filing this document as well as by delivering a copy via email to the following attorneys of record for the Patent Owner:

Timothy Devlin
tdevlin@devlinlawfirm.com
DEVLIN LAW FIRM LLC
1306 N. Broom Street, 1st Floor
Wilmington, DE 19806

Dated: October 02, 2018

Respectfully submitted,

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Counsel for Petitioner

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Transaction History Date 2018-10-02
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Trials@uspto.gov
Tel: 571.272.7822

Paper 7
Entered: October 2, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,
Petitioner,

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,
Patent Owner.

Case IPR2018-01061
Patent 6,557,540 B1[1]

Before NEIL T. POWELL, BARBARA A. PARVIS, MICHAEL L. WOODS, and SCOTT B. HOWARD, *Administrative Patent Judges*.[2]

PARVIS, *Administrative Patent Judge*.

---

[1] This Order addresses the same issue in the *inter partes* reviews listed in the Appendix. We exercise our discretion to issue one Order to be docketed in each case. The parties, however, are not authorized to use this style of filing in subsequent papers, without prior authorization.

[2] This is not an order from an expanded panel of the Board. Judges Parvis, Woods, and Howard are paneled on IPR2018-01061, -01064, -01073, -01075, and -01077. Judges Powell, Parvis, and Woods are paneled on IPR2018-01074 and -01078. Judges Powell, Woods, and Howard are paneled on IPR2018-01063, -01065, and -01072.

ORDER
Granting Joint Motions and Dismissing Proceedings
37 C.F.R. §§ 42.71(a), 42.72, 42.74

Hyundai Motor Company ("Petitioner") filed Petitions to institute *inter partes* reviews of certain claims of each of the challenged patents listed in the Appendix. Pursuant to 35 U.S.C. § 317, Petitioner and Michigan Motor Technologies LLC ("Patent Owner") filed a joint motion to terminate in each of the instant proceedings. *See, e.g.*, IPR2018-01061, Paper 5.[3] Along with each joint motion, the parties filed a Settlement Agreement. *See, e.g.*, IPR2018-01061, Ex. 1035. The parties also filed in each case a joint request that the settlement agreement be treated as business confidential information pursuant to 35 U.S.C. § 317(b) and 37 C.F.R. § 42.74(c). *See, e.g.*, IPR2018-01061, Paper 6. We authorized the above filings on September 24, 2018.

The parties represent that they have settled their disputes with respect to each of the challenged patents and memorialized their settlement in the written agreement submitted in each case. *See, e.g.*, IPR2018-01061, Paper 5. The parties state that they have agreed to settle and dismiss their related, co-pending district court lawsuit and have filed a joint stipulation requesting dismissal, with prejudice. *Id.* On this record, no motion by any third party for joinder with these proceedings is pending.

The instant proceedings are still at a preliminary stage. The Board has not yet instituted any trial. Upon consideration of the facts before us, we determine that it is appropriate to dismiss the petitions and the proceedings

[3] We cite to IPR2018-01061 herein, except as noted. The paper numbers and exhibit numbers for the other proceedings are listed in the Appendix.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

with respect to both parties. *See* 37 C.F.R. § 42.71(a). Therefore, the joint motions are granted. This paper does not constitute a final written decision pursuant to 35 U.S.C. § 318(a).

ORDER

For the foregoing reasons, it is:

ORDERED that the parties' joint request in each proceeding that the settlement agreement (IPR2018-01061, Ex. 1035; IPR2018-01063, Ex. 1015; IPR2018-01064, Ex. 1024; IPR2018-01065, Ex. 1036; IPR2018-01072, Ex. 1019; IPR2018-01073, Ex. 1021; IPR2018-01074, Ex. 1016; IPR2018-01075, Ex. 1021; IPR2018-01077, Ex. 1010; IPR2018-01078, Ex. 1026) be treated as business confidential information and be kept separate from the patent file is *granted*; and

FURTHER ORDERED that the joint motions in the IPR2018-01061, Paper 5; IPR2018-01063, Paper 5; IPR2015-01064, Paper 6; IPR2018-01065, Paper 5; IPR2018-01072, Paper 5; IPR2018-01073, Paper 5; IPR2018-01074, Paper 5; IPR2018-01075, Paper 5; IPR2018-01077, Paper 5; IPR2018-01078, Paper 5 proceedings are *granted* and each of the proceedings is *dismissed*.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

IPR2018-01061
Patent 6,557,540 B1

PETITIONER:

Brian C. McCormack
Matt Dushek
BAKER & MCKENZIE LLP
brian.mccormack@bakermckenzie.com
matt.dushek@bakermckenzie.com

PATENT OWNER:

Timothy Devlin
DEVLIN LAW FIRM LLC
tdevlin@devlinlawfirm.com

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

APPENDIX

Inter Partes Review	U.S. Patent No.	Joint Motion	Joint Request	Agreement
IPR2018-01061	6,557,540 B1	Paper No. 5	Paper No. 6	Ex. 1035
IPR2018-01063	7,487,761 B1	Paper No. 5	Paper No. 6	Ex. 1015
IPR2018-01064	6,581,574 B1	Paper No. 6	Paper No. 7	Ex. 1024
IPR2018-01065	6,757,149 B2	Paper No. 5	Paper No. 6	Ex. 1036
IPR2018-01072	6,988,031 B2	Paper No. 5	Paper No. 6	Ex. 1019
IPR2018-01073	6,571,157 B1	Paper No. 5	Paper No. 6	Ex. 1021
IPR2018-01074	6,644,155 B2	Paper No. 5	Paper No. 6	Ex. 1016
IPR2018-01075	6,561,166 B2	Paper No. 5	Paper No. 6	Ex. 1021
IPR2018-01077	7,143,501 B2	Paper No. 5	Paper No. 6	Ex. 1010
IPR2018-01078	7,116,081 B2	Paper No. 5	Paper No. 6	Ex. 1026

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Tel: 571.272.7822

Paper 7
Entered: October 2, 2018

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,
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Case IPR2018-01061
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Before NEIL T. POWELL, BARBARA A. PARVIS, MICHAEL L. WOODS, and SCOTT B. HOWARD, *Administrative Patent Judges*.[2]

PARVIS, *Administrative Patent Judge*.

---

[1] This Order addresses the same issue in the *inter partes* reviews listed in the Appendix. We exercise our discretion to issue one Order to be docketed in each case. The parties, however, are not authorized to use this style of filing in subsequent papers, without prior authorization.

[2] This is not an order from an expanded panel of the Board. Judges Parvis, Woods, and Howard are paneled on IPR2018-01061, -01064, -01073, -01075, and -01077. Judges Powell, Parvis, and Woods are paneled on IPR2018-01074 and -01078. Judges Powell, Woods, and Howard are paneled on IPR2018-01063, -01065, and -01072.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

ORDER
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The parties represent that they have settled their disputes with respect to each of the challenged patents and memorialized their settlement in the written agreement submitted in each case. *See, e.g.*, IPR2018-01061, Paper 5. The parties state that they have agreed to settle and dismiss their related, co-pending district court lawsuit and have filed a joint stipulation requesting dismissal, with prejudice. *Id.* On this record, no motion by any third party for joinder with these proceedings is pending.

The instant proceedings are still at a preliminary stage. The Board has not yet instituted any trial. Upon consideration of the facts before us, we determine that it is appropriate to dismiss the petitions and the proceedings

[3] We cite to IPR2018-01061 herein, except as noted. The paper numbers and exhibit numbers for the other proceedings are listed in the Appendix.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

with respect to both parties. *See* 37 C.F.R. § 42.71(a). Therefore, the joint motions are granted. This paper does not constitute a final written decision pursuant to 35 U.S.C. § 318(a).

ORDER

For the foregoing reasons, it is:

ORDERED that the parties' joint request in each proceeding that the settlement agreement (IPR2018-01061, Ex. 1035; IPR2018-01063, Ex. 1015; IPR2018-01064, Ex. 1024; IPR2018-01065, Ex. 1036; IPR2018-01072, Ex. 1019; IPR2018-01073, Ex. 1021; IPR2018-01074, Ex. 1016; IPR2018-01075, Ex. 1021; IPR2018-01077, Ex. 1010; IPR2018-01078, Ex. 1026) be treated as business confidential information and be kept separate from the patent file is *granted*; and

FURTHER ORDERED that the joint motions in the IPR2018-01061, Paper 5; IPR2018-01063, Paper 5; IPR2015-01064, Paper 6; IPR2018-01065, Paper 5; IPR2018-01072, Paper 5; IPR2018-01073, Paper 5; IPR2018-01074, Paper 5; IPR2018-01075, Paper 5; IPR2018-01077, Paper 5; IPR2018-01078, Paper 5 proceedings are *granted* and each of the proceedings is *dismissed*.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

IPR2018-01061
Patent 6,557,540 B1

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PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

APPENDIX

Inter Partes Review	U.S. Patent No.	Joint Motion	Joint Request	Agreement
IPR2018-01061	6,557,540 B1	Paper No. 5	Paper No. 6	Ex. 1035
IPR2018-01063	7,487,761 B1	Paper No. 5	Paper No. 6	Ex. 1015
IPR2018-01064	6,581,574 B1	Paper No. 6	Paper No. 7	Ex. 1024
IPR2018-01065	6,757,149 B2	Paper No. 5	Paper No. 6	Ex. 1036
IPR2018-01072	6,988,031 B2	Paper No. 5	Paper No. 6	Ex. 1019
IPR2018-01073	6,571,157 B1	Paper No. 5	Paper No. 6	Ex. 1021
IPR2018-01074	6,644,155 B2	Paper No. 5	Paper No. 6	Ex. 1016
IPR2018-01075	6,561,166 B2	Paper No. 5	Paper No. 6	Ex. 1021
IPR2018-01077	7,143,501 B2	Paper No. 5	Paper No. 6	Ex. 1010
IPR2018-01078	7,116,081 B2	Paper No. 5	Paper No. 6	Ex. 1026

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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Trials@uspto.gov
571-272-7822

Paper No. 9

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HYUNDAI MOTOR COMPANY,
Petitioner,

v.

MICHIGAN MOTOR TECHNOLOGIES LLC,
Patent Owner.

Case IPR2018-01061
Patent 6,557,540

Mailed: October 24, 2018

NOTICE OF REFUND

Petitioner's request for a refund of certain post-institution fees paid on May 14, 2018 in the above proceeding is hereby granted. The amount of $15,000 has been refunded to Petitioner's deposit account.

The parties are reminded that unless otherwise permitted by 37 C.F.R. § 42.6(b)(2), all filings in this proceeding must be made electronically in the Patent Trial and Appeal Board End to End (PTAB E2E), accessible from the Board Web site at http://www.uspto.gov/PTAB.

If there are any questions pertaining to this notice, please contact the Patent Trial and Appeal Board at 571-272-7822.

Case IPR2018-01061
Patent 6,557,540

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PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

AO 120 (Rev. 08/10)

TO:	**Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Michigan on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	2/15/2019	Eastern District of Michigan

PLAINTIFF	DEFENDANT
MICHIGAN MOTOR TECHNOLOGIES LLC	VOLKSWAGEN AKTIENGESELLSCHAFT

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 6,588,260 B1	7/8/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
2	US 6,443,128 B1	9/3/2002	MICHIGAN MOTOR TECHNOLOGIES LLC
3	US 6,581,565 B2	6/24/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
4	US 6,379,281 B1	4/30/2002	MICHIGAN MOTOR TECHNOLOGIES LLC
5	US 6,763,804 B2	7/20/2004	MICHIGAN MOTOR TECHNOLOGIES LLC

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK (CON'D)

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
6. US 6,347,680 B1	2/19/2002	MICHIGAN MOTOR TECHNOLOGIES LLC
7. US 6,561,166 B2	5/13/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
8. US 6,988,031 B2	1/17/2006	MICHIGAN MOTOR TECHNOLOGIES LLC
9. US 6,612,287 B2	9/2/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
10. US 7,487,761 B1	2/10/2009	MICHIGAN MOTOR TECHNOLOGIES LLC
11. US 6,644,115 B2	11/11/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
12. US 6,581,574 B1	6/24/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
13. US 6,609,497 B2	8/26/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
14. US 6,571,157 B1	5/27/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
15. US 6,736,122 B2	5/18/2004	MICHIGAN MOTOR TECHNOLOGIES LLC
16. US 6,757,149 B2	6/29/2004	MICHIGAN MOTOR TECHNOLOGIES LLC
17. US 7,116,081 B2	10/3/2006	MICHIGAN MOTOR TECHNOLOGIES LLC
18. US 8,909,482 B2	12/9/2014	MICHIGAN MOTOR TECHNOLOGIES LLC
19. US 6,557,540 B1	5/6/2003	MICHIGAN MOTOR TECHNOLOGIES LLC
20. US 6,345,604	2/12/2002	MICHIGAN MOTOR TECHNOLOGIES LLC

Transaction History Date 2019-11-25
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.
Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC
Patent Owner

Case IPR2020-00160
Patent 6,557,540

PETITIONER VOLKSWAGEN GROUP OF AMERICA, INC.'S POWER OF ATTORNEY

Mail Stop "PATENT BOARD"
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Petitioner Volkswagen Group of America, Inc.'s Power of Attorney

Pursuant to 37 C.F.R. § 42.10(b), Petitioner Volkswagen Group of America, Inc., hereby appoints the practitioners of Customer No. 26111 as its attorneys to transact all business in the United States Patent & Trademark Office associated with the above-captioned *inter partes* review of U.S. Patent No. 6,557,540.

These attorneys include at least:

Lead Counsel Michael D. Specht, Reg. No. 54,463
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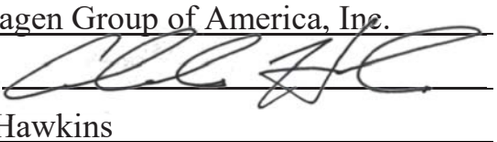
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BY: Charles Hawkins

TITLE: Assistant General Counsel IP & Litigation

DATE: November 19, 2019

Transaction History Date 2019-11-25
Date information retrieved from USPTO Patent Application Information Retrieval (PAIR) system records at www.uspto.gov

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES, LLC,
Patent Owner

Case IPR2020-00160
Patent 6,557,540

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,557,540

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U.S. Patent & Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

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IX. Conclusion 101

PETITIONER'S EXHIBIT LIST

Exhibit No.	Description
1001	U.S. Patent No. 6,557,540 B1 to Mianzo *et al.* ("'540 Patent")
1002	Prosecution File History of U.S. Patent No. 6,557,540 B1 ("'540 history")
1003	Expert Declaration of Mark Ehsani, Ph.D.
1004	Curriculum Vitae of Mark Ehsani, Ph.D.
1005	U.S. Patent No. 5,713,317 to Yoshioka, titled "Method of Continuously and Variably Controlling Valve Timing of Internal Combustion Engine," issued February 3, 1998 ("Yoshioka")
1006	U.S. Patent No. 4,995,351 to Ohkubo *et al.*, titled "Valve Timing Control Apparatus for an Internal Combustion Engine," issued February 26, 1991 ("Ohkubo")
1007	U.S. Patent No. 6,308,671 to Reed *et al.*, titled "Method of Increasing Torque and/or Reducing Emissions by Varying The Timing of Intake and/or Exhaust Valves," issued October 30, 2001 ("Reed")
1008	"Torque Management of Engines with Variable Cam Timing," M. Jankovic, F. Frischmuth, A. Stefanopoulou, and J. A. Cook, IEEE Control Systems, October 1998 ("Jankovic")
1009	"Bosch Fuel Injection Systems," F. Aird, Berkeley Publishing Group, 2001, ISBN 1-55788-365-3 ("Aird")
1010	McGraw-Hill Electronics Dictionary, 6th ed. By Neil Sclater and John Markus © 1997 Mcgraw-Hill Inc., ISBN 0-07-057837-0.
1011	"Automotive Encyclopedia," W. Toboldt & L. Johnson, Goodheart-Wilcox Co. Inc., 1979, ISBN 0-87006-268-9 ("Toboldt")
1012	"Bosch Automotive Handbook," Robert Bosch GmbH, 2000, ISBN 0-7680-0669-4 ("Bosch")
1013	"Modeling and Control of Advanced Technology Engines," A. Stefanopoulou, U. Mich., 1996 ("Stefanopoulou")
1014	U.S. Patent No. 4,220,120 to Jackson *et al.*, titled "Internal Combustion Engine System and Operation," issued September 2, 1980 ("Jackson")

1015	"Automotive Electronics Handbook," R. Jurgen, McGraw-Hill, Inc., ISBN0-07-033189-8, 1994 ("Jurgen")
1016	"Bosch Fuel Injection & Engine Management," C. O. Probst, Robert Bentley, Inc., 1992, ISBN-978-0-8376-0300-1 ("Probst")

I. Introduction

Volkswagen Group of America, Inc. ("VWGoA") petitions for *inter partes* review of claims 1-16 of U.S. Patent No. 6,557,540 to Mianzo *et al.* ("the '540 patent"), titled "Method of Calculating a Valve Timing Command for an Engine."

The '540 patent is directed to the well-known technique of varying valve timing in an internal combustion engine. Specifically, the '540 patent broadly claims methods of calculating a valve timing command that allegedly solves the problem of optimizing valve timing for a particular load on an engine. EX1001, '540 patent, 1:30-33. But this problem and the claimed solution were well-known at the time of the alleged invention, as numerous references predating the critical date of the '540 patent teach the alleged inventive concept embodied in the claims. The '540 patent concedes that "conventional" system components—an accelerator pedal, environmental sensor, and engine sensor—carry out the claimed methods, which "may be performed by any suitable device to calculate valve timing commands for any suitable engine with any suitable variable timing valves." *Id.*, 1:57-60, 2:6-8, 2:33-35, 2:45-47. There is no ingenuity in the arrangement of these conventional components, or in the calculations performed based on their inputs. Indeed, claim 1 boils down to using conventional engine and environmental sensors to determine a "valve feedforward term" (*e.g.*, pulling it from a common look-up

table stored in the control unit) and calculating a valve timing based on that feedforward term and a feedback term from the engine.

The Petition, supported by Dr. Ehsani's expert declaration, who has over 40 years of experience related to internal combustion engines and methods and systems of controlling them, demonstrates that all claims of the '540 patent are unpatentable. Therefore, Petitioner respectfully requests that the Board institute review and ultimately find all claims unpatentable.

II. Mandatory Notices (37 C.F.R. § 42.8(a)(1))

REAL PARTY IN INTEREST: Volkswagen Group of America, Inc. and Volkswagen Aktiengesellschaft, which is the parent corporation of Volkswagen Group of America, Inc., are real parties-in-interest.

RELATED MATTERS: The '540 patent is the subject of the following civil actions: *Michigan Motor Technologies LLC v. Volkswagen AG*, Case No. 2:19-cv-10485 (E.D. Mich.), filed February 18, 2019. An IPR petition was previously filed by Hyundai Motor Company against claims 1-3, 7, 10-11, and 14 the '540 patent in IPR2018-01061 on May 14, 2018. No Patent Owner Preliminary Response was filed, and the matter was dismissed on October 2, 2018 based on a settlement among the parties.

LEAD AND BACKUP COUNSEL: Under 37 C.F.R. § 42.8(b)(3) and 42.10(a), Petitioner appoints **Michael D. Specht** (Reg. No. 54,463) as lead counsel, **Jason A. Fitzsimmons** (Reg. No. 65,367) as first back-up counsel, **Danny E. Yonan** (Reg. No. 53,812) and **Christopher R. O'Brien** (Reg. No. 63,208) as additional back-up counsel, all at the address: STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C., 1100 New York Avenue, N.W., Washington, D.C., 20005, phone (202) 371-2600, and facsimile (202) 371-2540.

SERVICE INFORMATION: Petitioner consents to electronic service by email at: **mspecht-PTAB@sternekessler.com, jfitzsimmons-PTAB@sternekessler.com**, **dyonan-PTAB@sternekessler.com, cobrien-PTAB@sternekessler.com,** and **PTAB@sternekessler.com**.

III. Grounds for Standing (37 C.F.R. § 42.104(a))

The undersigned and Petitioner certify that the '540 patent is available for *inter partes* review. Petitioner is not barred or estopped from requesting *inter partes* review on the grounds herein. On February 18, 2019, Michigan Motor Technologies LLC ("MMT") filed a complaint against Volkswagen Aktiengesellschaft alleging infringement of the '540 patent. VWGoA was added via amended complaint on April 30, 2019. A Certificate of Service on VWGoA was filed with the court on May 22, 2019. This Petition is filed within one year of service by MMT.

IV. Identification of Challenge (37 C.F.R. § 42.104(b))

A. Citation of Prior Art

The ’540 patent issued May 6, 2003, from U.S. Application No. 10/014,286 (“the ’286 application”), which was filed on December 11, 2001. EX1001, (21), (22), (45).

The ’540 patent does not claim the benefit of, or priority to, any U.S. or foreign patent application. Thus, the earliest effective priority date of the ’540 patent is December 11, 2001.

U.S. Patent No. 5,713,317 to Yoshioka, “Method of and Apparatus for Continuously and Variably Controlling Valve Timing of Internal Combustion Engine” (EX1005, “Yoshioka”), issued on February 3, 1998, more than three years before the earliest effective priority date of the ’540 patent. Therefore, Yoshioka is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

U.S. Patent No. 4,995,351 to Ohkubo *et al.*, “Valve Timing Control Apparatus for an Internal Combustion Engine” (EX1006, “Ohkubo”), issued on February 26, 1991, more than ten years before the earliest effective priority date of the ’540 patent. Therefore, Ohkubo is prior art at least under 35 U.S.C. § 102(b) (pre-AIA).

U.S. Patent No. 6,308,671 to Reed *et al.*, "Method of Increasing Torque and/or Reducing Emissions By Varying the Timing of Intake and/or Exhaust Valves" (EX1007, "Reed"), was filed on September 11, 2000 and issued on October 30, 2001, which is before the earliest effective priority date of the '540 patent. Therefore, Ohkubo is prior art at least under 35 U.S.C. § 102(a) (pre-AIA).

B. Statutory Grounds for the Challenge

Ground	References	Basis	Claims Challenged
1	Yoshioka, Ohkubo	§103	1, 2, 7, 10-16
2	Yoshioka, Ohkubo, Reed	§103	3-6, 8, 9

V. The '540 Patent

A. Technology Overview

Long before the '540 patent, it was known that competing objectives are present in internal combustion engines, for example, achieving maximum power output while attaining fuel efficiency and minimizing exhaust byproducts. EX1003, ¶47. To achieve these objectives, electrical engine controls manage various aspects of engines including valve timing. For example, Jankovic explains that known variable cam timing (VCT) systems utilized electro-hydraulic mechanisms to rotate camshaft relative to the crankshaft in order to

retard the cam timing with respect to intake and exhaust strokes of the engine, as illustrated below:

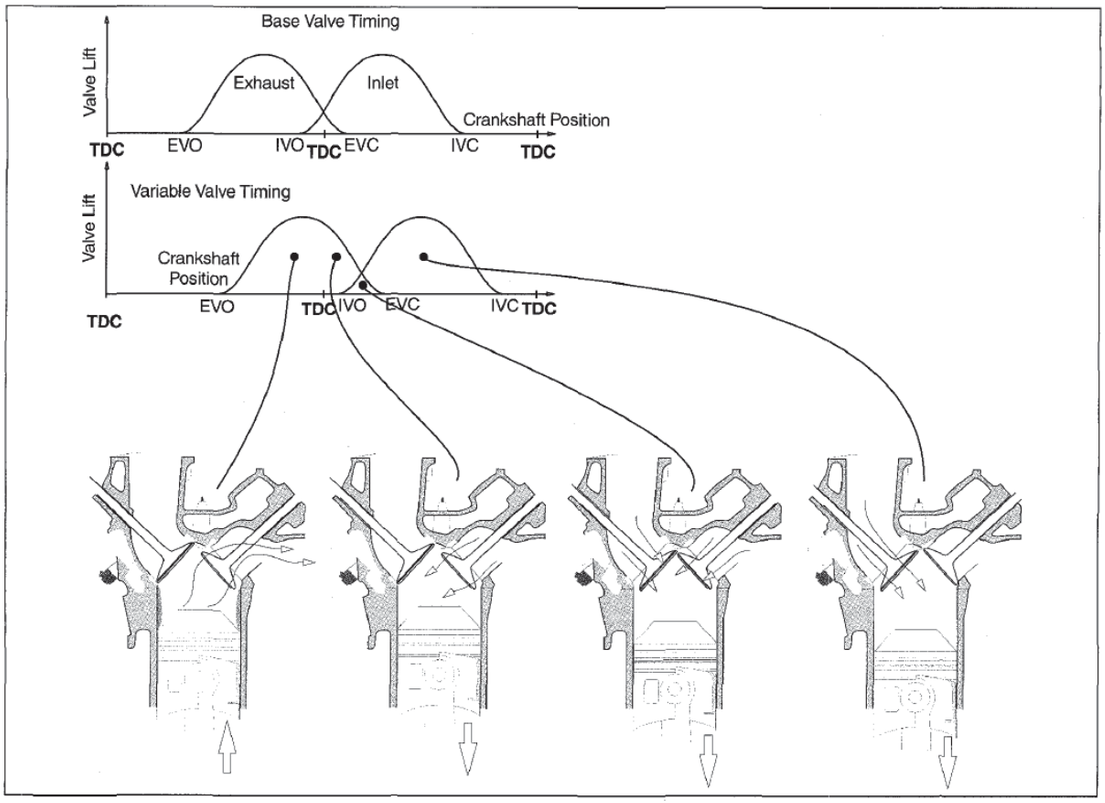


Fig. 1. Valve lift profiles of conventional and VCT engines. By retarding the cam phasing, the exhaust valve stays open during the intake event for a longer time period, retaining otherwise unburned HC and reducing the combustion temperature due to the dilution of the inert gas.

EX1008, FIG. 1.

EX1003, ¶48.

That is, it was known that varying intake and exhaust valve timing permits an engine designer to optimize valve timing over a wide range of engine operating conditions, *e.g.*, emission and torque. EX1008, Jankovic, 34-35;

EX1003, ¶¶49-51. The background of the '540 patent itself even admits that "fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine." EX1001, 1:30-33. Jankovic similarly recognized that there are multiple types of known VCT systems, including: phasing only the intake cam (intake only), phasing only the exhaust cam (exhaust only), phasing the intake and exhaust cams equally (dual equal), and phasing the two camshafts independently (dual independent). EX1008, 35; EX1003, ¶49. According to Jankovic, "intake valve timing and exhaust valve timing are advanced or retarded equally, gives the best overall performance in terms of emissions and fuel economy." EX1008, 35. A POSA would have thus been aware of these benefits and considered varying valve timing as a known technique to improve engine performance (*e.g.*, improve fuel efficiency and reduce emissions). EX1003, ¶49-51.

Yoshioka, Ohkubo, and Reed also describe engine control systems for varying valve timing. Yoshioka, in particular, discloses "a method of and an apparatus for optimizing valve timing according to atmospheric pressure for a continuously variable valve timing mechanism of an internal combustion engine." EX1005, Yoshioka, 1:40-43. This improves "the output of an engine at high

altitudes under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load." *Id.*, 1:44-47; EX1003, ¶¶52-56.

Ohkubo recognized a decade before the '540 patent that it was "well known that changing the opening and closed timings for the intake and exhaust valves of an engine depending upon the engine operating ranges results in improvements in the operating performance of the engine." EX1006, Ohkubo, 1:33-37. And Ohkubo specifically disclosed "a valve timing control apparatus for an internal combustion engine which is able to improve the air-intake and exhaust-discharge efficiency of the engine, thereby increasing engine output power." *Id.*, 1:55-59; EX1003, ¶57.

Reed also recognized that variable cam timing (VCT) "allows the timing of the camshafts, and thus the opening and closing of the valves, to be optimized over a wider range of operating conditions" for "improved performance at medium to full loads coupled with reduced emissions and improvements in fuel economy." EX1007, Reed, 4:54-59. For example, Reed recognized that it was "well known that use of a VCT mechanism on only the intake camshaft 71 improves engine operation" and that the benefits of doing so were also known: "it

reduces NOx emissions," "it reduces HC emissions," and "increases the torque output by the engine at medium to high speeds, improves fuel economy and enables the engine to be operated more stably at idle." EX1007, 5:63-6:27. Moreover, it was "also well known that use of a VCT mechanism on only the exhaust camshaft 81 has a significant effect on emissions" and provided similar benefits. *Id.*, 6:28-53; EX1003, ¶58.

B. Alleged Problem in the Prior Art

The '540 patent is directed to the problem of optimizing fuel efficiency and power output of an engine by varying valve timing for a particular load on an engine. EX1001, 1:30-36. However, long before the '540 patent, the problem of optimizing efficiency and power output of an engine was well-known, as were solutions for varying valve timing to optimize efficiency and power output of an engine. EX1005, 1:9-14, 1:44-47; EX1006, 1:33-37; EX1007, 4:54-59; EX1003, ¶¶59-60. And as discussed below, the '540 patent adds nothing to the realm of previously known solutions.

C. Alleged Invention of the '540 Patent

The '540 patent admits that it was already known "that fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine" and that variable valve timing engines were

known in the prior art. EX1001, 1:30-33. But according to the ’540 patent, these known variable valve timing engines allegedly could not achieve “the theoretical fuel efficiency and output power of these engines.” *Id.*, 1:33-36; EX1003, ¶61.

Without explaining why prior art variable valve timing engines could not reach their “theoretical fuel efficiency and output,” the ’540 patent purports to provide an inventive method for calculating valve timing commands. *Id.*, 1:7-9, 33-36. To allegedly solve the known problem of optimizing efficiency and power output by controlling valve timing, the ’540 patent provides a six step method, which includes: (1) obtaining an engine performance command 16; (2) receiving an environmental conditions signal 18; (3) determining a valve feedforward term 20; (4) receiving an engine performance feedback 22; (5) calculating a valve feedback term 24; and (6) calculating a valve timing command 26 based on the valve feedforward term and the valve feedback term. *Id.*, 1:61-2:1, FIG. 2; EX1003, ¶¶62-68. As discussed below, the ’540 patent admits that these steps are performed using what it refers to as “conventional” components (*e.g.*, an accelerator pedal and common sensors). EX1003, ¶69.

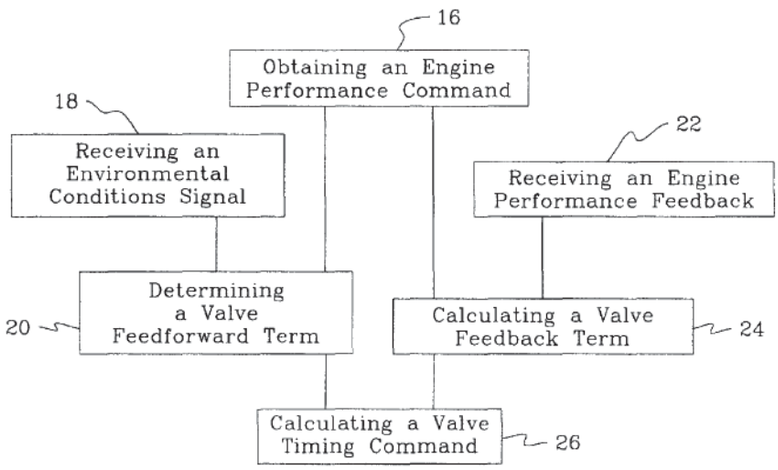


FIGURE 2

EX1001, FIG. 2.

The '540 patent discloses that the "engine performance command" (received at 16) is preferably based on a vehicle performance command from a driver (*e.g.*, by pressing down on a **conventional** pedal 28), but can also be a desired engine torque, desired engine acceleration, or other suitable variables. EX1001, 2:4-22[1]. The "environmental conditions signal" (received at 18) is preferably based on a signal from a **conventional** environmental sensor 30 (*e.g.*, ambient temperature, ambient pressure). *Id.*, 2:23-35. And the engine performance feedback (received at 22) is based on a signal from a **conventional** engine sensor 32 (*e.g.*, engine speed, engine

[1] Emphasis added unless indicated.

torque data, "engine measurable," or "other suitable information"). *Id.*, 2:36-47; EX1003, ¶¶70-72. These admittedly conventional components are used to apply the methods of the '540 patent. EX1003, ¶73.

Based on the received "engine performance command" (*e.g.*, engine torque) and "environmental conditions signal" (*e.g.*, temperature or pressure), the '540 patent discloses that the "valve feedforward term" is determined by a control unit 10. EX1001, 2:48-51. That is, the "valve feedforward term" is determined using known information from conventional components and sensors. In one example, the control unit 10 "determines" the "valve feedforward term" simply by using sensor measurements and a conventional look-up table. *Id.*, 2:51-65; EX1003, ¶74.

Based on the received "engine performance command" and "engine performance feedback," the '540 patent discloses that the "valve feedback term" is determined. EX1001, 2:66-3:1. Specifically, the '540 patent states that "the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any." *Id.*, 3:1-4. This standard feedback comparison can be performed by the control unit 10 or another device. *Id.*, 3:4-7. The "valve timing command" is then calculated based on the "valve feedforward term" and the "valve feedback term." *Id.*, 1:61-2:1. In some embodiments, calculating the "valve timing command" results in adjusting the timing of the

opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC"). *Id.*, 3:21-24; EX1003, ¶¶75-76.

But well before the '540 patent, its known problem had been solved in the same way. EX1003, ¶77. For example, Yoshioka and others optimized valve timing based on environmental conditions (*e.g.*, atmospheric pressure) and engine feedback to improve fuel consumption and reduce emissions. EX1005, 1:9-14, 1:44-47; *see also* EX1006, EX1007. Thus, the '540 patent claims recite nothing more than what was already taught in the prior art and well-known to POSAs. EX1003, ¶¶9-11, 77-78.

D. Prosecution History Summary

The Office issued a Notice of Allowance without a single Office Action. *See generally* EX1002. None of the references upon which this Petition rely were before the examiner during prosecution of the '540 patent. EX1003, ¶80.

E. Level of Ordinary Skill in the Art

A POSA at the time of the alleged invention would have had a B.S. degree in Electrical Engineering or Mechanical Engineering (or equivalent), as well as at least 2–4 years of academic or industry experience in the relevant field of engine control systems. EX1003, ¶44.

F. Claim Construction

In an *inter partes* review, claims are "construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b)." 37 C.F.R. § 42.100 (b). If trial is instituted, all claim terms must be given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the invention, in light of the specification and the prosecution history of the patent. *Id.*; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-1313 (Fed. Cir. 2015) (en banc); *see also* 83 Fed. Reg. 51,340 (Oct. 11, 2018).

Petitioner provides the following claim construction. All claim terms not identified below should receive their plain and ordinary meaning, in the context of the '540 patent specification, under the *Phillips* standard.

1. "calculating a valve feedback term" (claim 1)

Claim 1 recites "calculating a valve feedback term." EX1001, 4:2-4. The '540 patent states that:

> By the definition of the term, the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any.

Id., 3:1-4.

A POSA reading the ’540 patent would have thus understood the phrase “calculating a valve feedback term” to mean “calculating a correction based on a comparison of an input and an output.” EX1003, ¶82.

VI. Overview of the Applied References

Each applied reference discloses a control system for valve timing and thus is from the same field of endeavor as the ’540 patent. EX1003, ¶83.

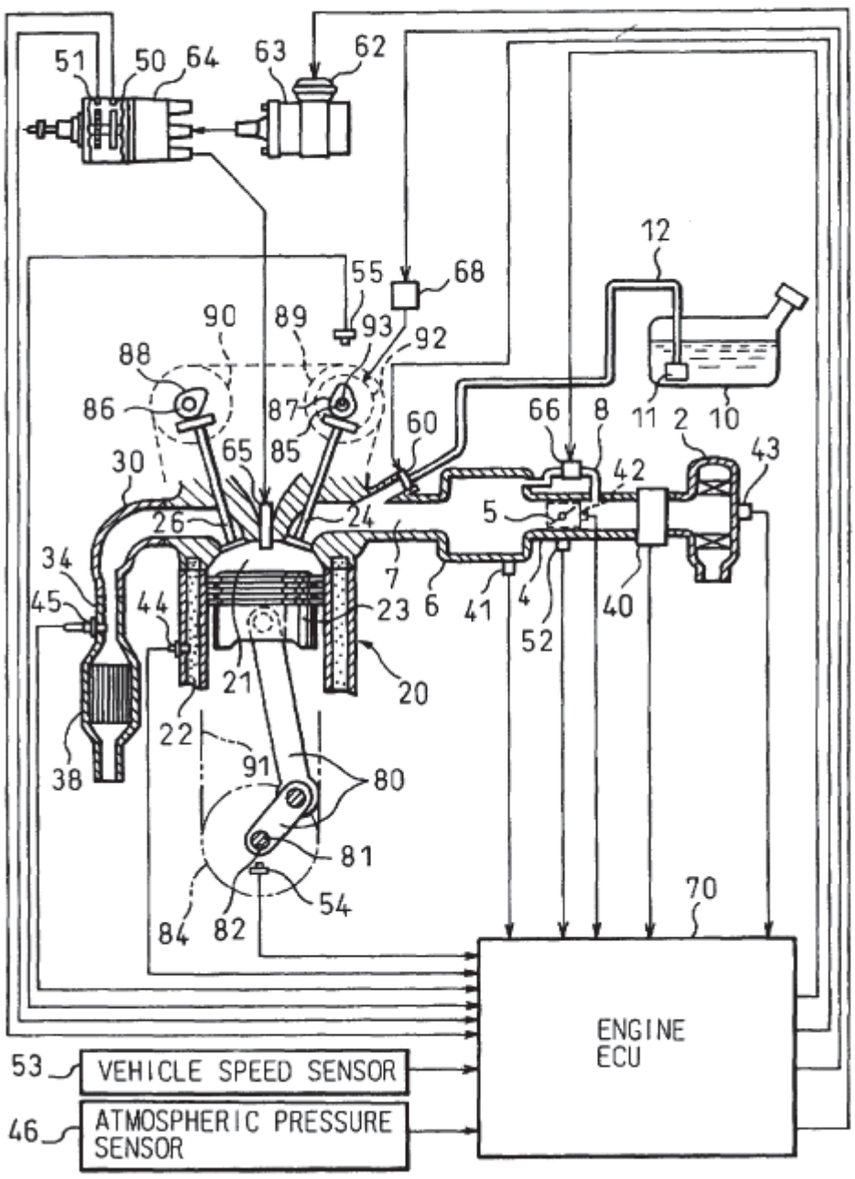
A. Yoshioka

Yoshioka, like the ’540 patent, is directed to a method and apparatus for continuously and variably controlling valve timing of an internal combustion engine. EX1005, Abstract. Specifically, Yoshioka discloses using a two-dimensional map of engine load and engine revolution speed to continuously control open/close timing of the intake valve, thereby smoothing torque characteristics with respect to engine load and throttle opening. *Id.*, 9:22-27; EX1003, ¶84.

Figure 1 of Yoshioka, below, illustrates an electronically controlled internal combustion engine that continuously and variably controls the open/close timing of a valve. EX1005, 4:6-10. As shown, Yoshioka’s engine includes a throttle valve 5 in a throttle body 4 that adjusts the quantity of intake air; an airflow meter 40 that measures the mass flow rate of intake air; a temperature sensor 43 that detects the temperature of intake air; an atmospheric pressure sensor 46; and a throttle sensor

42 that detects the opening of the throttle valve 5. *Id.*, 4:13-23. Intake duct 7 mixes fuel with air, which is drawn into a combustion chamber 21 of cylinder 20 through an intake valve 24, and combusted, and an exhaust valve 26 discharges exhaust gas of the combusted air-fuel mixture into an exhaust manifold 30 connected to an exhaust pipe 34. *Id.*, 4:29-33, 4:48-50; EX1003, ¶85.

Fig. 1



EX1005, FIG. 1.

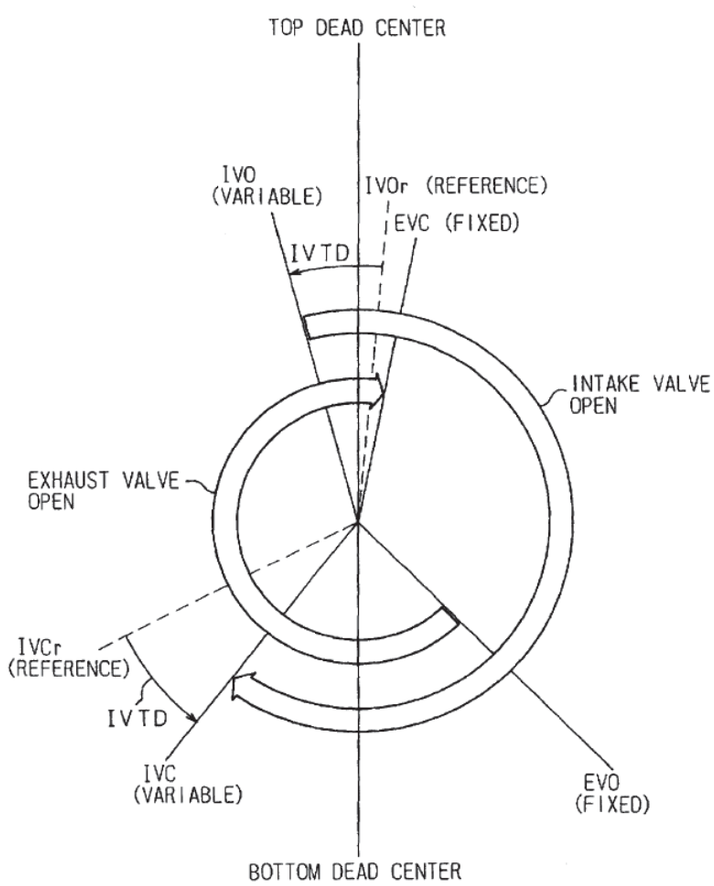
Yoshioka's engine further includes a crankshaft 81 to drive cam shafts 85 and 86 to open and close the intake valve 24 and exhaust valve 26 at predetermined crank angles. EX1005, 4:59-5:4. A continuously variable mechanism 92 is arranged between the cam shaft 85 and a timing pulley 89 to determine the open/close timing of the intake valve 24. *Id.*, 5:10-13. Specifically, the mechanism 92 uses the cam shaft 85 and timing pulley 89 as external gears and connects them to each other through an intermediate helical gear, which is axially moved by hydraulic pressure controlled by a control valve 68, to drive the cam shaft 85 and timing pulley 89 relative to each other. *Id.*, 5:13-20; EX1003, ¶86.

Yoshioka's engine also includes an electronic engine control unit (ECU) 70—a microcomputer—to control aspects of the engine including the open/close timing of intake valve 24 according to operating conditions by controlling the continuously variable mechanism 92. EX1005, 5:21-24. More precisely, the ECU feedback-controls the hydraulic pressure control valve 68 according to signals from first and second magnetic sensors 54 and 55 so that the cam shaft 85 of intake valve 24 maintains a required rotational phase with respect to crankshaft 81. *Id.*, 6:6-15; EX1003, ¶87.

Figure 3 of Yoshioka, below, illustrates a timing chart showing crank angles corresponding to the open/close timing of the intake and exhaust valves 24 and 26,

including: intake valve 24 opening timing IVO and close timing IVC, and exhaust valve 26 opening timing EVO and close timing EVC. EX1005, 6:16-37. Figure 3 also illustrates a valve timing displacement IVTD, which serves as an adjustable target for valve open/close timing. *Id.*, 6:27-28; EX1003, ¶88.

Fig. 3



EX1005, FIG. 3.

Yoshioka discloses utilizing a map—a look-up table—to determine the timing displacement IVTD for optimizing open/close timing of intake valve 24 according to an engine revolution speed NE and an engine load GN, *i.e.*, the mass of intake air per engine revolution. EX1005, 6:38-42, FIG. 4; EX1003, ¶89.

Fig. 4

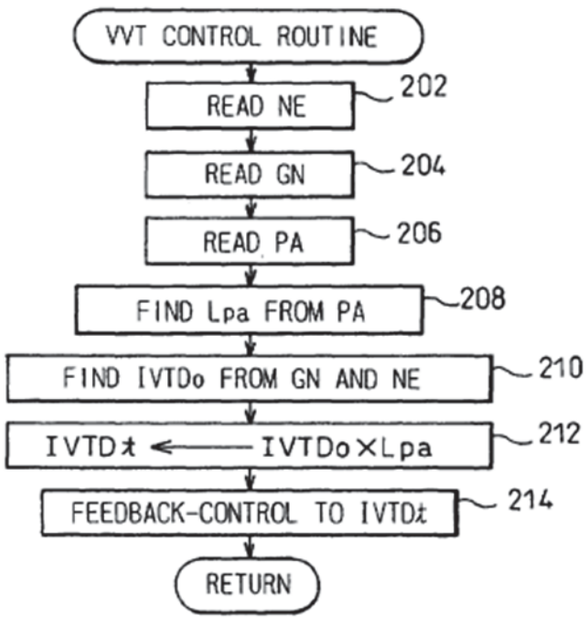
ENGINE REVOLUTION SPEED NE [rpm]

ENGINE LOAD GN [g/rev.]	800	1200	1600	2000	~	6000	6400
0.2	0	0	0	0	~	0	0
0.4	0	5	10	10	~	5	5
0.6	5	20	30	30	~	10	10
0.8	20	40	50	50	~	20	20
1.0	35	55	60	60	~	20	20
1.2	40	60	60	60	~	10	10
1.4	30	55	60	60	~	5	5
1.6	30	50	50	50	~	5	5
1.8	30	50	40	40	~	5	0
2.0	30	50	40	40	~	5	0

EX1005, FIG. 4.

Yoshioka illustrates, in Figure 9 below, a method of setting a target displacement for the open/close timing of intake valve 24 according to a detected engine load and atmospheric pressure:

Fig. 9



EX1005, FIG. 9.

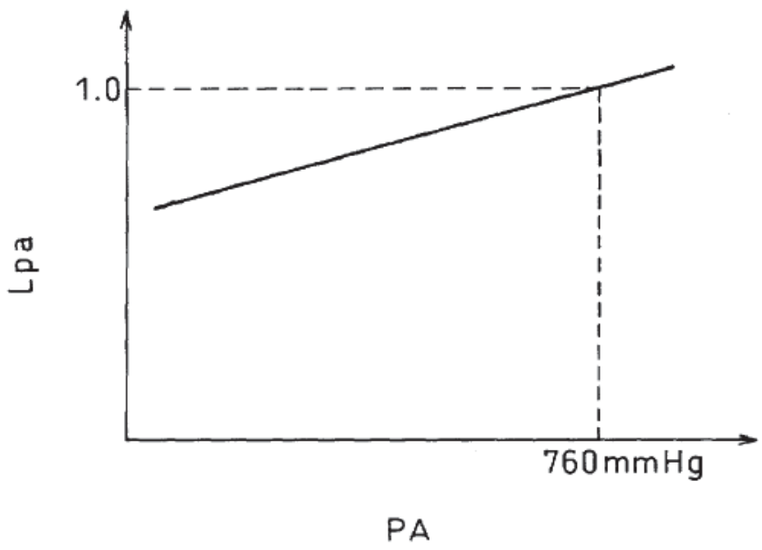
EX1003, ¶90.

First, an engine revolution speed NE is calculated according to the output of the crank angle sensor 51 (step 202); an engine load GN (the mass of intake air per engine revolution) is calculated according to the mass flow rate of intake air detected by the airflow meter 40 and the engine revolution speed provided by the crank angle sensor 51 (step 204); and an atmospheric pressure PA is detected by the

atmospheric pressure sensor 46 (step 206). EX1005, 7:18-25, 7:55-56. A POSA would have known that the throttle valve and the opening of the throttle is controlled by the driver to control the desired acceleration, *e.g.*, by depressing the accelerator pedal. *See e.g.*, EX1011, 11; EX1016, Probst, 5:11; EX1003, ¶¶91-93.

Second, the ECU determines (step 208) a correction coefficient Lpa based on the atmospheric pressure PA using a map stored in ROM 73 of the ECU. EX1005, 7:57-60; EX1003, ¶94. An example of this map is shown in Figure 10:

Fig. 10



EX1005, FIG. 10.

Third, the ECU determines (step 210) an initial valve displacement IVTD0 based on the engine load GN and engine speed NE. EX1005, 7:63-67. Here, the engine load GN is "the mass of intake air per engine revolution" calculated according to the mass flow rate of intake air detected by the air flow meter 40 and controlled based on the opening of the throttle valve 5. *Id.*, 7:20-24, 7:55-56, 6:38-42, 5:43-46. IVTD0 is determined according to the map above in Figure 4. EX1003, ¶95.

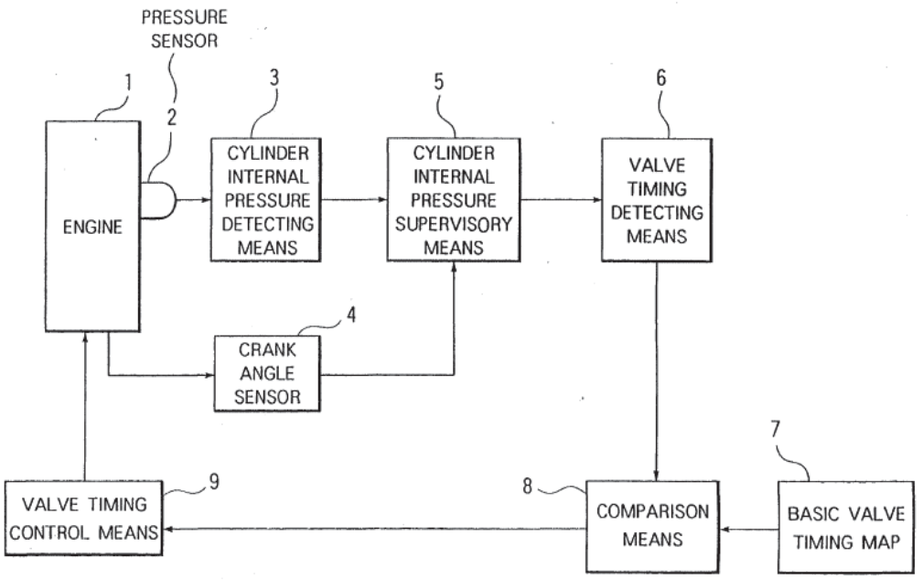
Fourth, the ECU 70 corrects the displacement IVTD0 to provide a target displacement IVTDt based on the atmospheric correction coefficient Lpa. EX1005, 8:1-5. And finally, the ECU 70 brings the actual displacement of the intake valve 24 to the target displacement IVTDt by feedback-controlling the hydraulic control valve 68. *Id.*, 8:6-8; EX1003, ¶96.

B. Ohkubo

Ohkubo, like Yoshioka and the '540 patent, is directed to a valve timing control system for an internal combustion engine which controls the opening and closing of intake and exhaust valves. EX1006, 1:6-10. Figure 1 of Ohkubo illustrates the valve timing control apparatus having: a pressure sensor 2 for sensing the internal pressure in engine cylinder 1; a pressure detecting means 3 for detecting the internal pressure in engine cylinder 2; a crank angle sensor 4; a cylinder pressure

supervisory means or disabling means 5 for supervising the internal pressure in engine cylinder 1; a valve timing detecting means 6 for detecting the opening and closing timings of intake and exhaust valves of the engine; a basic valve timing map 7; a comparison means 8 for comparing the valve opening and closing timings detected by the valve timing detecting means 6 with the basic valve timing map 7; and a valve timing control means 8 for controlling the opening and closing timings of the intake and exhaust valves based on the output of the comparison means 8. *Id.*, 2:61-3:44; EX1003, ¶97.

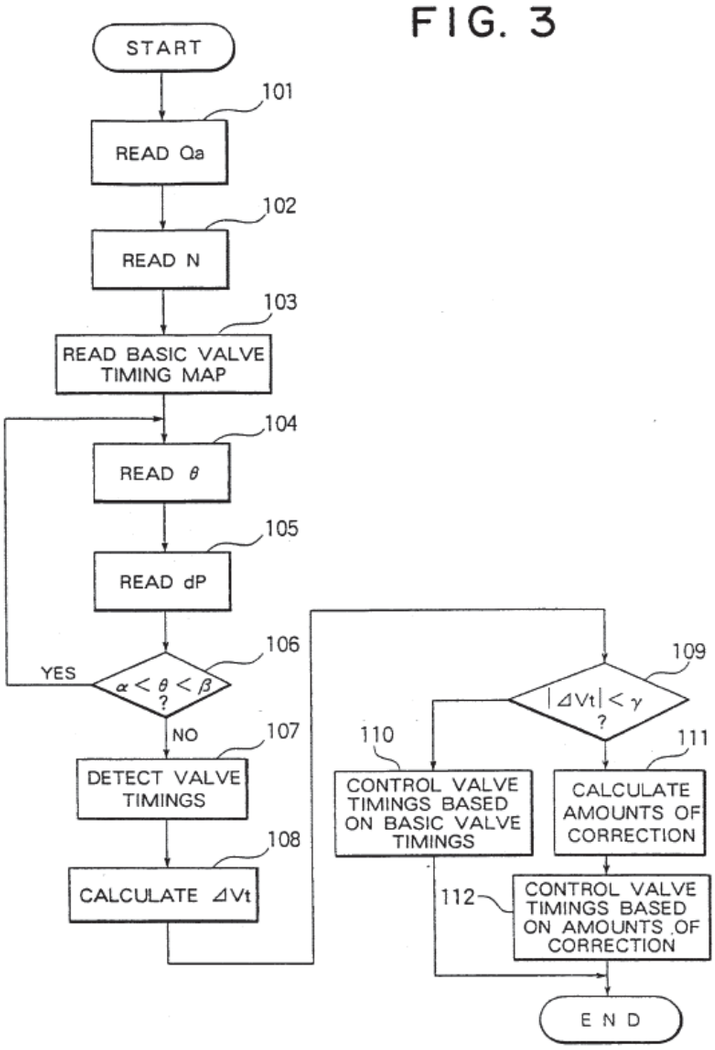
FIG. 1



EX1006, FIG. 1.

Figure 3 of Ohkubo illustrates the operation of the valve timing control system including: reading the quantity of intake air Qa (step 101); calculating the engine revolution speed N (step 102), reading open/close timing values for the intake and exhaust valves from a map (step 103); detecting the valve open/close times (step 107) depending on the crank angle Θ; calculating a deviation ΔVt between the predetermined open/close times and detected valve open/close times (step 108); calculating a correction for the timing(s) if the deviation ΔVt is outside an allowable range (step 111); and controlling the valve opening and closing times based on the corrected amounts in a feedback manner (step 112). EX1006, 4:66-5:57; EX1003, ¶98.

FIG. 3



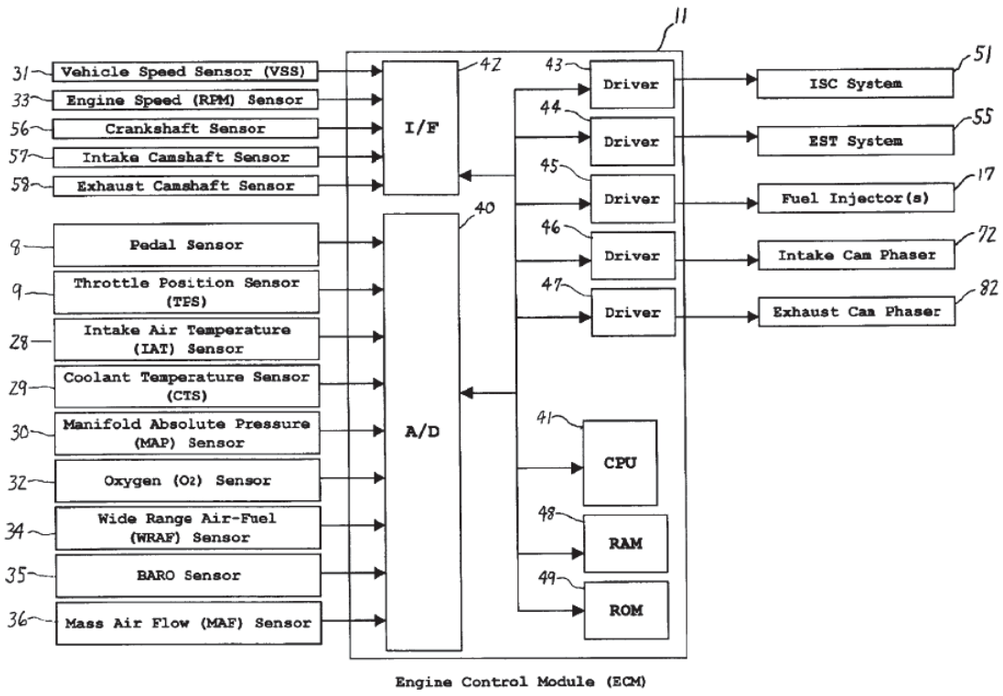
EX1006, FIG. 3.

C. Reed

Reed, like Yoshioka and Ohkubo, is also directed to variable cam timing to vary the phasing of intake valves and/or exhaust valves to achieve lower gas

emissions and improved fuel economy while delivering as closely as possible desired torque. EX1007, Abstract. Figure 2 of Reed illustrates the electronic control module (ECM) 11 controlling two continuously variable cam timing mechanisms 72 and 82, one for the intake valves and the other for the exhaust valves. *Id.*, 5:13-22; EX1003, ¶99.

FIGURE 2



EX1007, FIG. 2.

Reed further discloses that the ECM varies intake valve and exhaust valve timing based on temperature and pressure. EX1007, 12:45-59, 15:28-41; EX1003, ¶100.

VII. Ground 1: The combination of Yoshioka and Ohkubo renders obvious claims 1, 2, 7, and 10-16.

A. Rationale for combining Yoshioka with Ohkubo

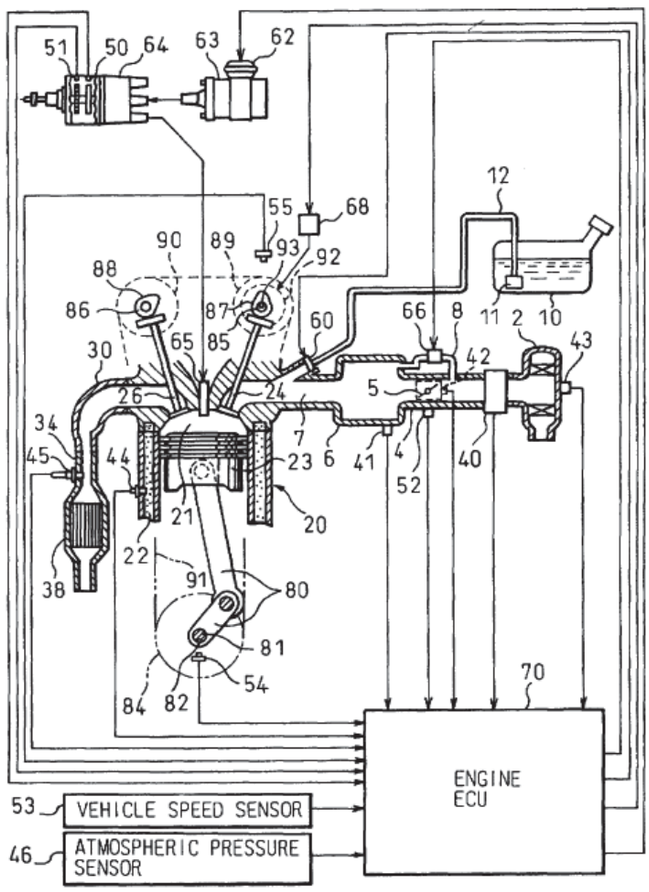
A POSA would have been motivated to combine the teachings of Yoshioka and Ohkubo for multiple reasons, rendering the claims obvious. EX1003, ¶101.

As an initial matter, Yoshioka and Ohkubo are from the same field of endeavor—control systems for valve timing for an internal combustion engine. *Id.*, ¶102. Yoshioka and Ohkubo, in particular, are directed to analogous valve timing control systems. *Id.* Indeed, Yoshioka discloses "a method of and apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing." EX1005, 1:9-14. Likewise, Ohkubo discloses "a valve timing control system for an internal combustion engine which controls the opening and closing of intake and exhaust …." EX1006, 1:6-10. And Yoshioka and Ohkubo's analogous valve timing control systems are both directed to improving power output of an engine by optimizing valve timing. EX1005, 2:32-34 ("The first and second aspects of the present invention are capable of optimizing valve timing to maintain the output of the engine at high altitudes."); EX1006, 1:55-59 ("Another object of the present invention is to provide a valve timing control apparatus for an internal combustion

engine which is able to improve the air-intake and exhaust-discharge efficiency of the engine, thereby increasing engine output power.”). The engines and control systems of Yoshioka and Ohkubo include analogous components:

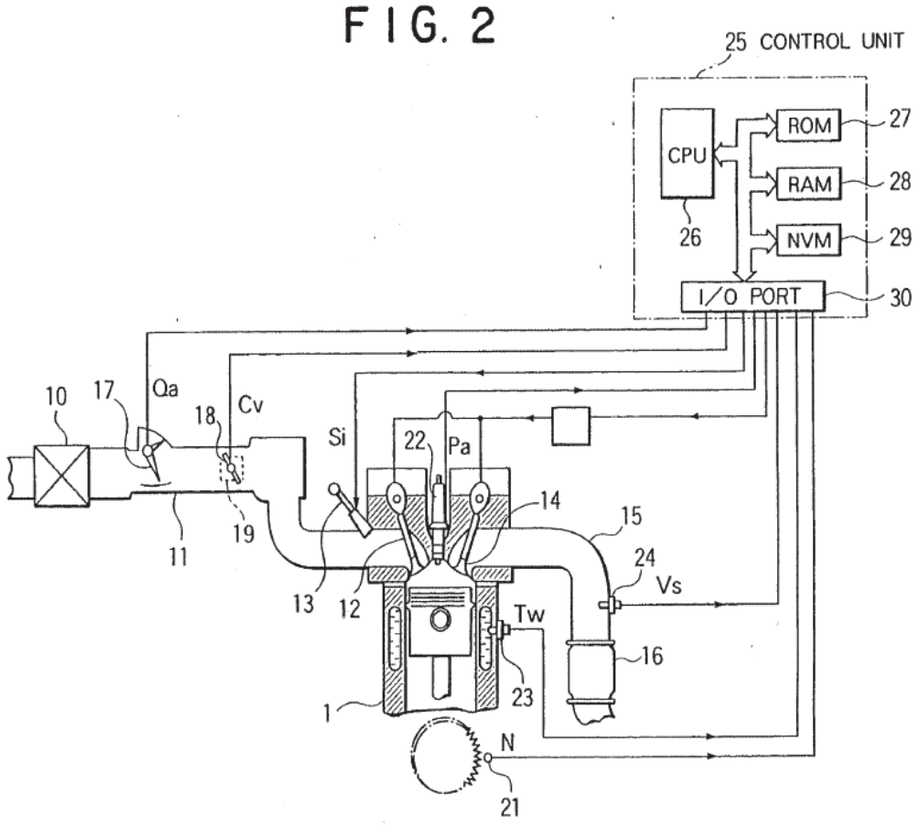
Yoshioka	Ohkubo
Electronic Control Unit (ECU) 70	Control Unit 25
Intake Valve 24	Intake Valve 12
Exhaust Valve 26	Exhaust Valve 14
Airflow Meter 40	Airflow Meter 17
Crank Angle Sensor 51	Crank Angle Sensor 21
O_2 (Oxygen) Sensor 45	Oxygen Sensor 24

Fig. 1



EX1005, FIG. 1.

FIG. 2



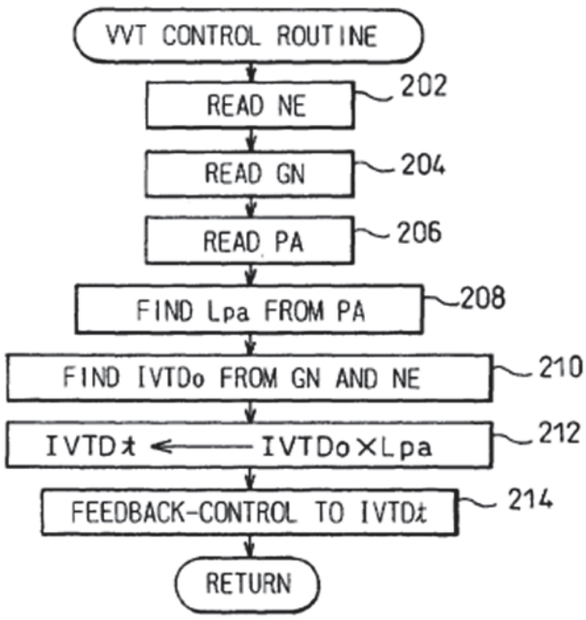
EX1006, FIG. 2.

EX1003, ¶102.

Yoshioka and Ohkubo also disclose similar methods of controlling valve timing, including: measuring aspects of engine performance (*e.g.*, engine revolution speed), determining target valve timings, detecting actual valve timings, and correcting valve timings in a feedback manner. EX1005, 7:16-8:8; EX1006, 4:66-

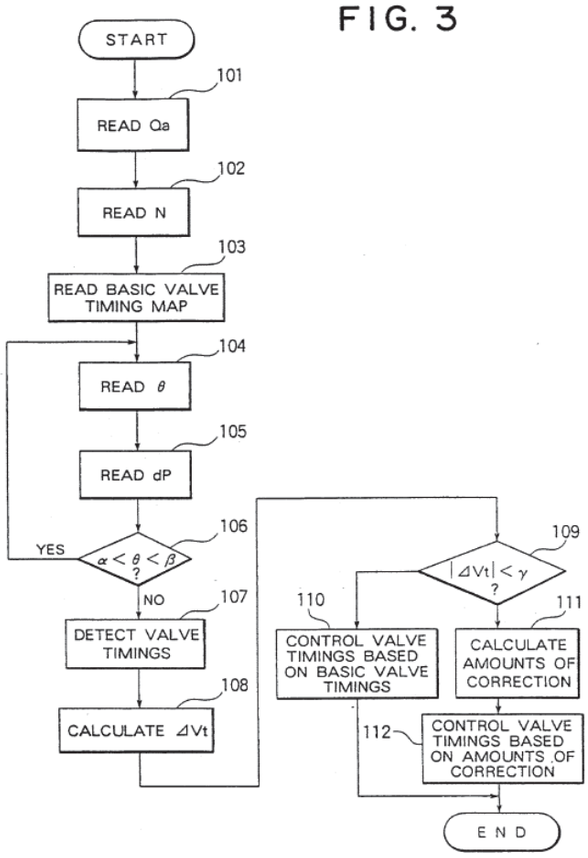
5:57. Yoshioka and Ohkubo are thus structurally and functionally similar. EX1003, ¶103.

Fig. 9



EX1005, FIG. 9.

FIG. 3



EX1006, FIG. 3.

Ohkubo discloses specific implementation details of controlling valve timing that would have been readily applicable to Yoshioka's ECU 70 for controlling valve timing. EX1003, ¶104. In particular, Ohkubo discloses that the control unit 25 calculates a deviation ΔVt between target valve timing and actual valve timing, and, if the ΔVt is outside of the allowable range γ, an appropriate amount of correction for the valve timing(s) is calculated. EX1006, 5:51-54; EX1003, ¶104. Ohkubo also

recognized that by controlling the valve opening and closing timings—including EVO, EVC, IVO, and IVC—in this feedback manner in accordance with the deviations between the detected values of the valve opening and closing timings and the predetermined values, the accuracy of controlling the valve opening and closing timings is improved and "the air-intake efficiency and the exhaust-discharge efficiency of the engine can be improved, thus increasing the output power of the engine." EX1006, 6:13-22; EX1003, ¶104.

Yoshioka, like Ohkubo, discloses "bring[ing] the actual displacement of the intake valve 24 to the target displacement IVTDt" but does not explicitly state how the actual displacement of the intake (or exhaust) valve is brought to the target displacement IVTDt. EX1005, 8:6-8. Thus, because Yoshioka is silent on this implementation detail, a POSA would have sought out these details, provided by Ohkubo's analogous valve control system. EX1003, ¶105. And combining the teachings of Yoshioka and Ohkubo would have yielded predictable benefits and results—for example, precise control of valve timing to "bring the actual displacement of the intake valve 24 to the target displacement IVTDt." EX1005, 8:6-8. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007) ("[I]f a technique has been used to improve one device, and a person of

ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious."); EX1003, ¶105.

Moreover, a POSA would have had a reasonable expectation of success combining Yoshioka and Ohkubo. EX1003, ¶106. A POSA, specifically, would have recognized that there are only a finite number of ways to "bring the actual displacement of the intake valve 24 to the target displacement IVTDt" as described by Yoshioka (EX1005, 8:6-8), including calculating a deviation between the actual valve timing displacement and the target valve timing displacement and a correction. EX1003, ¶106. Ohkubo's disclosed technique for bringing actual valve timing displacement to the target valve timing displacement was a predictable solution readily applicable to Yoshioka's ECU 70. *KSR*, 550 U.S. at 416 ("When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp."); EX1003, ¶106.

A POSA would have also understood how to combine the teachings of Yoshioka and Ohkubo to control the valve timing. EX1003, ¶107. A POSA would have simply used Ohkubo's implementation details, for example, calculating a deviation ΔVt between target valve timing and actual valve timing and calculating

an appropriate amount of correction for the valve timing(s), in order to accurately control Yoshioka's valve timings. *Id.* This would have been routine for a POSA. *Id.*

Furthermore, a POSA would have understood that Ohkubo's valve timing correction technique would have been combined in a known way to provide the predictable benefits disclosed in Ohkubo to improve the accuracy of controlling the valve opening and closing timings such that "the air-intake efficiency and the exhaust-discharge efficiency of the engine can be improved, thus increasing the output power of the engine." EX1006, 6:13-22; *KSR*, 550 U.S. at 419-421; EX1003, ¶¶47-51, 108.

Accordingly, it would have been obvious to combine the teachings of Yoshioka and Ohkubo. EX1003, ¶109.

B. Yoshioka and Ohkubo renders obvious claim 1.

1. [1.P] "A method for calculating a valve timing command for an engine of a vehicle"

Yoshioka discloses this preamble. Specifically, Yoshioka discloses "a method…for optimizing valve timing according to atmospheric pressure for a continuously variable valve timing mechanism…" and aims to "improve the output of an engine at high altitudes under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium

load." EX1005, 1:40-49, *see also* 2:30-34, 6:65-7:1, cl. 1 ("A method of controlling a continuously variable valve timing mechanism of an internal combustion engine"); EX1003, ¶110. Thus, it would have been apparent to a POSA that Yoshioka's methods include "calculating" a valve timing command. EX1003, ¶111.

Thus, Yoshioka discloses [1.P]. *Id.*

2. [1.A] "obtaining an engine performance command[2]"

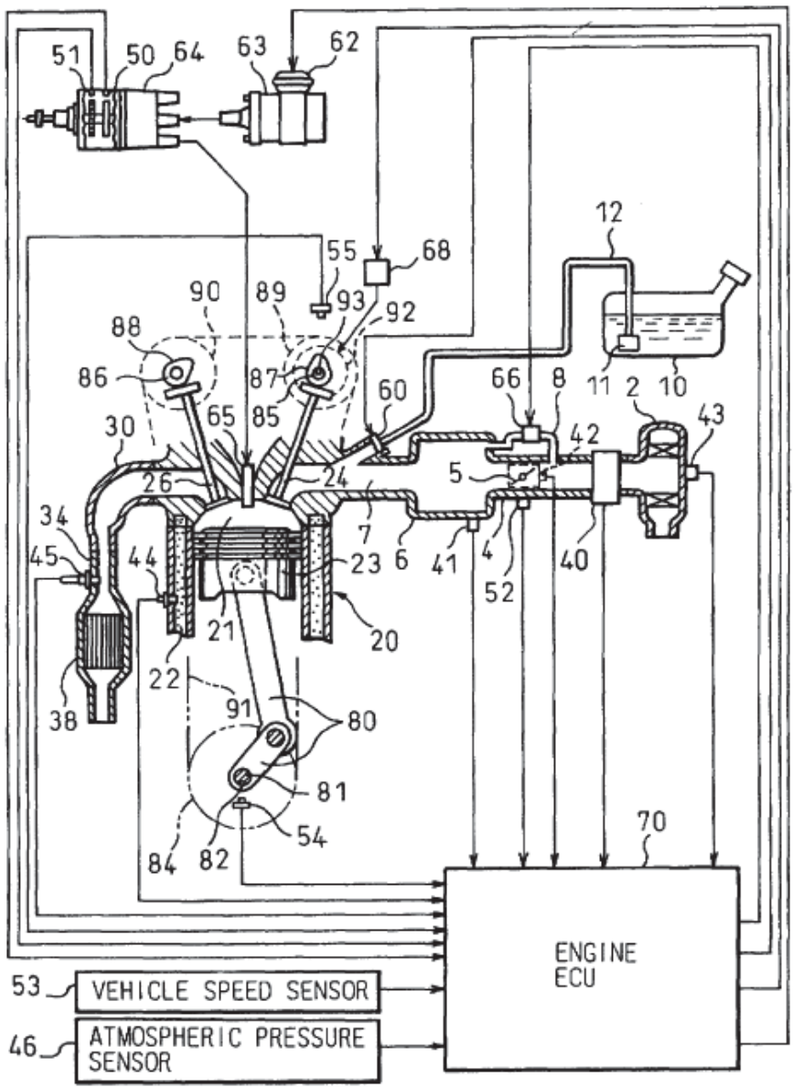
Yoshioka discloses this limitation. Yoshioka's ECU 70 receives a signal from the crank angle sensor 51 indicating the engine revolution speed NE, a signal from the airflow meter 40 indicating the mass flow rate of intake air, and a signal from the throttle opening sensor 42, each of which corresponds to "obtaining an engine performance command." EX1003, ¶113.

More specifically, Yoshioka discloses an electronically controlled internal combustion engine equipped with a throttle valve, a throttle sensor, and an electronic engine control unit (ECU). EX1005, 3:19-22, 5:21-34. Figure 1 of Yoshioka illustrates the engine, including: a "throttle valve 5 arranged in the throttle body 4,"

[2] The '540 patent broadly characterizes the claimed "engine performance command" as encompassing any variable related to engine performance, including but not limited to an engine torque command. EX1001, 2:4-22; EX1003, ¶112.

which "adjusts the quantity of intake air" (*id.*, 4:13-14); an airflow meter 40, which "measures the mass flow rate of intake air" (*id.*, 4:14-15); a throttle sensor 42, which "detects the opening of the throttle valve 5" (*id.*, 4:20-21); a crank angle sensor 51, which calculates "an engine revolution speed NE" (*id.*, 7:18-20); and an electronic engine control unit (ECU) 70, which is a "microcomputer to control fuel injection, ignition timing, idling speed, and in addition, the open/close timing of a valve." *Id.*, 5:22-25; EX1003, ¶114.

Fig. 1

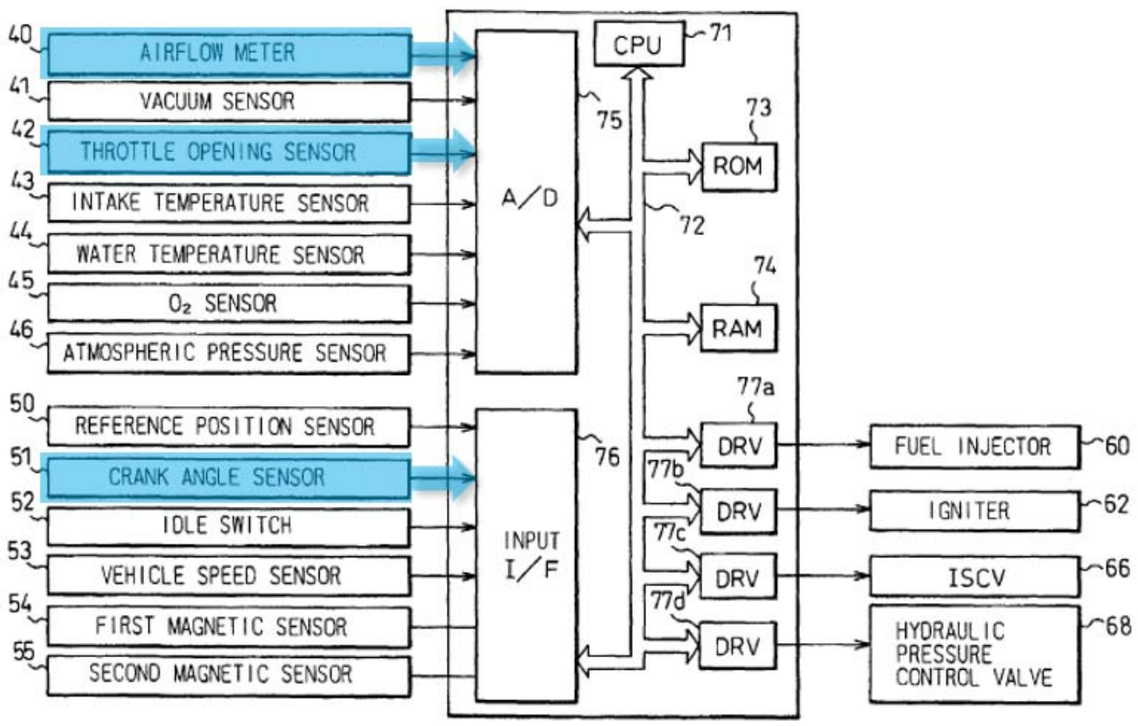


EX1005, FIG. 1.

Figure 2 illustrates the ECU 70 receiving input signals from the airflow meter 40, throttle opening sensor 42, and crank angle sensor 51, and processing those

input signals (together with the input signals from the other sensors 41 and 43-56) to generate engine control signals. EX1005, 5:25-31; EX1003, ¶115.

Fig.2



EX1005, FIG. 2 (annotated).

Yoshioka discloses that the engine revolution speed NE is calculated according to the output of the crank angle sensor 51. EX1005, 7:18-20. Also, the "airflow meter 40 measures the mass flow rate of intake air," where the quantity of intake air is controlled by adjusting the throttle valve 5. *Id.*, 4:14-15, 5:43-46. The

ECU 70 then "reads an engine load [GN] (the mass of intake air per engine revolution) calculated according to the mass flow rate of intake air detected by the airflow meter 40" and the engine revolution speed NE. *Id.*, 7:20-24. Thus, a POSA would have understood that Yoshioka's ECU 70 receiving the signal from the crank angle sensor 51 indicating engine revolution speed NE or the signal from the airflow meter 40 indicating mass flow rate of intake air, both of which relate to the performance of Yoshioka's engine, each correspond to the claimed "obtaining an engine performance command." EX1003, ¶116.

Further, a POSA would have understood that a driver would have controlled the desired engine acceleration by opening and closing the throttle valve 5, which is detected by Yoshioka's throttle opening sensor 42, *e.g.*, by depressing a conventional accelerator pedal. EX1016, 2:7 ("Fuel delivery requirements depend more than anything else on how much work you are asking the engine to do—on how much of a 'load' you are placing on it. To accelerate, you step down harder on the accelerator. This opens the throttle valve…."); EX1001, 2:6-8; EX1003, ¶¶117-119. A POSA would have thus understood that Yoshioka's ECU 70 receiving a signal from the throttle opening sensor 42 indicating the detected opening of the throttle valve 5 is a third instance of Yoshioka disclosing "obtaining an engine performance command." EX1003, ¶120.

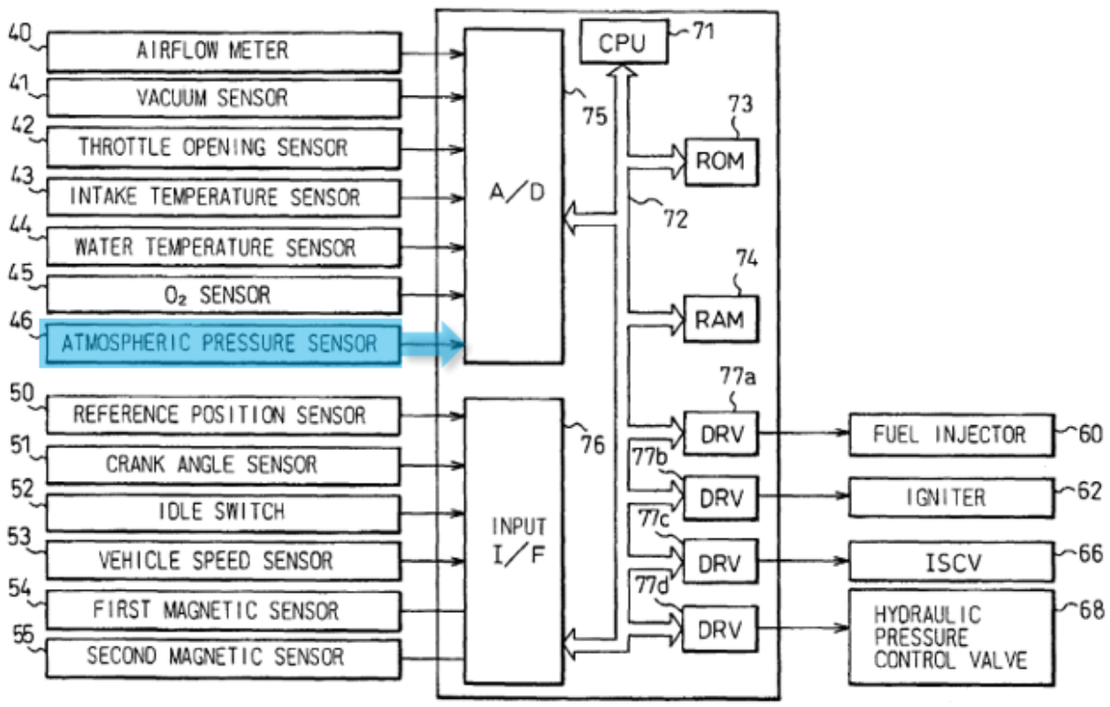
Thus, Yoshioka discloses [1.A]. *Id.*

3. [1.B] "receiving an environmental conditions signal[3]"

Yoshioka discloses this limitation. As shown below in Figure 2 of Yoshioka, the ECU receives a signal input from the atmospheric (*i.e.*, ambient) pressure sensor 46 (*i.e.*, an "environmental conditions signal"), and then processes that input (together with inputs received from the other sensors 41 and 43-56) to generate engine control signals. EX1005, 5:25-31, 7:24-25 ("Step 106 reads an atmospheric pressure PA detected by the atmospheric pressure sensor 46."); *compare to* EX1001, FIGs. 7, 9, 12, and 15 (showing steps for reading atmospheric pressure PA at 106, 206, 306, and 406, respectively); EX1003, ¶122.

[3] The '540 patent broadly characterizes the claimed "environmental conditions signal" as encompassing ambient pressure, temperature, or any other measureable environmental condition. EX1001, 2:23-35; EX1003, ¶121.

Fig.2



EX1005, FIG. 2 (annotated).

Thus, Yoshioka discloses [1.B]. EX1003, ¶123.

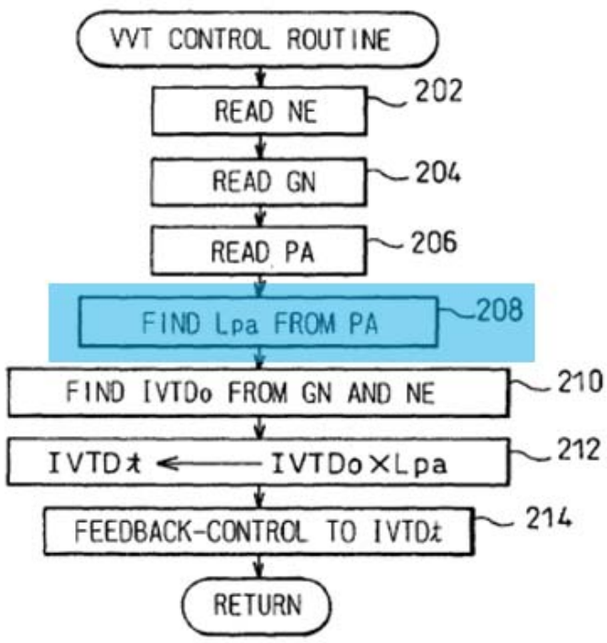
4. [1.C] "determining a valve feedforward term based on the engine performance command and the environmental conditions signal"

Yoshioka discloses this limitation. Specifically, Yoshioka describes setting a target displacement to be imposed on the open/close timing of intake valve 24 according to a detected engine load and decreasing the target displacement as

atmospheric pressure becomes lower, to maintain the output of the engine at high altitudes under high load. EX1005, 7:46-53; EX1003, ¶124.

First, as shown in Figure 9 below (step 208), the ECU determines a correction coefficient Lpa based on atmospheric pressure PA ("environmental conditions signal") using a map stored in ROM 73 of the ECU. EX1005, 7:57-60; EX1003, ¶125.

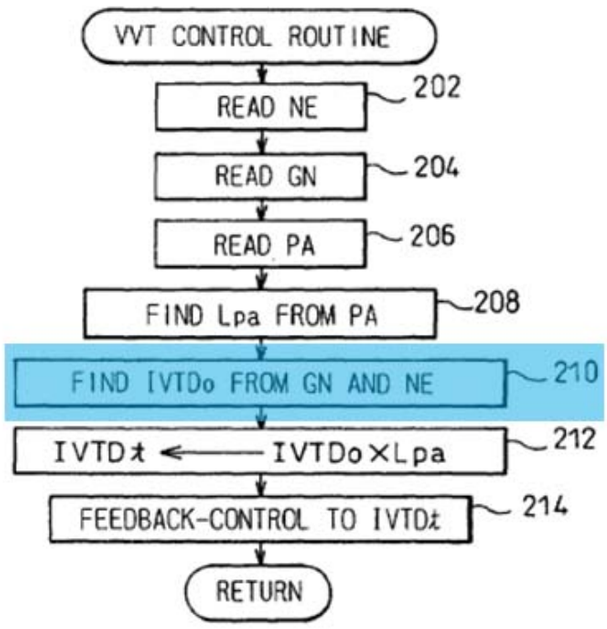
Fig. 9



EX1005, FIG. 9 (annotated).

Second, the ECU determines (step 210) an initial valve timing displacement IVTD0 based on the engine load GN and engine speed NE. EX1005, 7:63-67. Here, the engine load GN is "the mass of intake air per engine revolution" calculated according to the mass flow rate of intake air detected by the air flow meter 40 and controlled based on the opening of the throttle valve 5 (*i.e.*, the "engine performance command"). *Id.*, 7:20-24, 7:55-56, 6:37-41, 5:43-46 ("The mass of intake air per engine revolution is calculated according to the mass flow rate of intake air measured by the airflow meter 40…"), 4:13-15 ("A throttle valve 5 arranged in the throttle body 4 adjusts the quantity of intake air. An airflow meter 40 measures the mass flow rate of intake air."); EX1003, ¶126.

Fig. 9

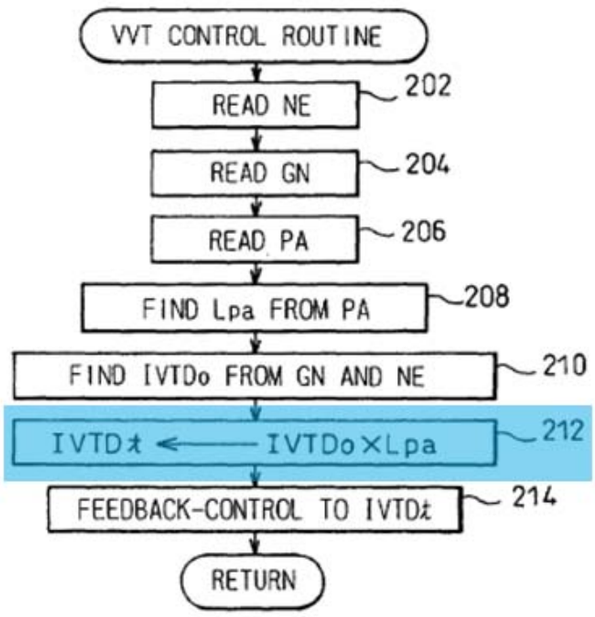


EX1005, FIG. 9 (annotated).

Third, the ECU determines (step 212) the target valve timing displacement, IVTDt, (*i.e.*, the "valve feedforward term") based on (1) the Lpa (correction coefficient based on the "environmental conditions signal") and the (2) IVTD0 (initial valve timing displacement that is based on the "engine performance command"). EX1005, 7:47-8:5. A POSA would have understood the target valve timing displacement IVTDt to be a "valve **feedforward** term" because it is the displacement to be imposed on the open/close timing of the intake valve 24

instead of a measurement of the actual open/close timing of the intake valve 24 (*i.e.*, feedback). Thus, Yoshioka's valve feedforward term is based on the engine performance command and the environmental conditions signal, as claimed. EX1003, ¶127.

Fig. 9



EX1005, FIG. 9 (annotated).

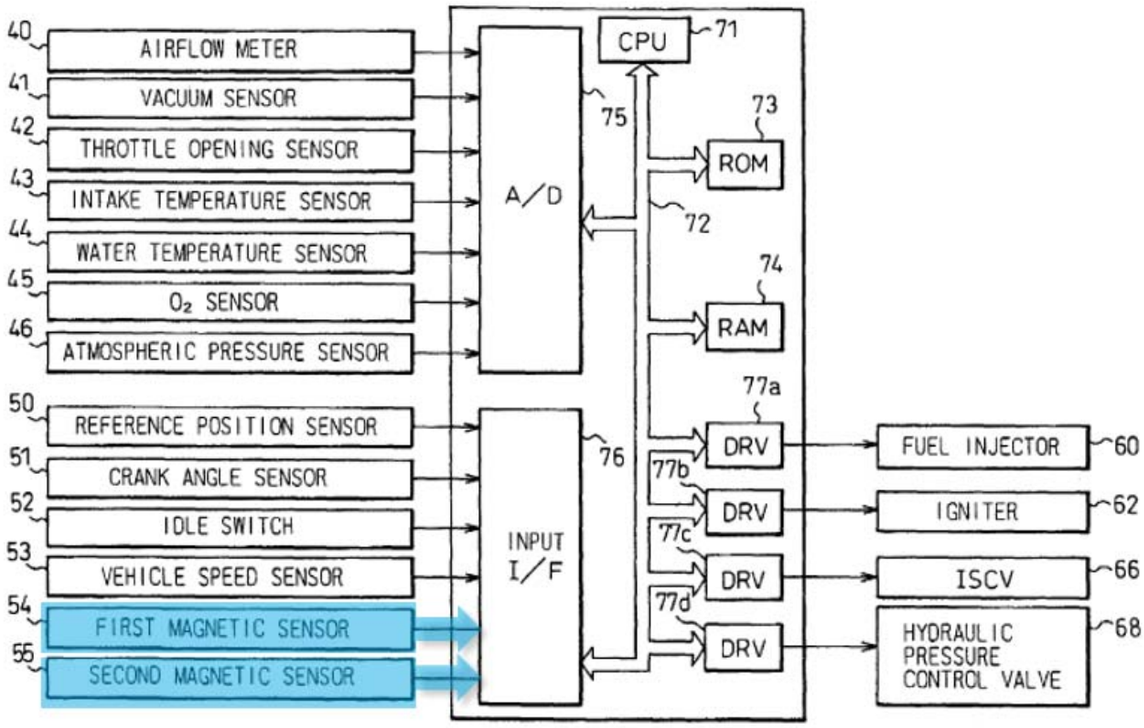
Thus, Yoshioka discloses [1.C]. EX1003, ¶128.

5. [1.D] "receiving an engine performance feedback[4]"

Yoshioka discloses this limitation. Specifically, Yoshioka's ECU 70 receives signal inputs from magnetic sensor 54 and magnetic sensor 55 indicating an actual timing displacement of the intake valve 24 for "feedback-control." EX1005, 5:4-9 ("The crank shaft 81 has a buried magnet 82, so that a first magnetic sensor 54 arranged close to the crankshaft 81 may generate a reference pulse. The cam shaft 85 of the intake valve 24 has a buried magnet 93, so that a second magnetic sensor 55 arranged close to the cam shaft 85 may generate a reference pulse."), 7:41-45 ("To bring an actual displacement to the target displacement IVTDt, signals from the first and second magnetic sensors 54 and 55 are monitored to **feedback-control** the hydraulic pressure control valve 68."), 8:6-8 ("To bring the actual displacement of the intake valve 24 to the target displacement IVTDt, the hydraulic control valve 68 is **feedback-controlled**."). This is an "engine performance feedback," as claimed. EX1003, ¶130.

[4] The '540 patent broadly characterizes the claimed "engine performance feedback" as encompassing any measureable information relating to engine performance including, but not limited to, engine speed or engine torque. EX1001, 2:36-47; EX1003, ¶129.

Fig.2

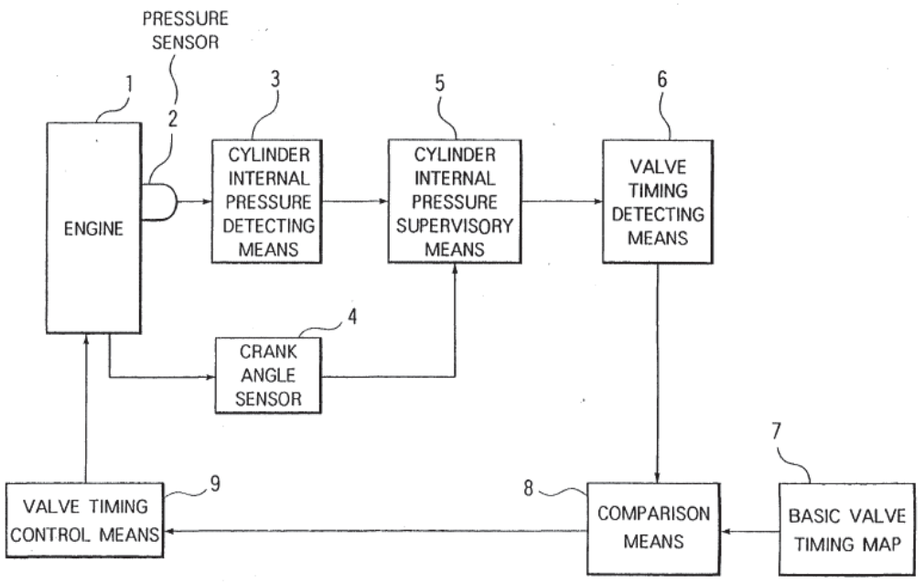


EX1005, FIG. 2 (annotated).

Accordingly, the received actual timing displacement of Yoshioka's intake valve 24 corresponds to "engine performance feedback." EX1003, ¶131.

Ohkubo similarly discloses a valve timing control apparatus for an internal combustion engine having a valve timing detecting means 6, as shown below in Figure 1. *Id.*, ¶132.

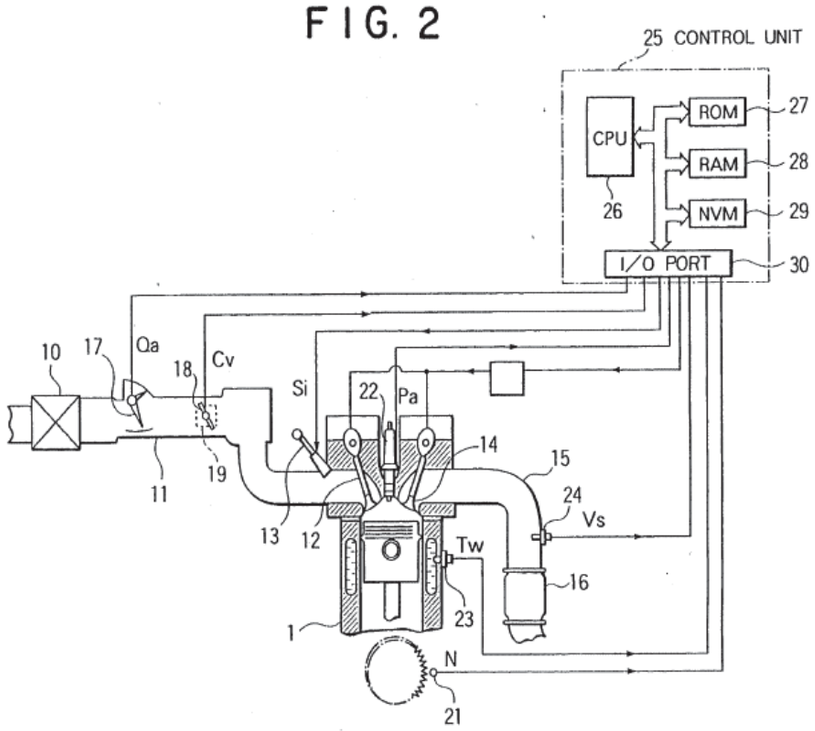
FIG. 1



EX1006, FIG. 1.

Specifically, Ohkubo discloses detecting the opening and closing timings of the engine intake and exhaust valves by valve detecting means 6 based on an input from the cylinder internal pressure supervisory means. EX1006, 3:25-40. The control unit 25 having a CPU 26, illustrated in Figure 2 below, determines the opening and closing timings of the intake and exhaust valves. *Id.*, 4:46-65. The detected opening and closing timings of the intake and exhaust valves are then compared with predetermined valve opening and closing timings to calculate deviations there between. *Id.*; EX1003, ¶132.

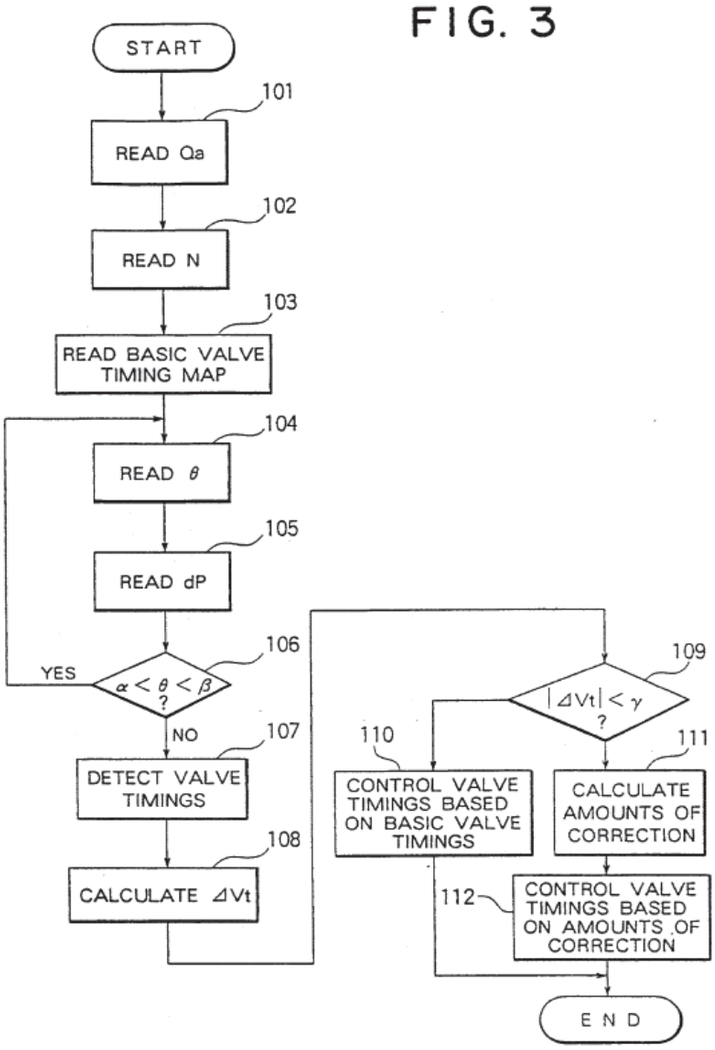
FIG. 2



EX1006, FIG. 2.

Figure 3 of Ohkubo illustrates detecting the actual opening and closing timings of the intake and exhaust valves (step 107) by detecting a crank angle at which an abrupt change in pressure takes place. EX1006, 5:38-41; EX1003, ¶133.

FIG. 3



EX1006, FIG. 3.

Accordingly, the detected opening and closing timings of the intake and exhaust valves (step 107) of Ohkubo also discloses the claimed "engine performance feedback." EX1003, ¶134. Thus, should MMT argue, incorrectly, that

Yoshioka does not disclose the claimed "engine performance feedback," it would have been obvious to implement this known technique of detecting opening and closing timings of the intake and exhaust valves of Ohkubo in Yoshioka. Doing so would have merely been applying a known technique to a similar device in the same way. *KSR*, 550 U.S. at 416; EX1003, ¶134.

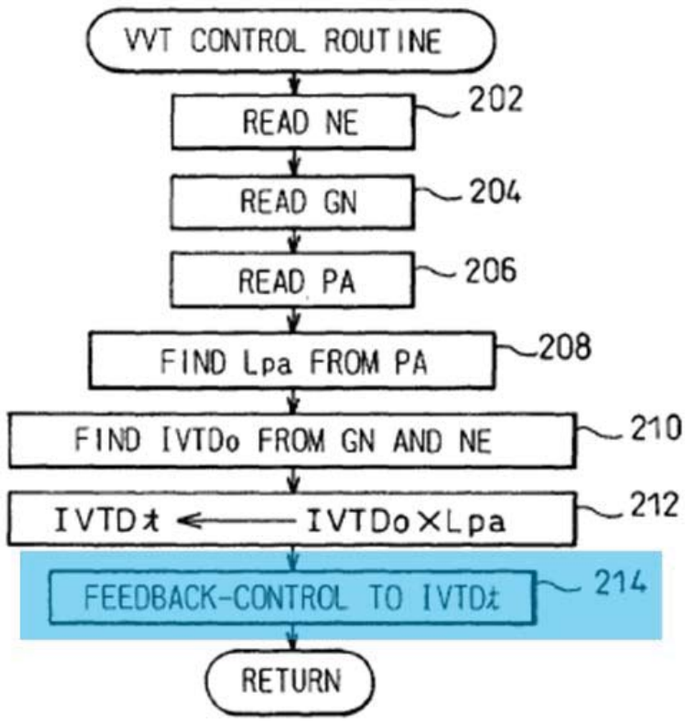
Thus, Yoshioka and Ohkubo both disclose [1.D]. EX1003, ¶135.

6. [1.E] "calculating a valve feedback term based on the engine performance command and the engine performance feedback"

Yoshioka, alone or in combination with Ohkubo, renders obvious this limitation. EX1003, ¶136. Yoshioka, in particular, discloses comparing the target timing displacement of intake valve 24, IVTDt ("valve feedforward term," which is based on the signal from the airflow meter 40—"engine performance command") and the actual timing displacement of intake valve 24 ("engine performance feedback") to control the open/close timing of the intake valve 24. EX1005, 6:6-15 ("Valve timing control sets the **target open/close timing of the intake valve 24** according to operating conditions and controls the continuously variable mechanism 92. …"); 7:42-45 ("**To bring an actual displacement to the target displacement IVTD**t, signals from the first and second magnetic sensors 54 and 55 are monitored to feedback-control the

hydraulic pressure control valve 68."); 7:47-56 ("The second embodiment sets a **target displacement to be imposed on the open/close timing of the intake valve 24** according to a detected engine load and decreases the target displacement as an atmospheric pressure becomes lower, to maintain the output of the engine at high altitudes under high load, similar to the first embodiment."); 8:6-8 ("**To bring the actual displacement of the intake valve 24 to the target displacement IVTDt**, the hydraulic control valve 68 is feedback-controlled."); EX1003, ¶136.

Fig. 9



EX1005, FIG. 9 (annotated).

Yoshioka does not explicitly state that a correction is calculated for the intake valve 24 based on this comparison. However, a POSA would have understood Yoshioka's disclosure of "feedback control" to mean calculating a correction based on the comparison of the target timing displacement IVTDt (an input) and the actual timing displacement of intake valve 24 (an output) to drive

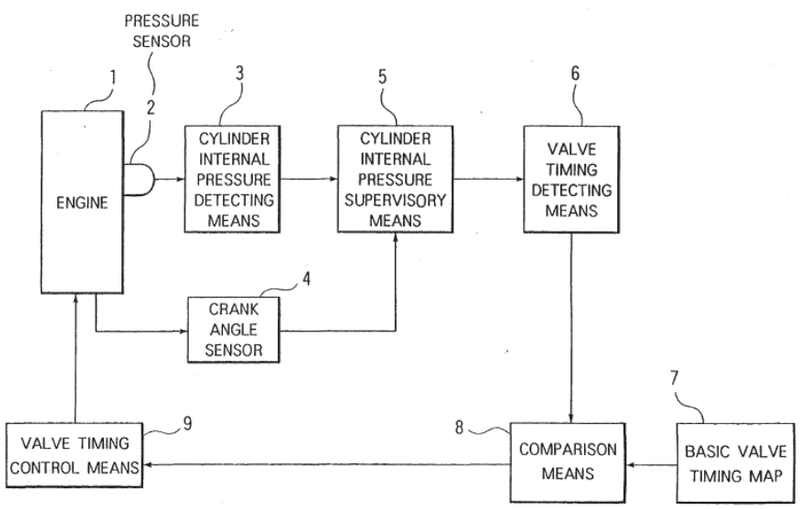
the actual timing displacement to the target timing displacement. *See* EX1013, Stefanopoulou, 12-13; EX1010, McGraw-Hill Electronics Dictionary, 162, 168 (defining "feedback controller" as "[a] circuit or element in a closed-loop system that controls the motor or other actuator in a closed loop system to correct an error signal," and "error signal" as "[a] voltage or current proportional to the difference between the desired and actual response in a closed-loop system").; EX1003, ¶137. That is, a POSA would have understood that in order for Yoshioka's ECU 70 to "bring the actual displacement of the intake valve 24 to the target displacement IVTDt," it calculates a correction to the actual valve timing displacement by comparing the target valve timing displacement IVTDt (an input) and the actual valve timing displacement (an output). EX1005, 8:6-8; EX1003, ¶138.

Accordingly, a POSA would have understood, or at least found it obvious, that Yoshioka's ECU 70 calculates a correction for the timing of the intake valve 24 based on the comparison of the target valve timing displacement of the intake valve 24, IVTDt ("valve feedforward term," which is based on the signal from the airflow meter 40—"engine performance command") and the actual valve timing displacement of intake valve 24 ("engine performance feedback").

EX1003, ¶139. Thus, a POSA would have understood Yoshioka discloses [1.E]. *Id.*

Should MMT argue, incorrectly, that Yoshioka does not disclose this limitation, Ohkubo also discloses calculating a valve feedback term based on the engine performance command and the engine performance feedback, as claimed. *Id.*, ¶140. As shown in Figure 1 of Ohkubo, the valve timing control apparatus includes a comparison means 8 for "compar[ing] the opening and closing timings … detected by the valve timing detecting means 6" with predetermined target valve opening and closing timings (from basic valve timing map 7) and calculating deviations there between. EX1006, 3:33-40; EX1003, ¶140.

FIG. 1

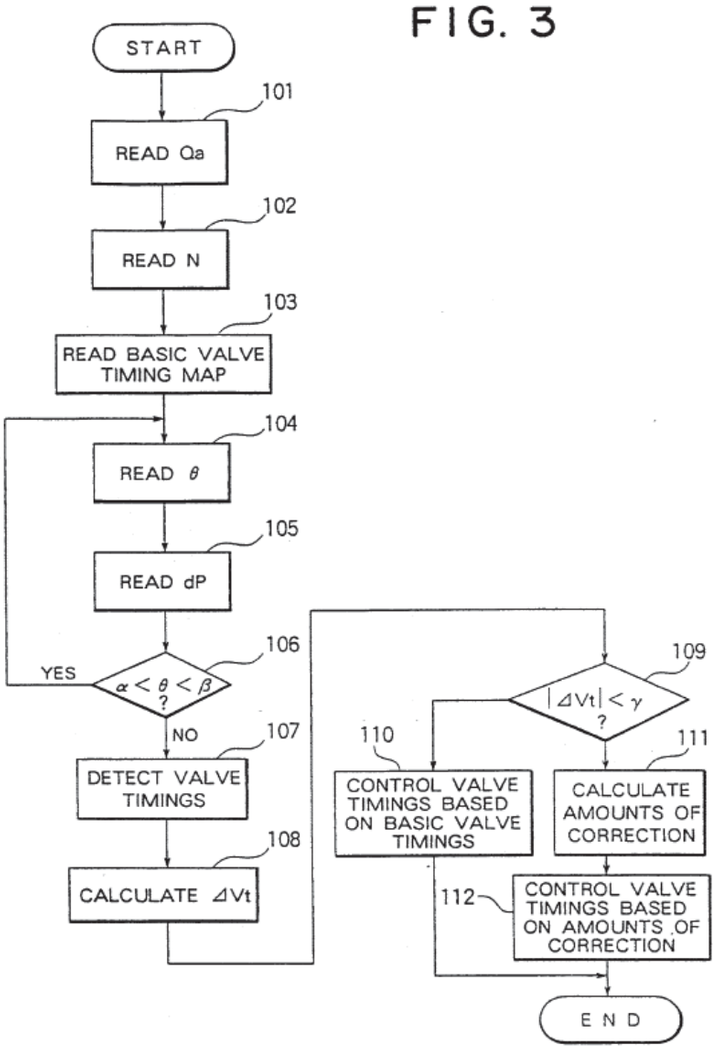


EX1006, FIG. 1.

Further, Figure 3 of Ohkubo illustrates (step 108) calculating a deviation ΔVt between each of the detected timing values and the corresponding predetermined basic values for valve opening and closing timings; and (step 109) determining whether each ΔVt falls within an allowable range γ. EX1006, 5:41-46. If the ΔVt is outside of the allowable range γ, the program (step 111) calculates appropriate amounts of correction for properly correcting the valve timings. *Id.*, 5:51-54; EX1003, ¶141.

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FIG. 3



EX1006, FIG. 3.

Accordingly, Ohkubo discloses calculating a correction for the timing of the intake and exhaust valves based on the comparison of the predetermined valve timing of the intake and exhaust valves ("valve feedforward term" based

on the "engine performance command") and the actual valve timing of the intake and exhaust valves ("engine performance feedback"). EX1003, ¶142.

As described above, Yoshioka and Ohkubo both disclose an ECU 70/control unit 25 for controlling valve timing to bring actual valve timing to target valve timing. And it would have been obvious to combine the known technique of calculating a correction for the timing of the intake (and exhaust) valve based on the comparison of the predetermined valve timing of the intake (and exhaust) valve and the actual valve timing of Ohkubo so that Yoshioka's ECU 70 may accurately "bring the actual displacement of the intake valve 24 to the target displacement IVTDt." EX1005, 8:6-8. Doing so would have merely been applying a known technique to a similar device in the same way. *KSR*, 550 U.S. at 416; *see supra* VII.A; EX1003, ¶143.

Thus, Yoshioka, alone or in combination with Ohkubo, discloses or renders obvious [1.E]. EX1003, ¶144.

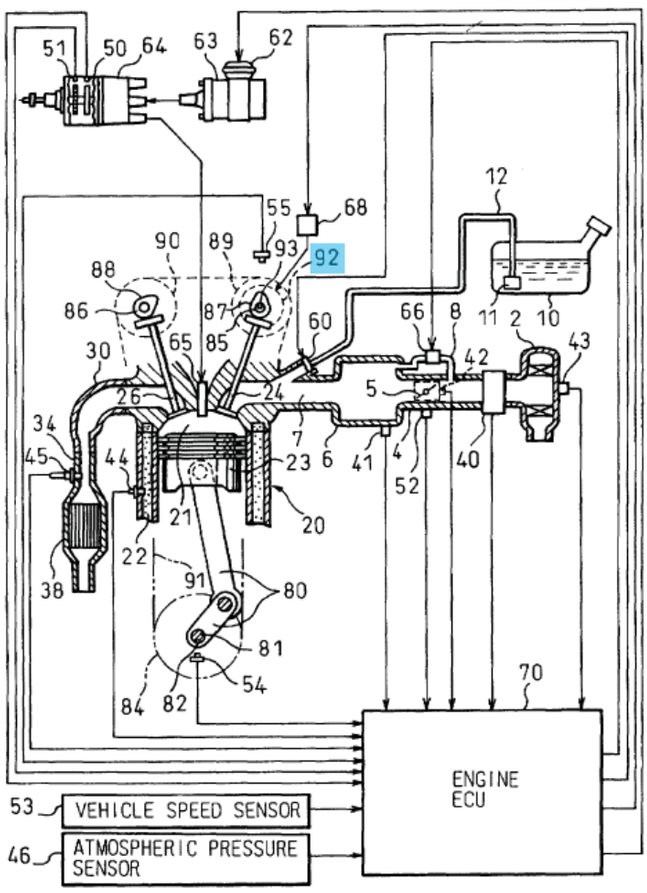
7. [1.F] "calculating a valve timing command based on the valve feedforward term and the valve feedback term[5]"

Yoshioka discloses this limitation. Specifically, Yoshioka discloses that the ECU 70 feedback controls the valve timing of the intake valve 24 by calculating an adjustment for the hydraulic pressure control valve 68 based on the correction for the timing of the intake valve 24 ("valve feedback term") from the comparison of the target timing displacement IVTDt ("valve feedforward term") and the actual timing displacement of intake valve 24 ("valve feedback term"). EX1003, ¶146.

Yoshioka, in particular, discloses a continuously variable mechanism 92 that uses the cam shaft 85 and timing pulley 89 as external gears and connects them to each through an intermediate helical gear, which is axially moved by hydraulic pressure controlled by a control valve 68 to drive the cam shaft 85 and timing pulley 89 relative to each other. EX1005, 5:10-20; EX1003, ¶147.

[5] The '540 patent broadly characterizes the claimed "valve timing command" as encompassing any "suitable parameter" for controlling valve timing. EX1001, 3:21-26; EX1003, ¶145.

Fig. 1



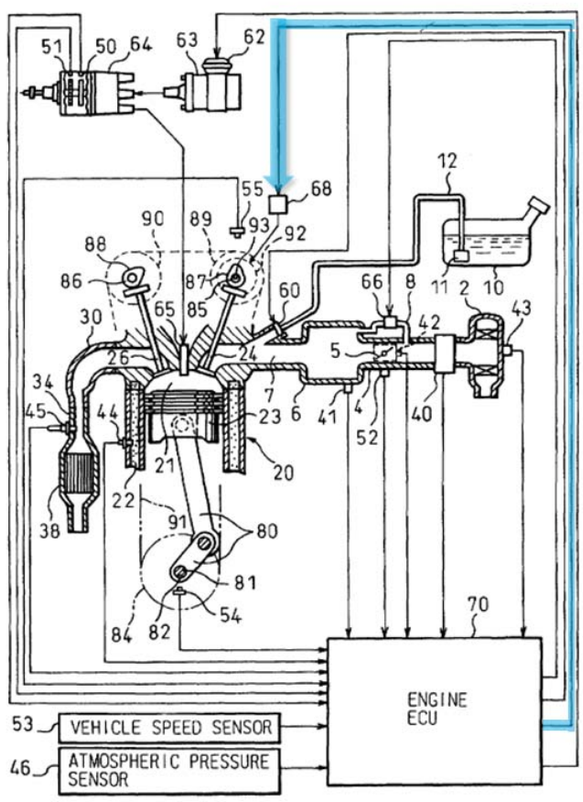
EX1005, FIG. 1 (annotated).

Yoshioka sets the target open/close timing of intake valve 24 (*i.e.*, valve opening timing IVO and valve close timing IVC) using the target displacement according to operating conditions (*e.g.*, engine load and atmospheric pressure). *Id.*, 6:6-8; 7:46-56. Once the target displacement IVTDt is set, the open/close timing of intake valve 24 is feedback-controlled using the hydraulic pressure control valve 68

according to signals from the first and second magnetic sensors 54 and 55 so that the cam shaft 85 of intake valve 24 maintains a required rotational phase with respect to the crankshaft 81 (*i.e.*, "bring the actual displacement of the intake valve 24 to the target displacement IVTDt."). *Id.*, 6:6-37; 7:46-56; 8:6-8; EX1003, ¶148.

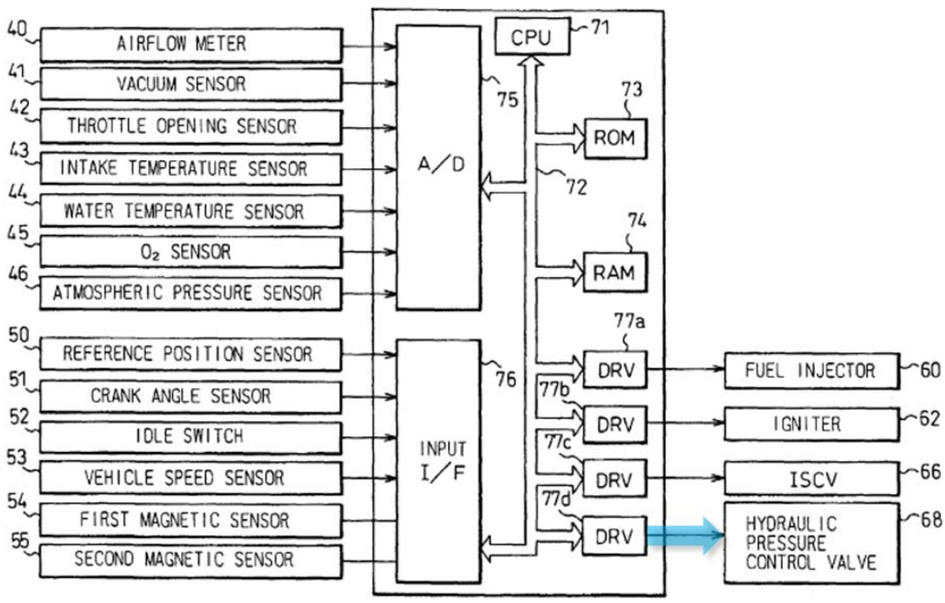
That is, Yoshioka's ECU 70 calculates an adjustment to the hydraulic control valve 68 ("a valve timing command") based on the correction needed to bring the detected actual timing displacement for the open/close timing of intake valve 24 to the target valve timing displacement IVTDt. This valve timing command provided to the hydraulic control valve 68 by the ECU 70 is shown below in Figures 1 and 2 (in blue). EX1003, ¶149.

Fig. 1



EX1005, FIG. 1 (annotated).

Fig.2



EX1005, FIG. 2 (annotated).

Thus, Yoshioka discloses [1.F]. EX1003, ¶150.

C. Yoshioka and Ohkubo renders obvious claim 2.

Claim 2 depends from claim 1 and recites "said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command." Yoshioka renders obvious this limitation. EX1003, ¶151.

The ’540 patent does not purport to have invented obtaining an engine performance command by receiving a vehicle performance command from a driver of a vehicle. The ’540 patent instead admits that a vehicle performance command is simply “received from the foot of a driver with the use of a **conventional pedal**” to obtain an engine performance command. EX1001, 2:4-8. Thus, the ’540 patent admits this “conventional” pedal that sends the vehicle performance command is known in the prior art. EX1003, ¶152

Yoshioka does not explicitly state that the opening and closing the throttle valve 5 detected by Yoshioka’s throttle opening sensor 42 are based on a vehicle performance command from a driver of the vehicle. As discussed above, however, a POSA would have understood that a driver would have controlled the desired engine acceleration by opening and closing the throttle valve 5 detected by Yoshioka’s throttle opening sensor 42, *e.g.*, by depressing a conventional accelerator pedal. *See supra* VI.A; EX1003, ¶¶153-155. A POSA would have also understood that the opening of the throttle valve 5 relates directly to a vehicle performance command received from a driver to control the desired engine acceleration, *e.g.*, by depressing a conventional accelerator pedal. *See supra* VI.A; *see also* EX1007, 1:39-42 (“The pedal sensor 8 enables the ECM 11 to monitor the position of the accelerator pedal, and thus to determine whether the driver wants the vehicle to maintain, increase or

decrease torque."); EX1016, 2:7 ("Fuel delivery requirements depend more than anything else on how much work you are asking the engine to do—on how much of a 'load' you are placing on it. To accelerate, you step down harder on the accelerator. This opens the throttle valve…"); EX1003, ¶¶153-155.

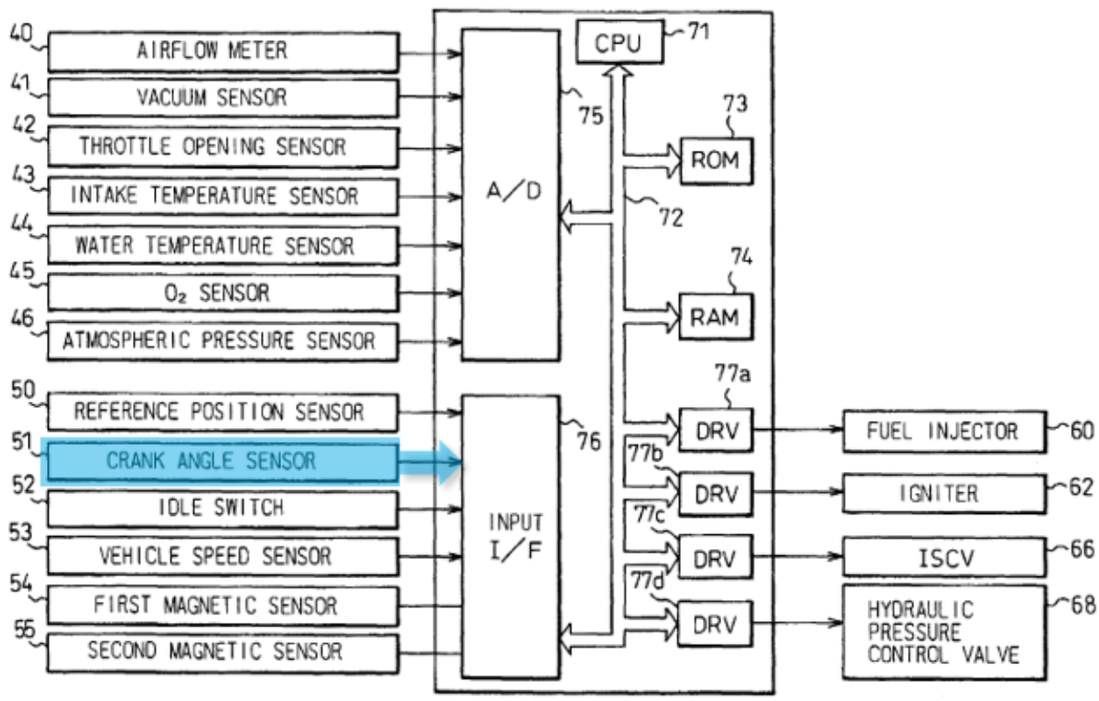
Thus, the combination of Yoshioka and Ohkubo renders obvious claim 2. EX1003, ¶156.

D. Yoshioka and Ohkubo renders obvious claim 7.

Claim 7 depends from claim 1 and recites "said receiving an engine performance feedback includes receiving engine speed data."

Yoshioka renders obvious this limitation. EX1003, ¶157. Yoshioka, in particular, discloses that the signal from the crank angle sensor 51 is used to calculate the engine revolution speed NE. EX1005, 7:16-24. Moreover, Yoshioka's ECU 70 receives signals from all of the sensors and switches, including the crank angle sensor 51, to provide actuator control signals through drive control circuits 77a to 77d. *Id.*, 5:21-30. Figure 2 of Yoshioka, below, shows the ECU 70 receiving the signal from the crank angle sensor 51. EX1003, ¶158.

Fig.2



EX1005, FIG. 2 (annotated).

Yoshioka further discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to continuously control the open/close timing of the intake valve both at low and high highlands, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening." EX1005, 9:22-27, 1:9-14 ("The present invention relates to a method of and an apparatus for controlling a continuously variable valve timing mechanism of an

internal combustion engine, to **continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing**."). EX1003, ¶159. A POSA would have thus understood that the engine revolution speed NE is continuously monitored and fed back to the ECU 70. EX1003, ¶160. Moreover, it would have been obvious to a POSA to utilize the engine revolution speed NE already available to the ECU 70 of Yoshioka when determining the target valve timing displacement ("valve feedforward term") to "continuously and variably" control the "open/close timing of the intake valve 24 according to operating conditions" and improve fuel efficiency. EX1005, 6:6-8. Doing so would have merely been applying a known technique in a known device to yield predictable results. *KSR*, 550 U.S. at 416; EX1003, ¶160.

Thus, the combination of Yoshioka and Ohkubo renders obvious claim 7. EX1003, ¶161.

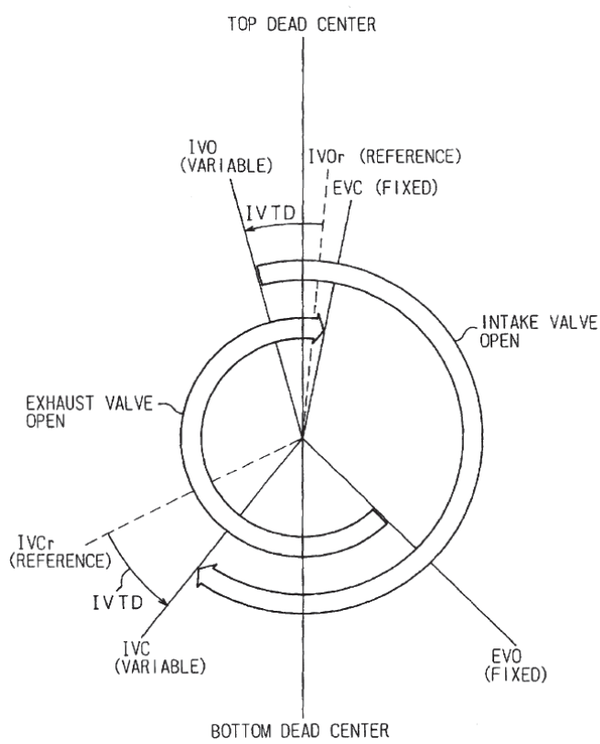
E. Yoshioka and Ohkubo renders obvious claim 10.

Claim 10 depends from claim 1 and recites "said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command."

Yoshioka, alone or in combination with Ohkubo, renders obvious this limitation. EX1003, ¶162. Figure 3 of Yoshioka, below, illustrates a timing chart

showing crank angles corresponding to the open/close timing of intake and exhaust valves 24 and 26, including: intake valve 24 opening timing IVO and close timing IVC, and exhaust valve 26 opening timing EVO and close timing EVC. EX1005, 6:16-36; EX1003, ¶163.

Fig. 3



EX1005, FIG. 3.

Yoshioka discloses "continuously and variably controlling the open/close timing of at least one of the intake **and** the exhaust valves of the engine," and in one

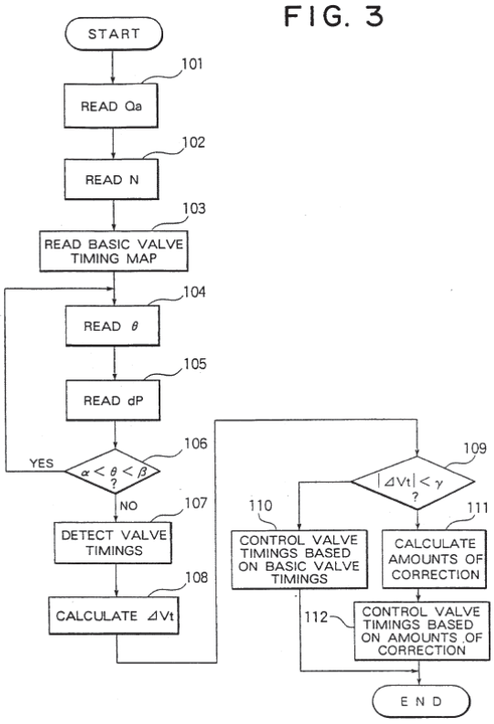
example, that the "[v]alve timing control sets the target open/close timing of the intake valve 24 according to operating conditions and controls the continuously variable mechanism 92." EX1005, 1:61-2:4, 6:6-8. Yoshioka further discloses that "although the embodiments variably control the open/close timing of the intake valve 24, the present invention is naturally applicable to control the exhaust valve 26 too." *Id.*, 9:35-37. That is, Yoshioka discloses varying the valve open/close timing for both the intake valve and exhaust valve—intake valve 24 opening timing IVO and close timing IVC, and exhaust valve 26 opening timing EVO and close timing EVC. EX1003, ¶164

A POSA would have thus understood that by controlling the continuously variable mechanism 92 for both the intake and exhaust valves 24 and 26, Yoshioka discloses calculating an EVO command, an EVC/IVO command, and an IVC command. EX1003, ¶165.

Should MMT argue, incorrectly, that Yoshioka does not disclose this limitation, Ohkubo also discloses calculating an EVO command, an EVC/IVO command, and an IVC command. *Id.*, ¶166. Specifically, Ohkubo discloses first determining the values "for the **basic valve timings** such as IVo (intake valve opening timing), IVc (intake valve closing timing), EVo (exhaust valve opening

timing) and EVc (exhaust valve closing timing)" from a two-dimensional table map which is stored in the NVM 29 (step 103). EX1006, 5:15-22; EX1003, ¶166.

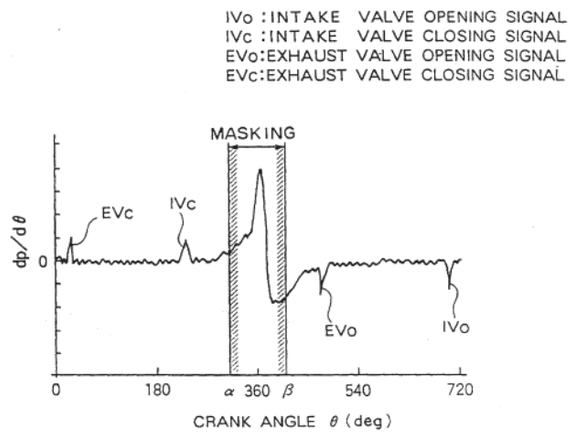
FIG. 3



EX1006, FIG. 3.

Ohkubo discloses that the EVO, EVC, IVO, and IVC valve timings are then detected (step 107). EX1006, 5:36-39. This is shown below in Figure 4:

FIG. 4



EX1006, FIG. 4.

EX1003, ¶167

Then (step 111), Ohkubo discloses calculating a correction for each of the EVO, EVC, IVO, and IVC valve timings, if needed. *Id.*, 5:51-54 ("…the program goes to Step 111 where appropriate amounts of correction for properly correcting the valve timings are calculated."). Based on this explicit teaching of Ohkubo, it would have been obvious to a POSA for the ECU 70 of Yoshioka to calculate an EVO command, an EVC/IVO command, and an IVC command to "bring an actual displacement to the target displacement" as disclosed by Yoshioka. EX1003, ¶168. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; *see supra* VII.A; EX1003, ¶168.

Thus, the combination of Yoshioka and Ohkubo renders obvious claim 10. EX1003, ¶169.

F. Yoshioka and Ohkubo renders obvious claim 11.

Claim 11 depends from claim 1 and recites "further comprising receiving fuel conversion data."

Yoshioka renders obvious this limitation. EX1003, ¶170. Yoshioka discloses that the ECU 70 receives "an air-fuel ratio feedback correction according to a signal from the O_2 sensor 45…" EX1005, 5:48-55. That is, the "exhaust valve 26 discharges an exhaust gas of the combusted air-fuel mixture into an exhaust manifold 30 connected to an exhaust pipe 34" such that the O_2 sensor 45 detects the concentration of oxygen in the exhaust gas. *Id.*, 4:48-52. Accordingly, Yoshioka discloses receiving fuel conversion data (*e.g.*, the concentration of oxygen in the exhaust gas) from the O_2 sensor 45. EX1003, ¶¶171-172.

Thus, the combination of Yoshioka and Ohkubo renders obvious claim 11. *Id.*, ¶173.

G. Yoshioka and Ohkubo renders obvious claim 12.

Claim 12 depends from claim 11 and recites "said determining a valve feedforward term includes determining a valve feedforward term based on the fuel conversion data."

Yoshioka in combination with Ohkubo renders obvious this limitation. EX1003, ¶174. As described above, Yoshioka's ECU 70 receives an input from the O_2 sensor 45 indicating fuel conversion data. *See supra* VII.F. Yoshioka further discloses that the ECU 70 receives the signals from the sensors, including the O_2 sensor 45, and controls the open/close timing of intake valve 24 according to various operating conditions by controlling the continuously variable mechanism 92. EX1005, 5:21-24, 6:6-15 ("Valve timing control sets the target open/close timing of the intake valve 24 according to operating conditions and controls the continuously variable mechanism 92. …"); EX1003, ¶175. A POSA would have understood that the fuel conversion data (*e.g.*, the concentration of oxygen in the exhaust gas) from the O_2 sensor 45 is an operating condition of the engine. EX1003, ¶176. Thus, a POSA would have at least found it obvious that Yoshioka's ECU 70 uses the signal input from the O_2 sensor 45, an operating condition of the engine, when determining the initial valve timing target displacement IVTDt ("valve feedforward term"). *Id.*

Ohkubo similarly discloses the engine having an oxygen sensor 24 to sense the concentration of oxygen contained in the exhaust gas discharged from the engine cylinder 1 and provides that as an input to control unit 25. EX1006, 4:30-42. The control unit 25 then uses the input from the sensors, including the oxygen sensor 24, to determine optimal opening and closing timings of intake and exhaust valves. *Id.*,

4:46-65; EX1003, ¶177. Thus, it would have been obvious to a POSA to utilize the fuel conversion data already available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") as taught by Ohkubo to improve fuel efficiency and reduce harmful exhaust components. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; *see supra* VII.F; EX1003, ¶¶178-179.

Thus, the combination of Yoshioka and Ohkubo renders obvious claim 12. EX1003, ¶180.

H. Yoshioka and Ohkubo renders obvious claim 13.

Claim 13 depends from claim 11 and recites "said calculating a valve feedback term includes calculating a valve feedback term based on the fuel conversion data."

Yoshioka, alone or in combination with Ohkubo, renders obvious this limitation. EX1003, ¶181. As described above, Yoshioka's ECU 70 receives an input from the O_2 sensor 45 indicating fuel conversion data and it would have been obvious to a POSA to utilize the fuel conversion data already available to the ECU 70 of Yoshioka to determine the initial valve timing target displacement IVTDt ("valve feedforward term") as taught by Ohkubo to improve fuel efficiency and reduce harmful exhaust components. *See supra* VII.G; EX1003, ¶182.

Yoshioka further discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to **continuously control** the open/close timing of the intake valve both at low and high highlands, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening." EX1005, 9:22-27, 1:9-14 ("The present invention relates to a method of and an apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to **continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing**."); EX1003, ¶183.

A POSA would have thus understood that the fuel conversion data from the O_2 sensor 45 is continuously monitored and fed back to the ECU 70 to "continuously and variably" control the "open/close timing of the intake valve 24 according to operating conditions." EX1005, 1:9-14, 6:6-8; EX1003, ¶184. Moreover, it would have been obvious to a POSA to use the most current fuel conversion data from the O_2 sensor 45 along with the measured actual valve timing displacement to determine the "valve feedback term." EX1003, ¶184. Indeed, by considering the input from the O_2 sensor 45 when calculating both the "valve feedforward term" and the "valve feedback term," it would have been obvious to a POSA that the valve open/close timings can be more accurately controlled to

improve fuel efficiency and reduce harmful exhaust components. *Id.* Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; EX1003, ¶184.

Thus, Yoshioka, alone or in combination with Ohkubo, renders obvious claim 13. EX1003, ¶185.

I. Yoshioka and Ohkubo renders obvious claim 14.

Claim 14 depends from claim 1 and recites "further comprising receiving engine emissions data."

Yoshioka renders obvious this limitation. EX1003, ¶186. Yoshioka discloses that the ECU 70 receives "an air-fuel ratio feedback correction according to a signal from the O_2 sensor 45, and an air-fuel ratio learning correction to equalize a central feedback correction value with a theoretical air-fuel ratio." EX1005, 5:48-55. That is, the "exhaust valve 26 discharges an exhaust gas of the combusted air-fuel mixture into an exhaust manifold 30 connected to an exhaust pipe 34" such that the O_2 sensor 45 detects the concentration of oxygen in the exhaust gas. *Id.*, 4:48-52. The quantity of oxygen present in the exhaust gas, as measured by the O_2 sensor 45 and received by the ECU 70 of Yoshioka, represents the level of emissions in the exhaust gas ("engine emissions data"). EX1003, ¶187.

Thus, the combination of Yoshioka and Ohkubo renders obvious claim 14. *Id.*, ¶188.

J. Yoshioka and Ohkubo renders obvious claim 15.

Claim 15 depends from claim 14 and recites "said determining a valve feedforward term includes determining a valve feedforward term based on the engine emissions data."

Yoshioka, alone or in combination with Ohkubo, renders obvious this limitation. EX1003, ¶189. As described above, Yoshioka's ECU 70 receives an input from the O_2 sensor 45 indicating fuel conversion data. *See supra* VII.F. Yoshioka further discloses that the ECU 70 receives the signals from the sensors, including the O_2 sensor 45, and controls the open/close timing of intake valve 24 according to various operating conditions by controlling the continuously variable mechanism 92. EX1005, 5:21-24, 6:6-15 ("Valve timing control sets the target open/close timing of the intake valve 24 according to operating conditions and controls the continuously variable mechanism 92. …"); EX1003, ¶190. A POSA would have understood that the engine emissions data (*e.g.*, the concentration of oxygen in the exhaust gas) from the O_2 sensor 45 is an operating condition of the engine. EX1003, ¶191. It would have thus been obvious to a POSA for the ECU 70 to use the signal input from the O_2 sensor 45, an operating condition of the engine,

when determining the initial valve timing target displacement IVTDt ("valve feedforward term"). Doing so would have merely been applying a known technique in a known device to yield predictable results. *KSR*, 550 U.S. at 416; EX1003, ¶¶178, 191.

Ohkubo similarly discloses the engine having the oxygen sensor 24 to sense the concentration of oxygen contained in the exhaust gas discharged from the engine cylinder 1 and provides that as an input to control unit 25. EX1006, 4:30-42. The control unit 25 then uses the input from the sensors, including the oxygen sensor 24, to determine optimal opening and closing timings of the intake and exhaust valves. *Id.*, 4:46-65; EX1003, ¶192. It would have been obvious to a POSA to utilize the engine emissions data already available to the ECU 70 of Yoshioka when determining the initial valve timing target displacement IVTDt ("valve feedforward term") as taught by Ohkubo to improve fuel efficiency and reduce harmful exhaust components. EX1003, ¶193. Doing so would have merely been applying a known technique in a known device to yield predictable results. *KSR*, 550 U.S. at 416; *see supra* VII.G; EX1003, ¶¶178, 193.

Thus, Yoshioka, alone or in combination with Ohkubo, renders obvious claim 15. EX1003, ¶194.

K. Yoshioka and Ohkubo renders obvious claim 16.

Claim 16 depends from claim 11 and recites "said calculating a valve feedback term includes calculating a valve feedback term based on the engine emissions data."

Yoshioka, alone or in combination with Ohkubo, renders obvious this limitation. EX1003, ¶195. As described above, Yoshioka's ECU 70 receives an input from the O_2 sensor 45 indicating engine emissions data and it would have been obvious to a POSA to utilize the engine emissions data already available to the ECU 70 of Yoshioka to determine the initial valve timing target displacement IVTDt ("valve feedforward term") as taught by Ohkubo to improve fuel efficiency and reduce harmful exhaust components. *See supra* VII.G; EX1003, ¶196.

Yoshioka further discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to **continuously control** the open/close timing of the intake valve both at low and high highlands, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening." EX1005, 9:22-27, 1:9-14 ("The present invention relates to a method of and an apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to **continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target**

timing."); EX1003, ¶197. A POSA would have thus understood that the engine emissions data from the O_2 sensor 45 is thus continuously monitored and fed back to the ECU 70 to "continuously and variably" control the "open/close timing of the intake valve 24 according to operating conditions." EX1005, 6:6-8; EX1003, ¶198. Moreover, it would have been obvious to a POSA to use the most current engine emissions data from the O_2 sensor 45 along with the measured actual valve timing displacement when determining the "valve feedback term." EX1003, ¶198. Indeed, by considering the input from the O_2 sensor 45 when calculating both the "valve feedforward term" and the "valve feedback term," it would have been obvious to a POSA that the valve open/close timings can be more accurately controlled to improve fuel efficiency and reduce harmful exhaust components. Doing so would have merely been applying a known technique in a known device to yield predictable results. *KSR*, 550 U.S. at 416; *see supra* VII.A; EX1003, ¶198.

Thus, Yoshioka, alone or in combination with Ohkubo, renders obvious claim 16. EX1003, ¶199.

VIII. Ground 2: The combination of Yoshioka, Ohkubo, and Reed renders obvious claims 3-6, 8, and 9.

A. Rationale for combining Yoshioka, Ohkubo, and Reed

A POSA would have been motivated to combine the teachings of Yoshioka, Ohkubo, and Reed for multiple reasons, rendering the claims obvious. EX1003,

¶200. The combination of Yoshioka and Ohkubo is discussed above in Section VII.A and applied equally here. *See supra* VII.A; EX1003, ¶200.

As an initial matter, Yoshioka, Ohkubo, and Reed are from the same field of endeavor—control systems for valve timing for an internal combustion engine. Yoshioka, Ohkubo, and Reed, in particular, are directed to analogous valve timing control systems. *See supra* VI. Like Yoshioka and Ohkubo, Reed discloses "…a method of increasing engine torque and/or of reducing engine emissions by varying the phasing of either the intake valves or the exhaust valves or both." EX1007, 1:11-14; EX1003, ¶201[6]. Moreover, Reed discloses an engine and electronic control

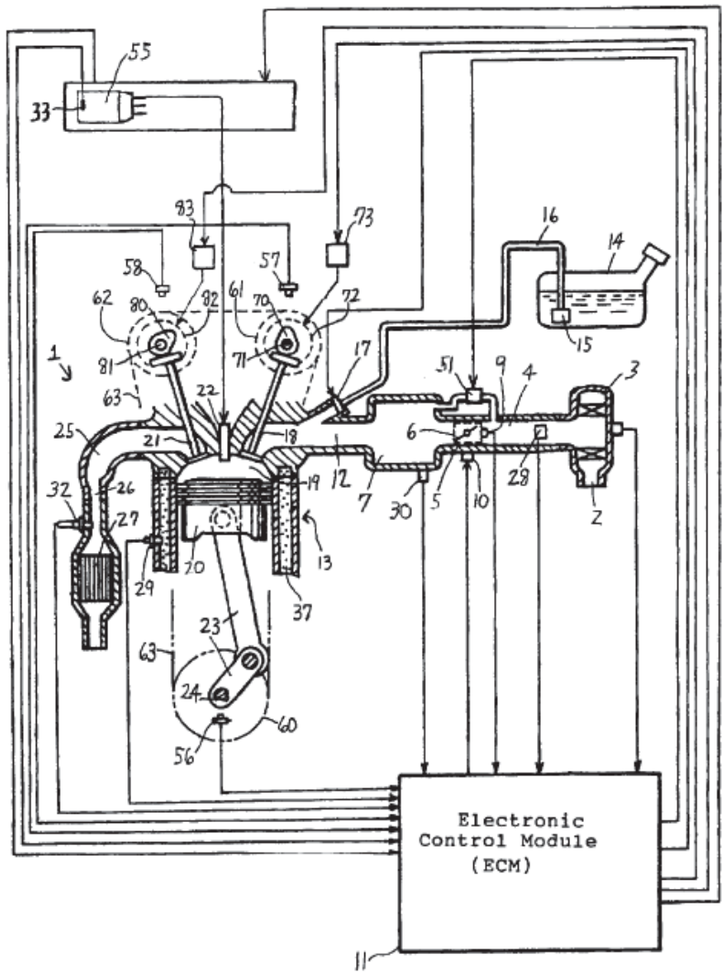
[6] Reed specifically cites to Yoshioka in the Background of the Invention section, stating that Yoshioka "purports to optimize the valve timing so as to improve the output of the engine at high altitudes while it is operating under high loads. It also purports to reduce the fuel consumption and emissions of the engine at high altitudes as it operates under low to medium loads." EX1007, 6:54-61. However, Reed incorrectly concludes that Yoshioka is limited to controlling valve timing of only the intake valve. EX1007, 6:61-65. As explained above in Section VII.E, Yoshioka discloses controlling valve timing of both the intake valve and

module (ECM) 11 having the same components as Yoshioka, including: ECM 11, intake valve 18, exhaust valve 21, air flow sensor 36, and O_2 (oxygen) sensor 32. *Id.*, 1:24-31, 1:64-2:10, 2:25-51; EX1003, ¶204.

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exhaust valve. *See* EX1005, 1:61-2:4, 6:6-8, 6:16-36, 9:35-37; *see also supra* VII.E; EX1003, ¶¶202-203.

FIGURE 1



EX1007, FIG. 1.

Reed discloses a method of setting target valve timing similar to that of Yoshioka, including measuring aspects of engine performance (*e.g.*, engine revolution speed), measuring environmental conditions (*e.g.*, pressure and

temperature), and determining target valve timing. EX1005, 7:16-8:8; EX1007, 12:45-47; EX1003, ¶205. Reed further discloses controlling valve timing based on temperature, which would have been readily applicable to Yoshioka's ECU 70 controlling valve timing. Indeed, Reed discloses that the desired valve timing should be corrected for both pressure **and** temperature. EX1007, 12:45-47, 13:44-46; EX1003, ¶205.

While Yoshioka is silent on controlling valve timing based on temperature, it would have been obvious to a POSA to combine the teachings of Yoshioka (and Ohkubo) and Reed, which would have yielded predictable benefits and results—for example, improved valve timing control by accounting for pressure and temperature. *KSR*, 550 U.S. at 416 ("[I]f a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious."); EX1003, ¶¶53-56, 206. Indeed, Reed recognized that it is **preferable** to adjust the valve timing to accommodate for the effects of both temperature and pressure to "improve[] the ability of the engine to deliver the desired torque, produce less feed gas emissions, idle more stably, and consume less fuel." EX1007, Abstract, 12:45-47, 13:44-46, 16:1-5; EX1003, ¶¶53-56, 206.

A POSA would have also had a reasonable expectation of success combining Reed with Yoshioka and Ohkubo. EX1003, ¶207. While Reed discloses using engine temperature to correct valve timing, a POSA would have understood that ambient temperature, like ambient pressure, also impacts engine performance. *Id.* For example, Jackson recognized in the 1970s that ambient temperature impacts engine performance. *See* EX1014, Jackson, 1:9-29 ("… internal combustion engines have several characteristics in common regarding the effect and control of **factors which influence the efficiency of fuel conversion** to useable heat and/or mechanical energy and attendant effects such as noxious exhaust component emissions" that "are expected to operate and are operated, under varying conditions of load, engine operating temperature, **ambient temperature and barometric pressure**" and "**all of these variables are known to effect the efficien[c]y of fuel conversion** to mechanical energy and the attendant production of undesirable byproducts or unreacted feed constituents in the form of exhaust emissions."), 1:30-34 ("For example, in the operation of a conventional spark ignition gasoline automotive engine, it is known that considerable reduction in air-to-fuel ratio, below that required for operation at design operating temperatures, is required when the engine is cold. This requirement is due to the relatively low volatility of the gasoline fuel at relatively low engine operating temperatures thus requiring the injection of

higher amounts of fuel per unit standard volume of air to obtain adequate performance."); EX1003, ¶¶53-56, 208.

A POSA would have thus recognized that Reed's technique of correcting valve timing based on pressure, just like Yoshioka, but also temperature, was a predictable solution readily applicable to Yoshioka's ECU 70. *KSR*, 550 U.S. at 416 ("When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp."); EX1003, ¶¶53-56, 209.

A POSA would have also understood how to combine the teachings of Reed with Yoshioka and Ohkubo to control the valve timing. EX1003, ¶210. A POSA would have simply used Reed's implementation details, for example, adjusting valve timing using a temperature-correction (in addition to pressure-correction) and calculating an appropriate amount of correction for the valve timing(s), in order to accurately control Yoshioka's valve timings. *Id.* And it would have been obvious to a POSA to utilize the ambient temperature data—already available to Yoshioka's ECU 70—to determine the initial valve timing target displacement IVTDt ("valve feedforward term") by applying a temperature correction coefficient as taught by Reed to improve fuel efficiency and reduce engine emissions. EX1007, 1:11-14

("…reducing engine emissions by varying the phasing of either the intake valves or the exhaust valves or both."); EX1003, ¶210.

Furthermore, a POSA would have understood that Reed's valve timing correction technique would have been combined in a known way to provide the predictable benefits disclosed in Yoshioka to improve the accuracy of controlling the valve opening and closing timings to "optimiz[e] valve timing to maintain the output of the engine." EX1005, 2:32-34; EX1006, 6:13-22 ("the air-intake efficiency and the exhaust-discharge efficiency of the engine can be improved, thus increasing the output power of the engine."); EX1003, ¶211. Doing so would have merely been applying a known technique in a known device to yield predictable results. *KSR*, 550 U.S. at 419-421; EX1003, ¶¶53-56, 211.

Accordingly, it would have been obvious to combine the teachings of Yoshioka, Ohkubo, and Reed. EX1003, ¶212.

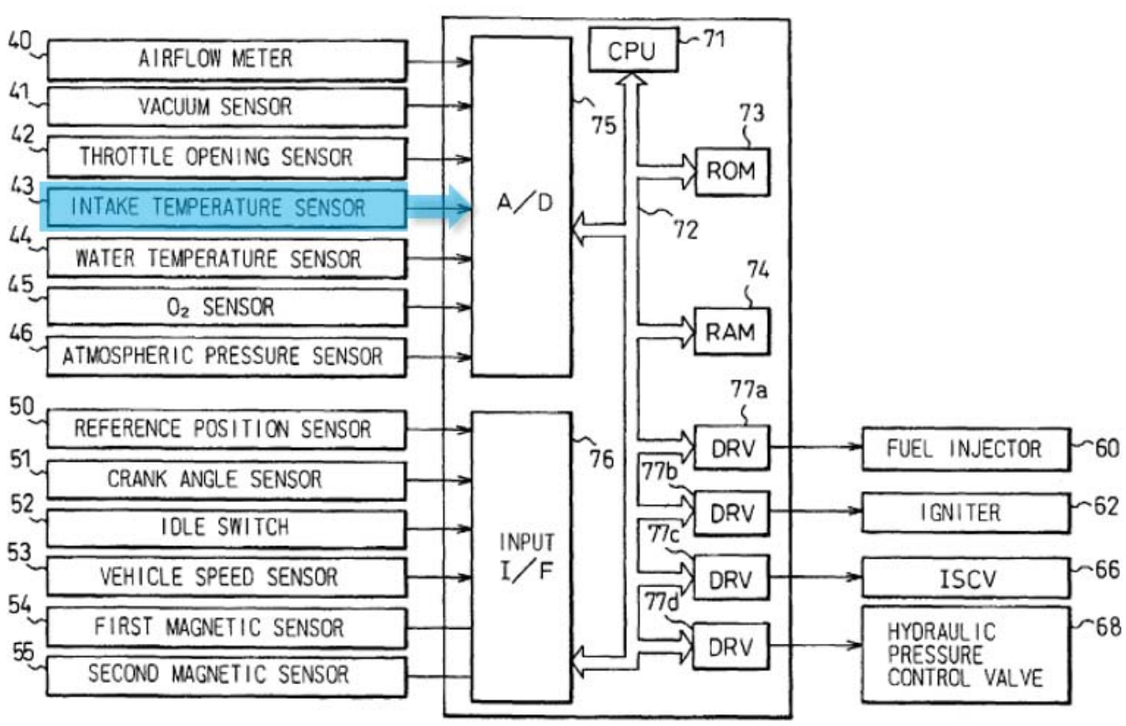
B. Yoshioka, Ohkubo, and Reed renders obvious claim 3.

Claim 3 depends from claim 1 and recites "said receiving an environmental conditions signal includes receiving ambient temperature data."

Yoshioka, alone or in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶213. Yoshioka discloses that a "temperature sensor 43 detects the temperature of intake air" (*i.e.*, ambient air temperature). EX1005, 4:15-

16, FIG. 2. As shown in Figure 2, below, the ECU 70 receives the signal from the temperature sensor 43, along with the "signals from the sensors and switches through an A/D converter 75 and an interface 76, processes the signals, and provides actuator control signals through drive control circuits 77a to 77d." *Id.*, 5:26-32. Accordingly, the signal received by the ECU 70 includes ambient temperature data detected by sensor 43. *Id.*, 4:15-16, 5:26-32; EX1003, ¶214.

Fig.2



EX1005, FIG. 2 (annotated).

Thus, Yoshioka discloses receiving ambient temperature data. EX1003, ¶215.

Should MMT argue that claim 3 requires using the received ambient temperature data to determine the "valve feedforward term," it would have been obvious to a POSA to use temperature data to determine the target valve timing displacement, IVTDd, ("valve feedforward term") as taught by Reed. *Id.*, ¶¶216-217.

Reed discloses that the intake valve timing is varied based on pressure and temperature using pressure and temperature-correction values. EX1007, 12:45-13:20, 15:28-41; EX1003, ¶218. That is, Reed, applies not only a pressure correction value (P_c) when determining valve timing, like Yoshioka's pressure correction coefficient Kpa, but also applies a temperature correction value (T_c) to "improve[] the ability of the engine to deliver the desired torque, produce less feed gas emissions, idle more stably, and consume less fuel." EX1007, Abstract, 16:1-5; EX1003, ¶218.

While Reed discloses using engine temperature to correct valve timing, a POSA would have understood that ambient temperature, like ambient pressure, also impacts engine performance. EX1003, ¶219. As discussed above, Jackson recognized in the 1970s that ambient temperature impacts engine performance. *See* EX1014, 1:9-29 ("… internal combustion engines have several characteristics in

common regarding the effect and control of factors which influence the efficiency of fuel conversion to useable heat and/or mechanical energy and attendant effects such as noxious exhaust component emissions" that are "are expected to operate and are operated, under varying conditions of load, engine operating temperature, **ambient temperature and barometric pressure**" and "all of these variables are known to effect the efficien[c]y of fuel conversion to mechanical energy and the attendant production of undesirable byproducts or unreacted feed constituents in the form of exhaust emissions."), 1:30-34 ("For example, in the operation of a conventional spark ignition gasoline automotive engine, it is known that considerable reduction in air-to-fuel ratio, below that required for operation at design operating temperatures, is required when the engine is cold. This requirement is due to the relatively low volatility of the gasoline fuel at relatively low engine operating temperatures thus requiring the injection of higher amounts of fuel per unit standard volume of air to obtain adequate performance."); EX1003, ¶219.

It would have thus been obvious to a POSA to utilize the ambient temperature data already available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") by applying a temperature correction coefficient as taught by Reed to improve fuel efficiency and reduce engine emissions. EX1007, 1:11-14 ("…reducing engine emissions by varying the

phasing of either the intake valves or the exhaust valves or both."); EX1003, ¶220. Doing so would have merely been applying a known technique—adjusting valve timing using a temperature correction coefficient—in a known device to yield predictable results—improved engine performance. *KSR*, 550 U.S. at 416; *see supra* VIII.A; EX1003, ¶220.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious claim 3. EX1003, ¶221.

C. Yoshioka, Ohkubo, and Reed renders obvious claim 4.

Claim 4 depends from claim 3 and recites "said determining a valve feedforward term includes determining the valve feedforward term based on the ambient temperature data."

Yoshioka, in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶222. As described above, Yoshioka discloses receiving ambient temperature data and Reed discloses determining valve timing based on temperature data. *See* EX1005, 4:15-16, 5:26-32; EX1007, 12:45-13:20, 15:28-41; *see also supra* VII.B. Moreover, it would have been obvious to a POSA to utilize the ambient temperature data already available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") as taught by Reed to improve fuel efficiency and reduce engine emissions, as

described above. EX1007, 1:11-14 ("…reducing engine emissions by varying the phasing of either the intake valves or the exhaust valves or both."); EX1003, ¶223. Doing so would have merely been applying a known technique—adjusting valve timing using a temperature correction coefficient—in a known device to yield predictable results—improved engine performance. *KSR*, 550 U.S. at 416; *see supra* VIII.A; EX1003, ¶223.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious claim 4. EX1003, ¶224.

D. Yoshioka, Ohkubo, and Reed renders obvious claim 5.

Claim 5 depends from claim 4 and recites "said determining a valve feedforward term includes determining the valve feedforward term based on the engine performance feedback."

Yoshioka, in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶225. Yoshioka does not explicitly state that the target valve timing displacement, IVTDt, is set using the actual valve timing displacement. However, Yoshioka discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to **continuously control the open/close timing** of the intake valve both at low and high highlands, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening."

EX1005, 9:22-26, 1:9-14 ("The present invention relates to a method of and an apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to **continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing**."). That is, Yoshioka's ECU 70 continuously receives the actual valve timing displacement (engine performance feedback) and sets the target valve timing displacement, IVTDt, (valve feedforward term). EX1003, ¶226.

A POSA would have understood that the actual valve timing displacement (engine performance feedback) is an operating condition of the engine. *Id.*, ¶227. It would have thus been obvious to a POSA to use this feedback already available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") to further improve fuel efficiency and optimize valve timing. EX1005, 9:40-43 ("… the present invention provides a method of and apparatus for setting optimum valve timing according to atmospheric pressure for a continuous variable valve timing mechanism of an internal combustion engine."); EX1003, ¶227. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; EX1003, ¶227.

Moreover, as described above, it would have been obvious to a POSA to utilize the engine revolution speed NE (an "engine performance feedback") already

available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") to improve fuel efficiency. EX1003, ¶228. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; *see supra* VII.D; EX1003, ¶228.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious claim 5. EX1003, ¶229.

E. Yoshioka, Ohkubo, and Reed renders obvious claim 6.

Claim 6 depends from claim 5 and recites "said determining a valve feedforward term includes referencing a look-up table with the engine performance command, the ambient temperature, and the engine performance feedback."

Yoshioka, in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶¶230-233. Yoshioka discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to continuously control the open/close timing of the intake valve both at low and high [loads], thereby smoothing the torque characteristics with respect to the engine load and the throttle opening." EX1005, 9:22-27; *id.*, 5:25-26 ("A read-only memory (ROM) 73 stores programs and maps."), 7:36-40; EX1003, ¶234. Ohkubo similarly discloses a basic valve timing map 7 used to determine valve opening and closing times.

EX1006, 3:33-40, 4:63-65 ("In this regard, predetermined optimal valve opening and closing timings are stored in the NVM 29 in an appropriate form such as a map."), 5:15-22; EX1003, ¶235. Reed also discloses the use of lookup tables to determine desired valve timing based on at least two variables such as engine speed and engine load. EX1007, 12:27-44; EX1003, ¶236.

As described above, it would have been obvious to a POSA to use the feedback (*e.g.*, actual valve timing or engine revolution speed NE) already available to Yoshioka's ECU 70 to determine the initial valve timing target displacement IVTDt ("valve feedforward term") to further improve fuel efficiency and optimize valve timing. *See supra* VIII.D; EX1003, ¶237. Moreover, it would have been obvious to a POSA to use the existing map/lookup table to determine the initial valve timing target displacement IVTDt ("valve feedforward term") with the ambient temperature measurement and engine performance feedback (*e.g.*, actual valve timing or engine revolution speed NE). EX1003, ¶237. Doing so would have simply required a modification of the preexisting map/lookup table to account for additional feedback when determining the initial valve timing target displacement IVTDt, which would have been well within the skill of a POSA at the time. *Id.* Indeed, this would have simply been the use of a known technique (map/lookup

tables) with a similar device (engine control unit) in the same way. *KSR*, 550 U.S. at 416; EX1003, ¶237.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious obvious claim 6. EX1003, ¶238.

F. Yoshioka, Ohkubo, and Reed renders obvious claim 8.

Claim 8 depends from claim 1 and recites "said obtaining an engine performance command includes obtaining an engine torque command; and wherein receiving an engine performance feedback includes receiving engine torque data."

Yoshioka, in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶239. Yoshioka discloses that the ECU 70 calculates the engine load GN based on the mass flow rate of the intake air detected by the airflow meter 40 and the engine revolution speed NE, and ultimately determines the target valve timing displacement, IVTDt, using these values. *See* EX1005, 7:46-8:5; *supra* VII.B. Reed similarly discloses calculating engine load and setting the desired valve timing accordingly. EX1007, Abstract, 9:51-53, 10:35-40, 12:27-44, 15:62-16:5. In particular, Reed discloses that the engine load is derived from engine torque. *Id.*, 14:19-21; EX1003, ¶240. Based on the teaching of Reed, it would have been obvious to a POSA for Yoshioka's ECU 70 to calculate the engine load GN based on desired engine torque. EX1003, ¶241. Doing so would have simply been the use

of a known technique (determining engine load based on desired engine torque) in a similar device (engine control unit) in the same way. *Id.* Yoshioka, in combination with Ohkubo and Reed, thus discloses "obtaining an engine performance command includes obtaining an engine torque command." *Id.*

Moreover, it would have been obvious to a POSA, and in fact a natural and logical extension, to monitor the engine torque data as feedback for continuous control of the open/close timing of the valve(s) to "thereby smooth[] the torque characteristics with respect to the engine load and the throttle opening" as described by Yoshioka. EX1005, 9:22-27; EX1003, ¶242. By considering the desired engine torque and the engine torque data, the valve open/close timings can be more accurately controlled to improve fuel efficiency and reduce harmful exhaust components. Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; *see supra* X.B; EX1003, ¶242.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious claim 8. EX1003, ¶243.

G. Yoshioka, Ohkubo, and Reed renders obvious claim 9.

Claim 9 depends from claim 8 and recites "calculating a valve feedback term includes calculating a valve feedback term based on the engine torque command and the engine torque data."

Yoshioka, in combination with Ohkubo and Reed, renders obvious this limitation. EX1003, ¶244. As described above, it would have been obvious to a POSA to obtain an engine torque command (engine performance command) and engine torque data (engine performance feedback). *See supra* VIII.F; EX1003, ¶245.

Yoshioka further discloses that the ECU 70 "uses the two-dimensional map of engine load and engine revolution speed, to **continuously control** the open/close timing of the intake valve both at low and high highlands, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening." EX1005, 9:22-27, 1:9-14 ("The present invention relates to a method of and an apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to **continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing**."); EX1003, ¶246. It would have thus been obvious to a POSA to use desired engine torque and the engine torque data to determine the "valve feedback term." EX1003, ¶247. Indeed, by considering the desired engine torque and the engine

torque data when calculating the "valve feedback term," the valve open/close timings can be more accurately controlled to improve fuel efficiency and reduce harmful exhaust components. *Id.* Doing so would have merely been applying a known technique in a similar, known device in the same way. *KSR*, 550 U.S. at 416; EX1003, ¶247.

Thus, the combination of Yoshioka, Ohkubo, and Reed renders obvious claim 9. EX1003, ¶248.

IX. Conclusion

For the reasons above, *inter partes* review of claims 1-16 of U.S. Patent No. 6,557,540 is requested.

Respectfully submitted,

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/Michael D. Specht/

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Attorney for Petitioner
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Date: November 25, 2019

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CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE REQUIREMENTS

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,964 words, excluding the parts exempted by 37 C.F.R. § 42.24(a).

2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word 2010 in 14 point Times New Roman.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.

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CERTIFICATION OF SERVICE (37 C.F.R. §§ 42.6(e), 42.105(a))

The undersigned hereby certifies that on November 25, 2019, true and correct copies of the foregoing **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,557,540**, Petitioner's Power of Attorney, and all associated exhibits were served in their entireties on the following parties via FedEx Express® or Express Mail:

VISTEON GLOBAL
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Intellectual Property Department
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PAIR Correspondence Address for US Patent No. 6,557,540

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Date: November 25, 2019

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US006557540B1

(12) **United States Patent**
Mianzo et al.

(10) **Patent No.: US 6,557,540 B1**
(45) **Date of Patent: May 6, 2003**

(54) **METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE**

(75) Inventors: **Lawrence A. Mianzo**, Plymouth, MI (US); **Brett D. Collins**, Ypsilanti, MI (US); **Ibrahim Haskara**, Brownstown, MI (US)

(73) Assignee: **Visteon Global Technologies, Inc.**, Dearborn, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/014,286**

(22) Filed: **Dec. 11, 2001**

(51) **Int. Cl.**[7] **F01L 1/34**
(52) **U.S. Cl.** **123/678**; 123/90.15; 701/103
(58) **Field of Search** 123/678, 90.15, 123/90.19; 701/103

(56) **References Cited**

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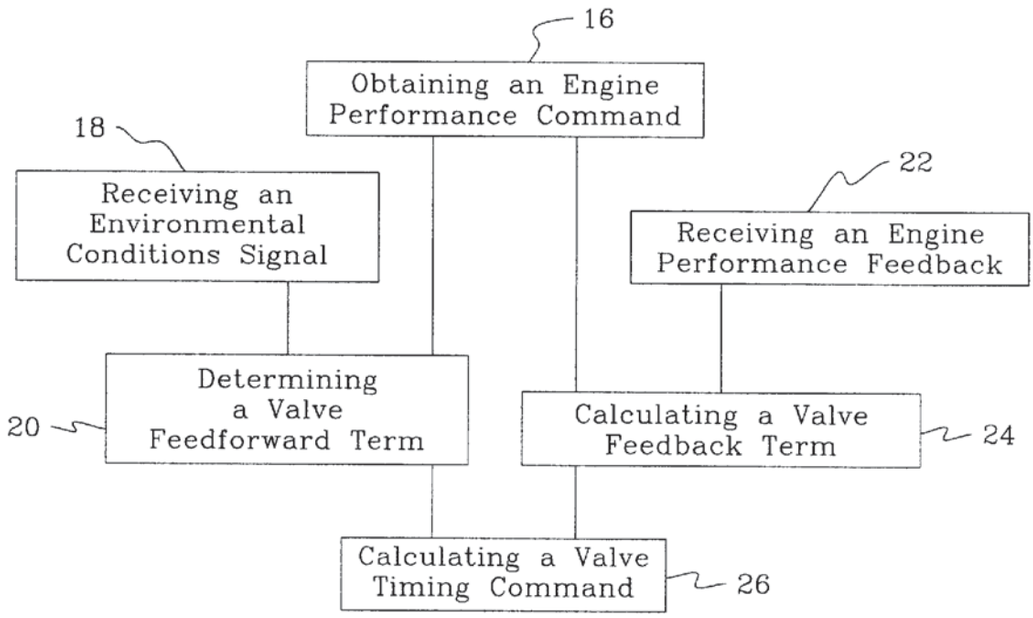
* cited by examiner

Primary Examiner—Erick Solis
(74) *Attorney, Agent, or Firm*—Brinks Hofer Gilson & Lione

(57) **ABSTRACT**

A method to calculate valve timing commands for an engine with variable valve timing is hereby disclosed. The method includes determining a valve feedforward term based on an engine performance command and an environmental conditions signal, calculating a valve feedback term based on the engine performance command and an engine performance feedback, and calculating a valve timing command based on the valve feedforward term and the valve feedback term.

16 Claims, 3 Drawing Sheets



VW EX1001
U.S. Patent No. 6,557,540

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US PATENT NO. 6,557,540

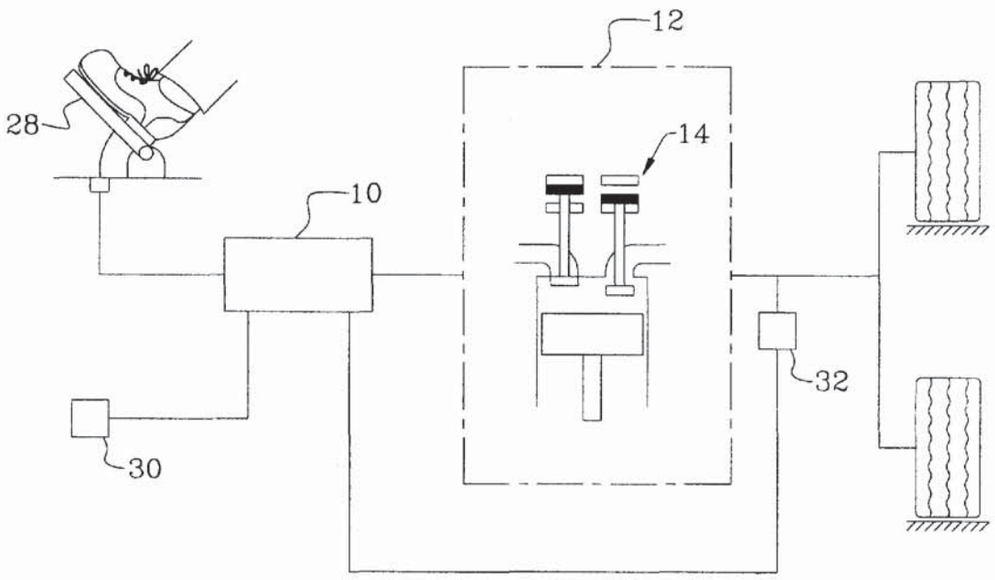


FIGURE 1

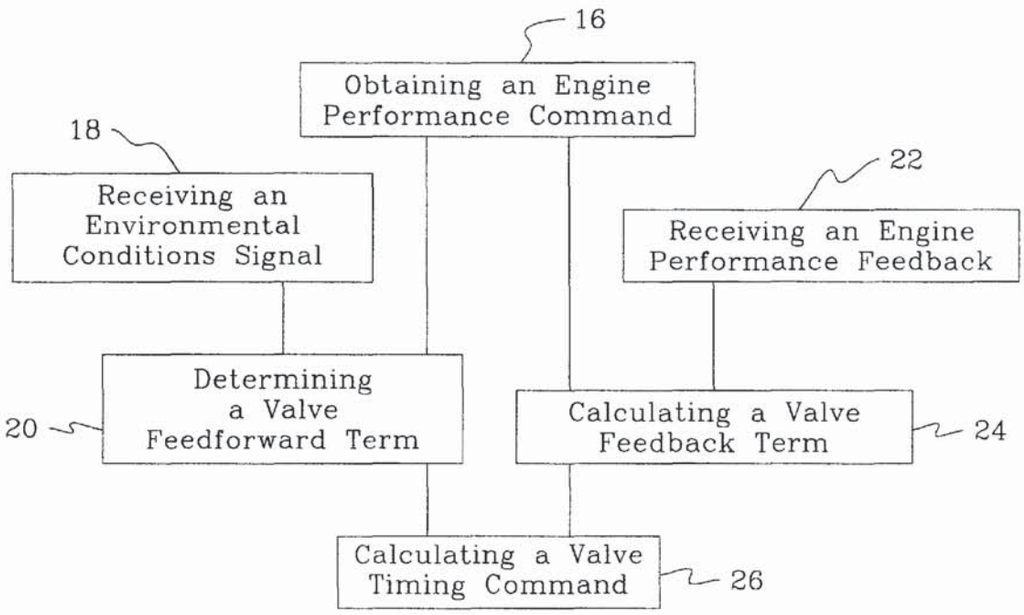

16
Obtaining an Engine Performance Command
18
Receiving an Environmental Conditions Signal
22
Receiving an Engine Performance Feedback
Determining a Valve Feedforward Term
20
Calculating a Valve Feedback Term
24
Calculating a Valve Timing Command
26

FIGURE 2

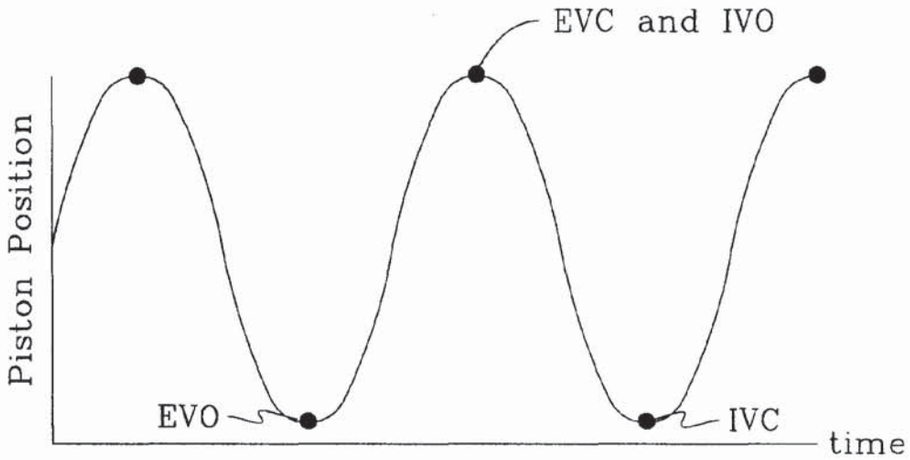


FIGURE 3A

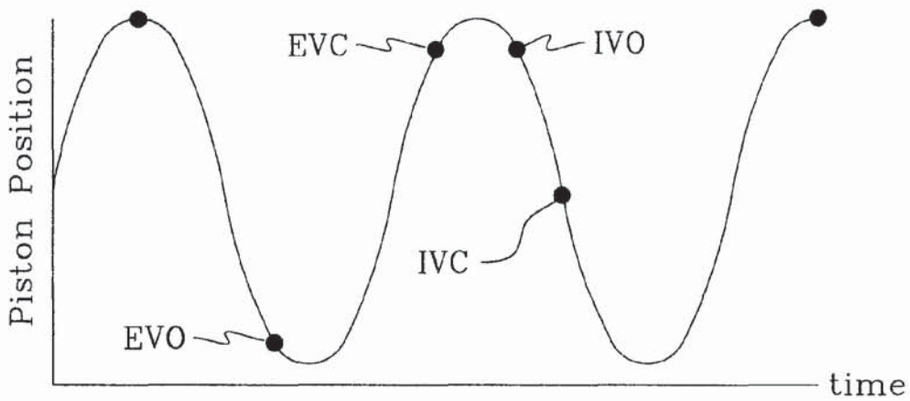


FIGURE 3B

METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

TECHNICAL FIELD

This invention relates generally to calculating commands for an engine and, more specifically, to calculating a valve timing command for an engine with variable timing valve actuators.

BACKGROUND

In gasoline engines of most vehicles, each cylinder of the engine cycles through four unique stages. In the first stage, an inlet valve opens and a piston draws air and fuel through the inlet valve and into the cylinder. The inlet valve closes and the piston reverses direction in the second stage to compress the air and fuel mixture. In the third stage, a spark combusts the mixture, which drives the piston (and powers the vehicle). An exhaust valve opens and the piston once again reverses direction, in the fourth stage, to push the combusted mixture through the exhaust valve and out of the cylinder.

The controlling of the inlet valve and the exhaust valve of each cylinder is a difficult task. The engine speed, which can exceed 6,000 rpm in most vehicles, dictates that the opening and closing of the inlet valve and the exhaust valve must be able to occur up to 50 times per second. In conventional engines, cams driven by the engine actuate the inlet valve and the exhaust valve. Modern research, however, has shown that fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine. Some variable valve timing engines have been proposed, but the theoretical fuel efficiency and output power of these engines have not yet been reached.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is schematic of a vehicle having an engine controlled with the method of the preferred embodiment;

FIG. **2** is a flowchart of the method of the preferred embodiment; and

FIG. **3** is two timing charts of the valves of an engine.

DESCRIPTION OF THE PREFERRED METHODS

The following description of the two preferred method of the invention is not intended to limit the invention to these preferred methods, but rather to enable any person skilled in the art of variable valve timing control to make and use this invention.

As shown in FIG. **1**, the preferred method of the invention has been specifically created to be performed by a control unit **10** to calculate valve timing commands for an engine **12** with electromagnetic valve actuators **14**. The method, however, may be performed by any suitable device to calculate valve timing commands for any suitable engine with any suitable variable timing valves.

As shown in FIG. **2**, the preferred method of the invention has six principle actions: obtaining an engine performance command **16**; receiving an environmental conditions signal **18**; determining a valve feedforward term **20**; receiving an engine performance feedback **22**; calculating a valve feedback term **24**; and calculating a valve timing command **26** based on the valve feedforward term and the valve feedback term. The method performed by the control unit may, of course, include other suitable actions before, during, or after these principle actions.

The action of obtaining an engine performance command **16** preferably includes receiving a vehicle performance command from a driver. Preferably, the vehicle performance command is received from the foot of a driver with the use of a conventional pedal **28**, as shown in FIG. **1**. Alternatively, the vehicle performance command could be received from the driver with the use of any suitable device. The action of obtaining an engine performance command also preferably includes deriving the engine performance command from the vehicle performance command. The engine performance command is preferably based on the vehicle performance command, but may alternatively be based on additional suitable factors, such as a traction control signal or a cruise control signal. The engine performance command is preferably a desired engine torque and, for this reason, the engine performance command may be thought of as an engine torque command. The engine performance command, however, may alternatively be another suitable variable, such as a desired engine acceleration.

The action of receiving an environmental conditions signal **18** preferably includes receiving an environmental conditions signal from an environmental sensor **30** in the vehicle. The environmental sensor **30** preferably senses the ambient temperature outside the vehicle and communicates this data to the control unit **10**, which uses the data to determine the valve feedforward term. Other information, such as the ambient pressure, may be useful in the determination of the valve feedforward term. For this reason, the environmental sensor **30** may alternatively sense other suitable information. The environmental sensor **30** is preferably a conventional environmental sensor, but may alternatively be any suitable device.

Similarly, the action of receiving an engine performance feedback **22** preferably includes receiving the engine performance feedback from an engine sensor **32** in the vehicle. The engine sensor **32** preferably senses the engine speed and communicates this data to the control unit **10**, which uses the data to determine the valve feedforward term and the valve feedback term. Other engine measurables, such as engine torque data, may be useful in the determination of the terms. For this reason, the engine sensor **32** may alternatively sense other suitable information. The engine sensor **32** is preferably a conventional engine sensor, but may alternatively be any suitable sensor.

The action of determining a valve feedforward term **20** preferably includes determining the valve feedforward term based on the engine torque command, the ambient temperature data, and the engine speed data. The determination, however, may be based on other suitable factors, such as engine torque data, air-fuel ratio data, engine combustion stability data, or ambient pressure data. The control unit **10** preferably includes a look-up table, which has been optimized for fuel efficiency, power output, and engine emissions based on various engine torque commands, various ambient temperature data, and various engine speed data (or engine torque data). The control unit **10** may alternatively be programmed to perform a real-time optimization of the fuel efficiency, power output, and engine emission (or any other suitable measurement) based on the engine torque command, the ambient temperature data, and the engine speed data (or any other suitable commands and measurables).

The action of calculating the valve feedback term **24** preferably includes comparing the engine performance com-

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mand and the engine performance feedback. By the definition of the term, the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any. The comparison and the calculation are preferably accomplished by the control unit **10**, but may alternatively be accomplished by a suitable separate device.

As shown in FIG. **3**A, the position of the piston in the cylinder can be traced as a sinusoidal wave over a time period. The events of the opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC") can be placed on this sinusoidal wave. As shown in FIG. **3**B, the events of the EVO, the EVC, the IVO, and the IVC may be shifted within the time period (note that the shift in the EVC and the IVO preferably mirror each another, but may alternatively be separately controlled). The adjustment of the timing of the EVO, the EVC/IVO, and the IVC when used partially, separately, or together may provide the desired fuel efficiency, power output, and emissions from the engine **12** of the vehicle. The action of calculating a valve timing command **26** preferably includes calculating an EVO command, an EVC/IVO command, and an IVC command. The control unit **10**, of course, may alternatively include other suitable parameters for the control of the variable timing valves.

The second preferred method of the invention includes the principle actions of the first preferred method and the additional principle action of receiving fuel conversion data and engine emissions data. These preferably include receiving the fuel conversion data and engine emissions data from suitable emission sensors (not shown) in the cylinder or the exhaust port of the engine **12**. The emission sensors preferably sense the amount of NO_x in the exhaust and communicates this data to the control unit **10**. The control unit **10** preferably uses this information to modify the output value from the look-up table, but may alternatively use this information to continually adjust the values in the look-up table. The control unit **10** may alternatively use this information as another factor in the determination of the valve feedback term. The emission sensors are preferably conventional emission sensors, but may alternatively be any suitable sensor.

As any person skilled in the art of variable valve engine control will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred methods without departing from the scope of this invention defined in the following claims.

We claim:

1. A method for calculating a valve timing command for an engine of a vehicle, comprising:

obtaining an engine performance command;

receiving an environmental conditions signal;

determining a valve feedforward term based on the engine performance command and the environmental conditions signal;

receiving an engine performance feedback;

calculating a valve feedback term based on the engine performance command and the engine performance feedback; and

calculating a valve timing command based on the valve feedforward term and the valve feedback term.

2. The method of claim **1** wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.

3. The method of claim **1** wherein said receiving an environmental conditions signal includes receiving ambient temperature data.

4. The method of claim **3** wherein said determining a valve feedforward term includes determining the valve feedforward term based on the ambient temperature data.

5. The method of claim **4** wherein said determining a valve feedforward term includes determining the valve feedforward term based on the engine performance feedback.

6. The method of claim **5** wherein said determining a valve feedforward term includes referencing a look-up table with the engine performance command, the ambient temperature, and the engine performance feedback.

7. The method of claim **1** wherein said receiving an engine performance feedback includes receiving engine speed data.

8. The method of claim **1** wherein said obtaining an engine performance command includes obtaining an engine torque command; and wherein receiving an engine performance feedback includes receiving engine torque data.

9. The method of claim **8** wherein calculating a valve feedback term includes calculating a valve feedback term based on the engine torque command and the engine torque data.

10. The method of claim **1** wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.

11. The method of claim **1** further comprising receiving fuel conversion data.

12. The method of claim **11** wherein said determining a valve feedforward term includes determining a valve feedforward term based on the fuel conversion data.

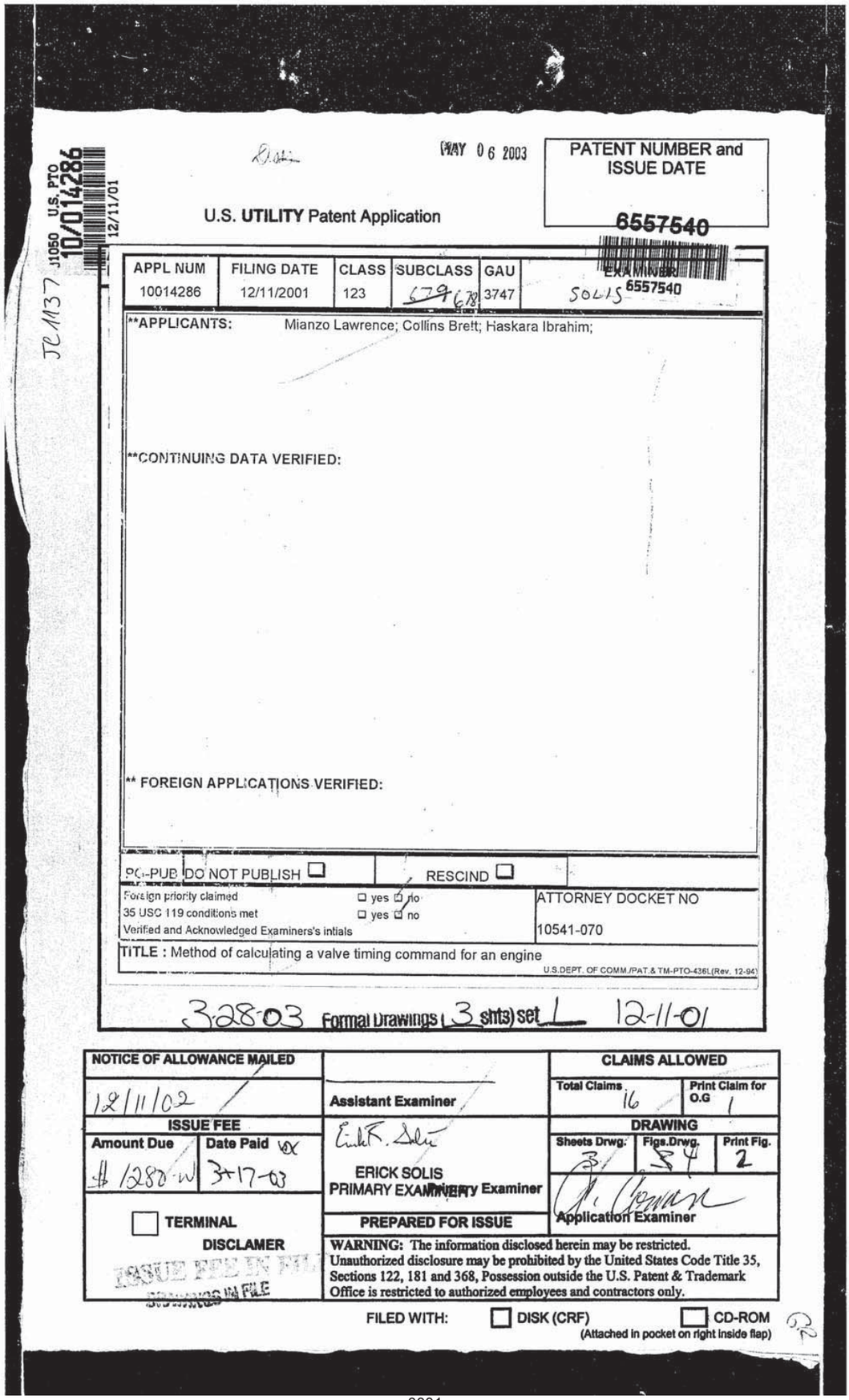
13. The method of claim **11** wherein said calculating a valve feedback term includes calculating a valve feedback term based on the fuel conversion data.

14. The method of claim **1** further comprising receiving engine emissions data.

15. The method of claim **14** wherein said determining a valve feedforward term includes determining a valve feedforward term based on the engine emissions data.

16. The method of claim **11** wherein said calculating a valve feedback term includes calculating a valve feedback term based on the engine emissions data.

* * * * *



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PATENT NUMBER and ISSUE DATE

6557540

U.S. PTO 10/014286 12/11/01 JC11137 J1050

U.S. **UTILITY** Patent Application

APPL NUM	FILING DATE	CLASS	SUBCLASS	GAU	EXAMINER
10014286	12/11/2001	123	679 678	3747	SOLIS

**APPLICANTS: Mianzo Lawrence; Collins Brett; Haskara Ibrahim;

**CONTINUING DATA VERIFIED:

** FOREIGN APPLICATIONS VERIFIED:

PG-PUB DO NOT PUBLISH ☐ RESCIND ☐

Foreign priority claimed ☐ yes ☑ no	ATTORNEY DOCKET NO
35 USC 119 conditions met ☐ yes ☑ no	10541-070
Verified and Acknowledged Examiners's intials	

TITLE : Method of calculating a valve timing command for an engine

U.S.DEPT. OF COMM./PAT.& TM-PTO-436L(Rev. 12-94)

3-28-03 Formal Drawings (3 shts) set 1 12-11-01

NOTICE OF ALLOWANCE MAILED		CLAIMS ALLOWED	
12/11/02	Assistant Examiner	Total Claims 16	Print Claim for O.G 1
ISSUE FEE		**DRAWING**	
Amount Due / Date Paid		Sheets Drwg. 3 / Figs.Drwg. 4 / Print Fig. 2	
# 1280.00 / 3-17-03	ERICK SOLIS PRIMARY EXAMINER Primary Examiner	Application Examiner	
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VW EX1002
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US PATENT NO. 6,557,540

9003.4-001

10014286

J1050 U.S. PTO
10/014286
12/11/01

INITIALS 1-15-02

CONTENTS

		Date Received (incl. C. of M.) or Date Mailed			Date Received (incl. C. of M.) or Date Mailed
1.	Application papers + PTO		31.		
2.	IDS	12-11-01	32.		
3.	NOA	12/11/02	33.		
4.	Prior Art	6-12-03	34.		
7/8 5.	misletter	7/8/03	35.		
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PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

12/18/2001 MAHMED1 00000001 061500 10014286
01 FC:101 740.00 CH

PTO-1556
(5/87)
*U.S. GPO: 2000-468-987/39595

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US PATENT NO. 6,557,540

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Bib Data Sheet

CONFIRMATION NO. 3146

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/014,286	12/11/2001 RULE	123	3747	10541-070

APPLICANTS

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Brett D. Collins, Ypsilanti, MI;
Ibrahim Haskara, Brownstown, MI;

** CONTINUING DATA ********** None ES

** FOREIGN APPLICATIONS ********** None ES

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		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed	☐ yes ☑ no	MI	3	16	1
35 USC 119 (a-d) conditions met	☐ yes ☐ no ☐ Met after Allowance				
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TITLE
Method of calculating a valve timing command for an engine

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12-14-01 A

J1054 U.S. PTO 12/11/01

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	10541-070
First Inventor	Mianzo et al.
Title	Method of Calculating a Valve Timing Command for an Engine
Express Mail Label No.	ET718954276US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231

1. [✓] Fee Transmittal Form (e.g., PTO/SB/17) *(Submit an original, and a duplicate for fee processing)*
2. [ ] Applicant claims small entity status. See 37 CFR 1.27.
3. [✓] Specification *[Total Pages 10]* *(preferred arrangement set forth below)*
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [✓] Drawing(s) *(35 U.S.C. 113)* *[Total Sheets 3]*
5. Oath or Declaration *[Total Pages 3]*
   a. [✓] Newly executed (original or copy)
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      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
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      ii. [ ] paper
   c. [ ] Statements verifying identity of above copies

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ACCOMPANYING APPLICATION PARTS

9. [✓] Assignment Papers (cover sheet & document(s))
10. [ ] 37 CFR 3.73(b) Statement *(when there is an assignee)* [✓] Power of Attorney
11. [ ] English Translation Document *(if applicable)*
12. [✓] Information Disclosure Statement (IDS)/PTO-1449 [✓] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [✓] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
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18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No.: ____ / ____

Prior application information: Examiner ____ Group / Art Unit ____

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19. CORRESPONDENCE ADDRESS

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Address			
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Name (Print/Type) Jeffrey M. Cox		Registration No. (Attorney/Agent)	42,445
Signature		Date	11 December 2001

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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
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FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT **$780.00**

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Mianzo
Examiner Name	
Group Art Unit	
Attorney Docket No.	10541-070

METHOD OF PAYMENT

1. ☒ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit Account Number: 06-1500

Deposit Account Name:

☒ Charge Any Additional Fee Required Under 37 CFR §§ 1.16 and 1.17

☐ Applicant claims small entity status. See 37 CFR § 1.27

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	740	201	370	Utility filing fee	740.00
106	330	206	165	Design filing fee	
107	510	207	255	Plant filing fee	
108	740	208	370	Reissue filing fee	
114	160	214	80	Provisional filing fee	
				SUBTOTAL (1)	$740.00

2. EXTRA CLAIM FEES

	Extra Claims			Fee from below	Fee Paid
Total Claims	16	-20** =	0	X =	0.00
Independent Claims	1	- 3** =	0	X =	0.00
Multiple Dependent				=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	84	202	42	Independent claims in excess of 3
104	280	204	140	Multiple dependent claim, if not paid
109	84	209	42	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent
				SUBTOTAL (2) $0.00

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non - English specification	
147	2,520	147	2,520	For filing a request for *ex parte* reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	920	217	460	Extension for reply within third month	
118	1,440	218	720	Extension for reply within fourth month	
128	1,960	228	980	Extension for reply within fifth month	
119	320	219	160	Notice of Appeal	
120	320	220	160	Filing a brief in support of an appeal	
121	280	221	140	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,280	241	640	Petition to revive - unintentional	
142	1,280	242	640	Utility issue fee (or reissue)	
143	460	243	230	Design issue fee	
144	620	244	310	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR § 1.17(q)	
126	180	126	180	Submission of Information Disclosure Statement	
581	40	581	40	Recording each patent assignment per property (times number of properties)	40.00
146	740	246	370	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	740	249	370	For each additional invention to be examined (37 CFR § 1.129(b))	
179	740	279	370	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	
Other fee (specify)					

*Reduced by Basic Filing Fee Paid SUBTOTAL (3) $40.00

SUBMITTED BY

Name (Print/Type)	Jeffrey M. Cox	Registration No. (Attorney/Agent)	42,445	Complete (if applicable) Telephone	(734) 302-6000
Signature				Date	11 December 2001

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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11 December 2001

Commissioner of Patents
Box Patent Application
Washington, D.C. 20231

Sir:

EXPRESS MAILING CERTIFICATE

Applicant(s):	Mianzo et al
Title:	Method of Calculating a Valve Timing Command for an Engine
Attorney Docket:	10541-070
Attorney:	Jeffrey M. Cox

"Express Mail" Mailing Label No. ET718954276US

Date of Deposit .....11 December 2001

I hereby certify and verify that the accompanying **Utility Patent Application Transmittal, Fee Transmittal, Specification on ten (10) pages, Formal Drawings on three (3) sheets, Declaration and Power of Attorney, Recordation Cover Sheet, Assignment, Information Disclosure Statement, PTO Form 1449 with references, and two (2) Return Postcards** are being deposited with the United States Postal Service Express Mail Post Office To Addressee service under 37 C.F.R. 1.10 on the date indicated above and are addressed to Commissioner for Patents, Box Patent Application, Washington, D.C. 20231.

Signature of Person Mailing Document(s)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

TECHNICAL FIELD

[0001] This invention relates generally to calculating commands for an engine and, more specifically, to calculating a valve timing command for an engine with variable timing valve actuators.

BACKGROUND

[0002] In gasoline engines of most vehicles, each cylinder of the engine cycles through four unique stages. In the first stage, an inlet valve opens and a piston draws air and fuel through the inlet valve and into the cylinder. The inlet valve closes and the piston reverses direction in the second stage to compress the air and fuel mixture. In the third stage, a spark combusts the mixture, which drives the piston (and powers the vehicle). An exhaust valve opens and the piston once again reverses direction, in the fourth stage, to push the combusted mixture through the exhaust valve and out of the cylinder.

[0003] The controlling of the inlet valve and the exhaust valve of each cylinder is a difficult task. The engine speed, which can exceed 6,000 rpm in most vehicles, dictates that the opening and closing of the inlet valve and the exhaust valve must be able to occur up to 50 times per second. In conventional engines, cams driven by the engine actuate the inlet valve and the exhaust valve. Modern research, however, has shown that fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the

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engine. Some variable valve timing engines have been proposed, but the theoretical fuel efficiency and output power of these engines have not yet been reached.

BRIEF DESCRIPTION OF THE FIGURES

[0004] FIGURE 1 is schematic of a vehicle having an engine controlled with the method of the preferred embodiment;

[0005] FIGURE 2 is a flowchart of the method of the preferred embodiment; and

[0006] FIGURE 3 is two timing charts of the valves of an engine.

DESCRIPTION OF THE PREFERRED METHODS

[0007] The following description of the two preferred method of the invention is not intended to limit the invention to these preferred methods, but rather to enable any person skilled in the art of variable valve timing control to make and use this invention.

[0008] As shown in FIGURE 1, the preferred method of the invention has been specifically created to be performed by a control unit 10 to calculate valve timing commands for an engine 12 with electromagnetic valve actuators 14. The method, however, may be performed by any suitable device to calculate valve timing commands for any suitable engine with any suitable variable timing valves.

[0009] As shown in FIGURE 2, the preferred method of the invention has six principle actions: obtaining an engine performance command 16; receiving an environmental conditions signal 18; determining a valve feedforward term 20; receiving an engine performance feedback 22; calculating a valve feedback term

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24; and calculating a valve timing command 26 based on the valve feedforward term and the valve feedback term. The method performed by the control unit may, of course, include other suitable actions before, during, or after these principle actions.

[00010] The action of obtaining an engine performance command 16 preferably includes receiving a vehicle performance command from a driver. Preferably, the vehicle performance command is received from the foot of a driver with the use of a conventional pedal 28, as shown in FIGURE 1. Alternatively, the vehicle performance command could be received from the driver with the use of any suitable device. The action of obtaining an engine performance command also preferably includes deriving the engine performance command from the vehicle performance command. The engine performance command is preferably based on the vehicle performance command, but may alternatively be based on additional suitable factors, such as a traction control signal or a cruise control signal. The engine performance command is preferably a desired engine torque and, for this reason, the engine performance command may be thought of as an engine torque command. The engine performance command, however, may alternatively be another suitable variable, such as a desired engine acceleration.

[00011] The action of receiving an environmental conditions signal 18 preferably includes receiving an environmental conditions signal from an environmental sensor 30 in the vehicle. The environmental sensor 30 preferably senses the ambient temperature outside the vehicle and communicates this data to the control unit 10, which uses the data to determine the valve feedforward term. Other information, such as the ambient pressure, may be useful in the determination

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of the valve feedforward term. For this reason, the environmental sensor 30 may alternatively sense other suitable information. The environmental sensor 30 is preferably a conventional environmental sensor, but may alternatively be any suitable device.

[00012] Similarly, the action of receiving an engine performance feedback 22 preferably includes receiving the engine performance feedback from an engine sensor 32 in the vehicle. The engine sensor 32 preferably senses the engine speed and communicates this data to the control unit 10, which uses the data to determine the valve feedforward term and the valve feedback term. Other engine measurables, such as engine torque data, may be useful in the determination of the terms. For this reason, the engine sensor 32 may alternatively sense other suitable information. The engine sensor 32 is preferably a conventional engine sensor, but may alternatively be any suitable sensor.

[00013] The action of determining a valve feedforward term 20 preferably includes determining the valve feedforward term based on the engine torque command, the ambient temperature data, and the engine speed data. The determination, however, may be based on other suitable factors, such as engine torque data, air-fuel ratio data, engine combustion stability data, or ambient pressure data. The control unit 10 preferably includes a look-up table, which has been optimized for fuel efficiency, power output, and engine emissions based on various engine torque commands, various ambient temperature data, and various engine speed data (or engine torque data). The control unit 10 may alternatively be programmed to perform a real-time optimization of the fuel efficiency, power output, and engine emission (or any other suitable measurement) based on the engine

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torque command, the ambient temperature data, and the engine speed data (or any other suitable commands and measurables).

[00014] The action of calculating the valve feedback term 24 preferably includes comparing the engine performance command and the engine performance feedback. By the definition of the term, the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any. The comparison and the calculation are preferably accomplished by the control unit 10, but may alternatively be accomplished by a suitable separate device.

[00015] As shown in FIGURE 3A, the position of the piston in the cylinder can be traced as a sinusoidal wave over a time period. The events of the opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC") can be placed on this sinusoidal wave. As shown in FIGURE 3B, the events of the EVO, the EVC, the IVO, and the IVC may be shifted within the time period (note that the shift in the EVC and the IVO preferably mirror each another, but may alternatively be separately controlled). The adjustment of the timing of the EVO, the EVC/IVO, and the IVC when used partially, separately, or together may provide the desired fuel efficiency, power output, and emissions from the engine 12 of the vehicle. The action of calculating a valve timing command 26 preferably includes calculating an EVO command, an EVC/IVO command, and an IVC command. The control unit 10, of course, may alternatively include other suitable parameters for the control of the variable timing valves.

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[00016] The second preferred method of the invention includes the principle actions of the first preferred method and the additional principle action of receiving fuel conversion data and engine emissions data. These preferably include receiving the fuel conversion data and engine emissions data from suitable emission sensors (not shown) in the cylinder or the exhaust port of the engine 12. The emission sensors preferably sense the amount of NO_x in the exhaust and communicates this data to the control unit 10. The control unit 10 preferably uses this information to modify the output value from the look-up table, but may alternatively use this information to continually adjust the values in the look-up table. The control unit 10 may alternatively use this information as another factor in the determination of the valve feedback term. The emission sensors are preferably conventional emission sensors, but may alternatively be any suitable sensor.

[00017] As any person skilled in the art of variable valve engine control will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred methods without departing from the scope of this invention defined in the following claims.

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CLAIMS

We Claim:

1. A method for calculating a valve timing command for an engine of a vehicle, comprising:

obtaining an engine performance command;

receiving an environmental conditions signal;

determining a valve feedforward term based on the engine performance command and the environmental conditions signal;

receiving an engine performance feedback;

calculating a valve feedback term based on the engine performance command and the engine performance feedback; and

calculating a valve timing command based on the valve feedforward term and the valve feedback term.

2. The method of Claim 1 wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.

3. The method of Claim 1 wherein said receiving an environmental conditions signal includes receiving ambient temperature data.

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4. The method of Claim 3 wherein said determining a valve feedforward term includes determining the valve feedforward term based on the ambient temperature data.

5. The method of Claim 4 wherein said determining a valve feedforward term includes determining the valve feedforward term based on the engine performance feedback.

6. The method of Claim 5 wherein said determining a valve feedforward term includes referencing a look-up table with the engine performance command, the ambient temperature, and the engine performance feedback.

7. The method of Claim 1 wherein said receiving an engine performance feedback includes receiving engine speed data.

8. The method of Claim 1 wherein said obtaining an engine performance command includes obtaining an engine torque command; and wherein receiving an engine performance feedback includes receiving engine torque data.

9. The method of Claim 8 wherein calculating a valve feedback term includes calculating a valve feedback term based on the engine torque command and the engine torque data.

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10. The method of Claim 1 wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.

11. The method of Claim 1 further comprising receiving fuel conversion data.

12. The method of Claim 11 wherein said determining a valve feedforward term includes determining a valve feedforward term based on the fuel conversion data.

13. The method of Claim 11 wherein said calculating a valve feedback term includes calculating a valve feedback term based on the fuel conversion data.

14. The method of Claim 1 further comprising receiving engine emissions data.

15. The method of Claim 14 wherein said determining a valve feedforward term includes determining a valve feedforward term based on the engine emissions data.

16. The method of Claim 11 wherein said calculating a valve feedback term includes calculating a valve feedback term based on the engine emissions data.

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ABSTRACT

[00018] A method to calculate valve timing commands for an engine with variable valve timing is hereby disclosed. The method includes determining a valve feedforward term based on an engine performance command and an environmental conditions signal, calculating a valve feedback term based on the engine performance command and an engine performance feedback, and calculating a valve timing command based on the valve feedforward term and the valve feedback term.

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PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Attorney Docket No.: 10541-070
Visteon Case No.: V200-0655

DECLARATION AND POWER OF ATTORNEY ORIGINAL APPLICATION

As a below named inventor, I hereby declare:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor or an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled:

METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge my duty to disclose to the United States Patent and Trademark Office all information that I know to be material to the patentability of this application as defined in Title 37 C.F.R. § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s):			Priority Not Claimed
_____ (Number)	_____ (Country)	_____ (Filing Date)	☐
_____ (Number)	_____ (Country)	_____ (Filing Date)	☐
_____ (Number)	_____ (Country)	_____ (Filing Date)	☐

I hereby claim the benefit under 35 U.S. C. Section 119(e) of any United States provisional application(s) listed below:

_____ (Application Serial No.)	_____ (Filing Date)
_____ (Application Serial No.)	_____ (Filing Date)
_____ (Application Serial No.)	_____ (Filing Date)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

I hereby claim the benefit un)5 U.S.C. Section 120 of any United St applications(s), or Section 365(c) of any PCT International Application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C.F.R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorneys, agents, and each shareholder, attorney of counsel, associate, and employee of Brinks Hofer Gilson & Lione, who is a registered Patent Attorney or registered Patent Agent, my attorney with full power of substitution and revocation to prosecute this application and transact all business in the United States Patent and Trademark Office connected therewith and to act on my behalf before the competent International Authorities in connection with any and all international applications filed by me.

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David D. Murray, Reg. No. 28,647
Eric J. Sosenko, Reg. No. 34,440
Jeffrey M. Cox, Reg. No. 42,445
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J. Matthew Buchanan, Reg. No. 47,459
Sujatha Subramaniam, Reg. No. P48,739
Larry I. Shelton, Reg. No. 45,100
John Kajander, Reg. No. 47,693

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29074
PATENT & TRADEMARK OFFICE

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2

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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Second inventor's signature	Brett D Collins — Date 11/01/01
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Post Office Address	SAME AS RESIDENCE ADDRESS

Full name of third inventor, if any	Ibrahim Haskara
Third inventor's signature	Date 11/02/01
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Citizenship	TR
Post Office Address	SAME AS RESIDENCE ADDRESS

PTO/SB/01 (08-00)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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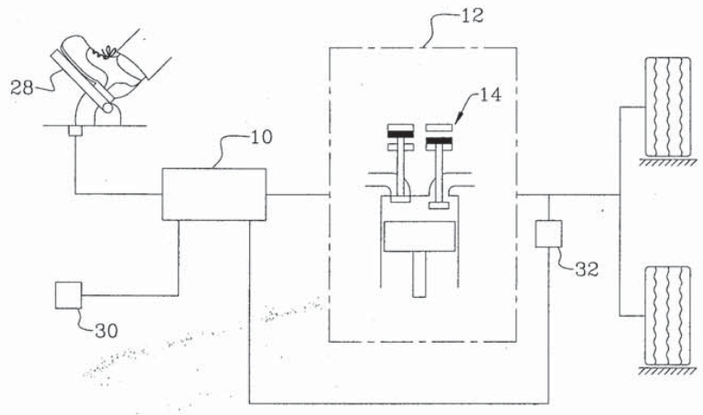


FIGURE 1

Petitioner's Exhibit 1002 - US Patent No. 6,557,540

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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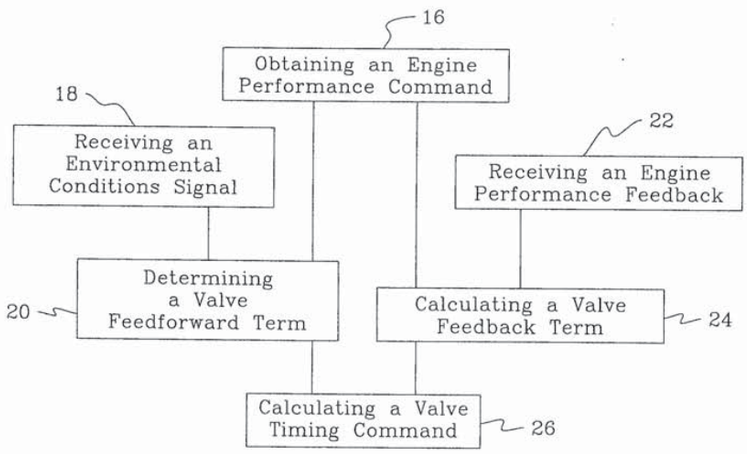


FIGURE 2

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

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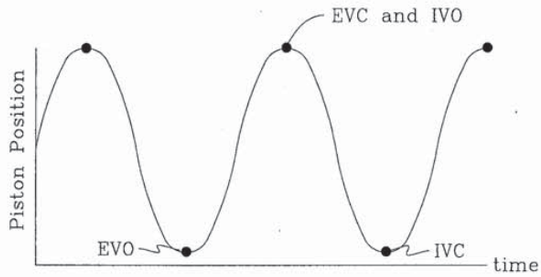


FIGURE 3A

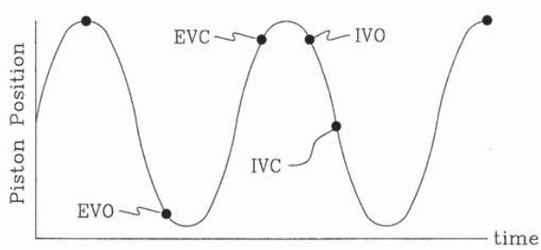


FIGURE 3B

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

3700

1-3

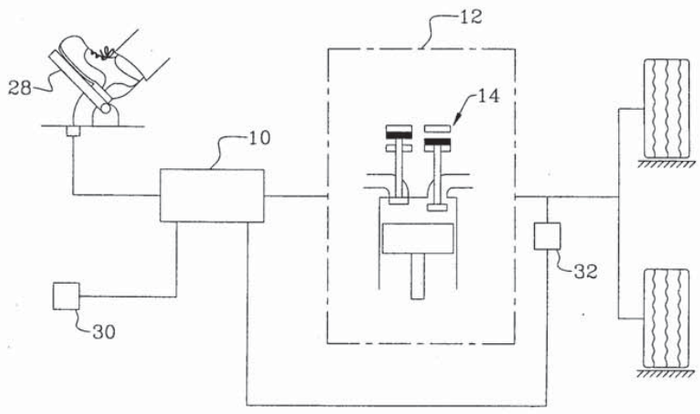


FIGURE 1

FILED: 05-13-03

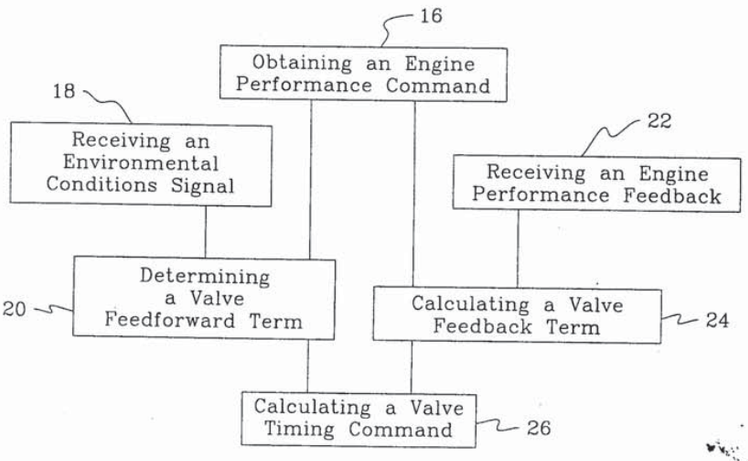


FIGURE 2

PATENT-2001-070

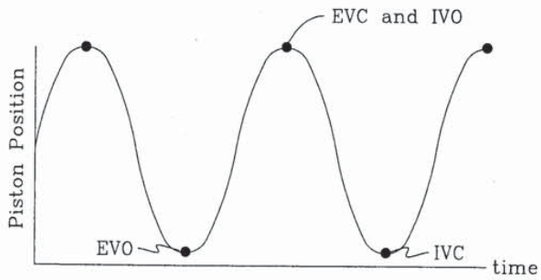


FIGURE 3A

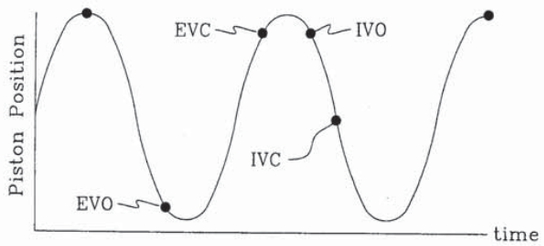


FIGURE 3B

PATENT
Attorney Docket No.: 10541-070

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#2

J1050 U.S. PTO
10/014286
12/11/01

Group Art Unit:	Unknown	
Examiner:	Unknown	
Inventors:	PENG, et al.	
Serial No:	Unknown	
Filed:	Concurrent Herewith	
For:	METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE	

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
Washington, DC 20231

Sir:

Under the duties of disclosure, candor, and good faith of 37 CFR §1.56, the Applicant hereby submits the references listed on the attached PTO-1449 form for consideration by the Examiner. In the opinion of the Applicant, the pending claims are patentably distinct from the listed references.

Under 37 CFR §1.97(b)(1), no fee should be required. If a fee is required, however, please charge any such fee pursuant to 37 CFR §1.16 or §1.17 to deposit account no. 06-1500.

Respectfully submitted,

Date: 11 December 2001

Jeffrey M. Cox
Reg. No. 42,445
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. Box 10395
Chicago, IL 60610
(734) 302-6000

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

INFORMATION DISCLOSURE CITATION *(Use several sheets if necessary)*	Docket Number (Optional) 10541-070	Application Number Unknown
	Applicant(s) Peng et al.	
	Filing Date Concurrent Herewith	Group Art Unit Unknown 3747

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL	REF	DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE
ES		4,700,684	10/20/87	Pischinger et al.			
ES		5,743,221	04/28/98	Schmitz			
ES		5,752,491	05/19/98	Schmitz et al.			

J1050 U.S. PTO 10/014286 12/11/01

FOREIGN PATENT DOCUMENTS

	REF	DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO

OTHER DOCUMENTS *(Including Author, Title, Date, Pertinent. Pages, Etc)*

EXAMINER	DATE CONSIDERED
Erich R Sché	12/9/2002

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP Section 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

FORM PTO-A820 COMMERCE (also form PTO-1449) P09A/REV04 Patent and Trademark Office*U.S. DEPARTMENT OF

SHEET 1 OF 1

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Notice of Allowability	Application No.	Applicant(s)	
	10/014,286	MIANZO ET AL.	
	Examiner	Art Unit	
	Erick R Solis	3747	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the filing of 11 December 2001*.
2. ☒ The allowed claim(s) is/are *1-16*.
3. ☒ The drawings filed on *11 December 2001* are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
   (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

8. ☐ CORRECTED DRAWINGS must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No. ____.
   (b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.
   (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the top margin (not the back) of each sheet. The drawings should be filed as a separate paper with a transmittal letter addressed to the Official Draftsperson.

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1☒ Notice of References Cited (PTO-892)
2☐ Notice of Informal Patent Application (PTO-152)
3☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
4☐ Interview Summary (PTO-413), Paper No.____ .
5☒ Information Disclosure Statements (PTO-1449), Paper No. 2.
6☐ Examiner's Amendment/Comment
7☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
8☐ Examiner's Statement of Reasons for Allowance
9☐ Other .

Erick R. Solis
Primary Examiner
Art Unit: 3747

U.S. Patent and Trademark Office
PTO-37 (Rev. 04-01) **Notice of Allowability** Part of Paper No. 3 .

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

Notice of References Cited	Application/Control No. 10/014,286	Applicant(s)/Patent Under Reexamination MIANZO ET AL.	
	Examiner Erick R Solis	Art Unit 3747	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
X	A	US-6,196,174	03-2001	Wada et al.	123/90.15
X	B	US-6,053,137	04-2000	Trzmiel et al.	123/90.17
X	C	US-2002/0092488	07-2002	Aoyama et al.	123/90.16
X	D	US-2001/0013324	08-2001	Yoshizawa et al.	123/90.16
X	E	US-2001/0004884	06-2001	Tachibana et al.	123/90.15
X	F	US-6,330,869	12-2001	Yoshiki et al.	123/90.15
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

29074 7590 12/11/2002

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

EXAMINER	
SOLIS, ERICK R	
ART UNIT	**CLASS-SUBCLASS**
3747	123-679000

DATE MAILED: 12/11/2002

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

TITLE OF INVENTION: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1280	$300	$1580	03/11/2003

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:
A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status is changed, pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above and notify the United States Patent and Trademark Office of the change in status, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check the box below and enclose the PUBLICATION FEE and 1/2 the ISSUE FEE shown above.

☐ Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (REV. 04-02) Approved for use through 01/31/2004.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Box ISSUE FEE**
Commissioner for Patents
Washington, D.C. 20231
Fax (703)746-4000

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

29074 7590 12/11/2002

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above, or being facsimile transmitted to the USPTO, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

TITLE OF INVENTION: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1280	$300	$1580	03/11/2003

EXAMINER	ART UNIT	CLASS-SUBCLASS
SOLIS, ERICK R	3747	123-679000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1_____

2_____

3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the USPTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) ❑ individual ❑ corporation or other private group entity ❑ government

4a. The following fee(s) are enclosed:

❑ Issue Fee

❑ Publication Fee

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s):

❑ A check in the amount of the fee(s) is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Commissioner is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number _____(enclose an extra copy of this form).

Commissioner for Patents is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.

(Authorized Signature) (Date)

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Washington, DC 20231.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMIT THIS FORM WITH FEE(S)

PTOL-85 (REV. 04-02) Approved for use through 01/31/2004. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

29074 7590 12/11/2002

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

EXAMINER	
SOLIS, ERICK R	
ART UNIT	**PAPER NUMBER**
3747	

DATE MAILED: 12/11/2002

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The patent term adjustment to date is 0 days. If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the term adjustment will be 0 days.

If a continued prosecution application (CPA) was filed in the above-identified application, the filing date that determines patent term adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) system. (http://pair.uspto.gov)

Any questions regarding the patent term extension or adjustment determination should be directed to the Office of Patent Legal Administration at (703)305-1383.

PTOL-85 (REV. 04-02) Approved for use through 01/31/2004.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

29074 7590 12/11/2002

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611
UNITED STATES

EXAMINER	
SOLIS, ERICK R	
ART UNIT	**PAPER NUMBER**
3747	

DATE MAILED: 12/11/2002

Notice of Fee Increase on January 1, 2003

If a reply to a "Notice of Allowance and Fee(s) Due" is filed in the Office on or after January 1, 2003, then the amount due will be higher than that set forth in the "Notice of Allowance and Fee(s) Due" since there will be an increase in fees effective on January 1, 2003. See Revision of Patent and Trademark Fees for Fiscal Year 2003; Final Rule, 67 Fed. Reg. 70847, 70849 (November 27, 2002).

The current fee schedule is accessible from: http://www.uspto.gov/main/howtofees.htm.

If the issue fee paid is the amount shown on the "Notice of Allowance and Fee(s) Due," but not the correct amount in view of the fee increase, a "Notice to Pay Balance of Issue Fee" will be mailed to applicant. In order to avoid processing delays associated with mailing of a "Notice to Pay Balance of Issue Fee," if the response to the Notice of Allowance and Fee(s) due form is to be filed on or after January 1, 2003 (or mailed with a certificate of mailing on or after January 1, 2003), the issue fee paid should be the fee that is required at the time the fee is paid. If the issue fee was previously paid, and the response to the "Notice of Allowance and Fee(s) Due" includes a request to apply a previously-paid issue fee to the issue fee now due, then the difference between the issue fee amount at the time the response is filed and the previously paid issue fee should be paid. See Manual of Patent Examining Procedure, Section 1308.01 (Eighth Edition, August 2001).

Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

PTOL-85 (REV. 04-02) Approved for use through 01/31/2004.

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

OIPE JC66
JUN 12 2003
PATENT & TRADEMARK OFFICE

3747

Attorney Docket No.: 10541-070

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Mianzo et al.

Serial No.: 10/014,286
Filed: December 11, 2001
For: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

Examiner: Erick R. Solis
Group Art Unit: 3747

TRANSMITTAL

Commissioner for Patents
U.S. Patent and Trademark Office
P. O. Box 1450
Alexandria, VA 22313-1450

RECEIVED
JUN 16 2003
TECHNOLOGY CENTER R3700

Sir:

Attached is/are:

- ☒ Information Disclosure Statement
- ☒ Form PTO - 1449 with copy of references
- ☐
- ☒ Return Receipt Postcard

Fee calculation and payment:

- ☐ No additional fee is required.
- ☐ An extension fee in an amount of $_____ for a _____-month extension of time under 37 C.F.R. § 1.136(a).
- ☒ A petition or processing fee in an amount of $180.00 under 37 C.F.R. § 1.17(p).
- ☐ An additional filing fee has been calculated as shown below:

	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra
Total		Minus		
Indep.		Minus		
First Presentation of Multiple Dep. Claim				

Small Entity		or	Other Than Small Entity	
Rate	Add'l Fee		Rate	Add'l Fee
x $9=			x $18=	
x 42=			x $84=	
+$140=			+ $280=	
Total	$		Total	$

- ☐ A check in the amount of $_____ to cover the above-identified fee(s) is enclosed.
- ☒ Please charge Deposit Account No. 06-1500 (VISTEON GLOBAL TECHNOLOGIES, INC.) in the amount of $180.00. A copy of this Transmittal is enclosed for this purpose.
- ☒ The Commissioner is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 06-1500. A copy of this Transmittal is enclosed for this purpose.

Respectfully submitted,

June 9, 2003
Date

Eric J. Sosenko (Reg. No. 34,440)
☒ Attorney/Agent Of Record
☐ 37 C.F.R. 1.34(a)

CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, U.S. Patent and Trademark Office, P. O. Box 1450, Alexandria, VA 22313-1450, on the below date:

Date: June 9, 2003 Name: Ashley L. Rhoades Signature: Ashley L. Rhoades

BRINKS HOFER GILSON & LIONE
P.O. Box 10395
Chicago, IL 60610

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

PE JC66
JUN 12 2003
PATENT & TRADEMARK OFFICE

Attorney Docket No.: 10541-070

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Mianzo et al.	
Serial No.: 10/014,286	Examiner: Erick R. Solis
Filed: December 11, 2001	Group Art Unit: 3747
For: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE	

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
U.S. Patent and Trademark Office
P. O. Box 1450
Alexandria, VA 22313-1450

RECEIVED
JUN 16 2003
TECHNOLOGY CENTER R3700

Sir:

In accordance with the duty of disclosure under 37 C.F.R. §1.56, and more particularly in accordance with 37 C.F.R. §1.97(d), Applicant cites the following references (each listed for the Examiner's convenience on the enclosed Form PTO-1449):

DOCUMENT NUMBER	DATE	NAME
5,123,397	06/23/1992	Richeson
5,967,115	10/19/1999	Konopka et al.

A copy of each listed reference for which a copy is required under 37 C.F.R. §1.98(a)(2) is also enclosed. Applicant respectfully solicits the Examiner's consideration of the listed references and entry thereof into the record of this application.

06/13/2003 SSESHE1 00000060 061500 10014286
01 FC:1806 180.00 CH

BRINKS HOFER GILSON & LIONE
P.O. Box 10395
Chicago, IL 60610

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

The PTO Form 1449 Attached with this Paper was Missing from the Official PTO File Wrapper

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

M

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

29074 7590 07/08/2003

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

EXAMINER	
SOLIS, ERICK R	

ART UNIT	PAPER NUMBER
3747	5

DATE MAILED: 07/08/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Tra aark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

Ko

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.

EXAMINER	
ART UNIT	PAPER
	5

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

Aknowledgement of Receipt of Information Disclosure Statement

The Information Disclosure Statement received on 12 June 2003 has been received and entered into the file of this application. This Information Disclosure Statement does not comply with MPEP 609 as it has been received after the payment of the issue fee and as a matter of fact after the publication of the patent. Therefore, the cited references have not been considered.

Erick R Solis
Primary Examiner
Art Unit: 3747
(703) 308-2651

PTO-90C (Rev.04-03)

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Box ISSUE FEE
Commissioner for Patents
Washington, D.C. 20231
Fax (703)746-4000

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

29074 7590 12/11/2002

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60611

OIPE JC140 MAR 17 2003 PATENT & TRADEMARK OFFICE

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above, or being facsimile transmitted to the USPTO, on the date indicated below.

Jeffrey M. Cox	(Depositor's name)
	(Signature)
10 March 2003	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/014,286	12/11/2001	Lawrence A. Mianzo	10541-070	3146

TITLE OF INVENTION: METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	~~$1290~~ $1300	$300	~~$1590~~ $1600	03/11/2003

EXAMINER	ART UNIT	CLASS-SUBCLASS
SOLIS, ERICK R	3747	123-679000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Brinks Hofer Gilson & Lione
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

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(A) NAME OF ASSIGNEE: Visteon Global Technologies, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Dearborn, Michigan

Please check the appropriate assignee category or categories (will not be printed on the patent) ☐ individual ☒ corporation or other private group entity ☐ government

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☒ Publication Fee
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(Authorized Signature)

(Date) 3/10/2003

Jeffrey M. Cox
Reg. No. 42,445

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10/014,286

03/20/2003 STEUMEL2 00000072 061500 10014286

01 FC:1501 1300.00 CH
02 FC:1504 300.00 CH

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PTOL-85 (REV. 04-02) Approved for use through 01/31/2004. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10014286

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	16	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	16 minus 20=	* —
INDEPENDENT CLAIMS	1 minus 3 =	* —
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	740

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
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RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
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X42=		OR	X84=	
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* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 8/01) ☆U.S.GPO:2001 482-124 / 59197 Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

CLAIMS ONLY

SERIAL NO.	FILING DATE
APPLICANT(S)	

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
1	1					
2		1				
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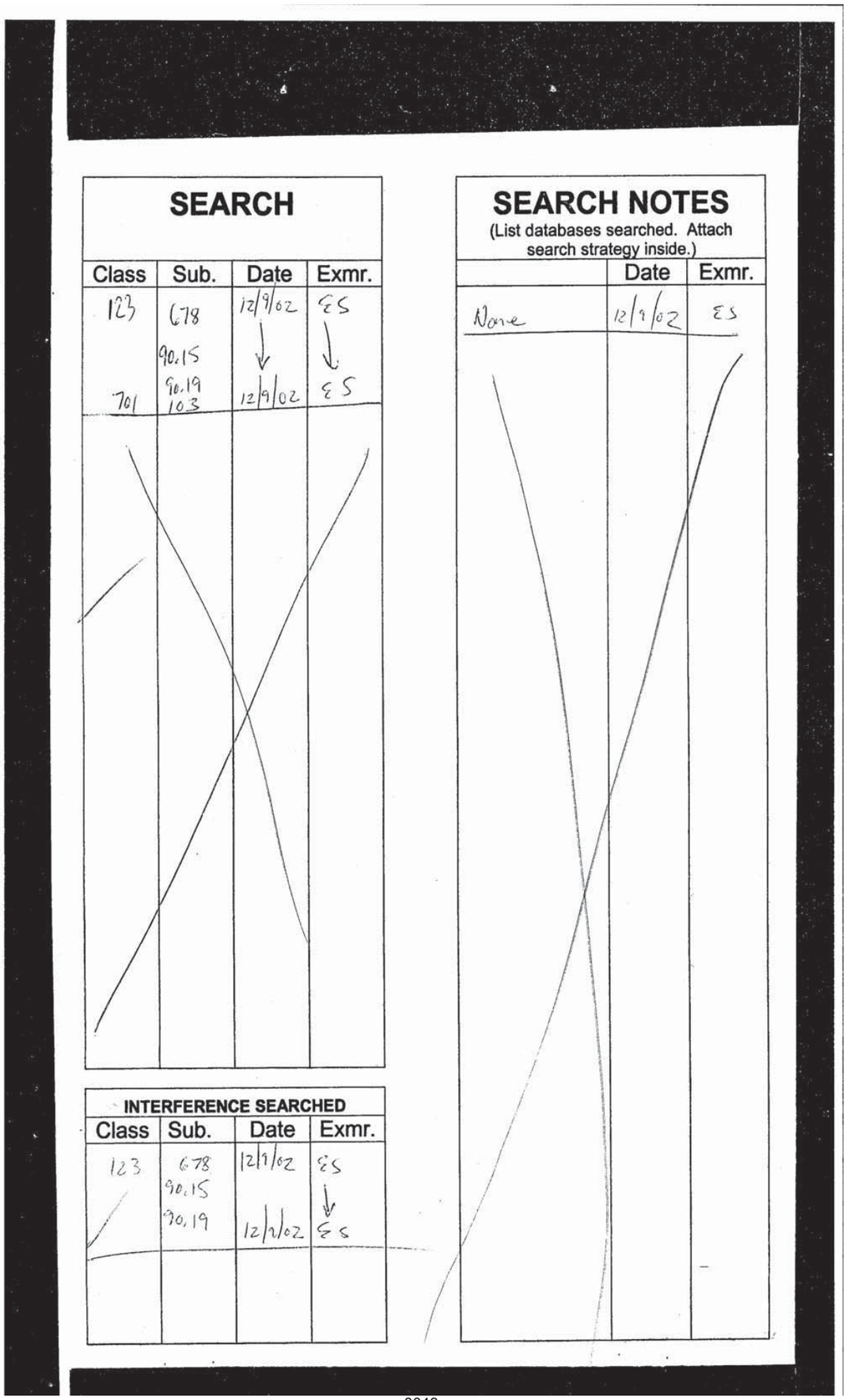
* *MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS*

FORM PTO-2022 (1-98)

U.S.DEPARTMENT OF COMMERCE
Patent and Trademark Office

*U.S. Government Printing Office: 1998 - 433-214/70303

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540



SEARCH

Class	Sub.	Date	Exmr.
123	678	12/9/02	ES
	90.15	↓	↓
701	90.19 103	12/9/02	ES

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.
123	678 90.15 90.19	12/9/02 12/9/02	ES ↓ ES

SEARCH NOTES

(List databases searched. Attach search strategy inside.)

	Date	Exmr.
None	12/9/02	ES

ISSUE SLIP STAPLE AREA (for additional cross-references)

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)	
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)
123	878	123	90.15
INTERNATIONAL CLASSIFICATION		701	103
F 0 1 L	1134		
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INDEX OF CLAIMS

✓ ..... Rejected – (Through numeral) ... Canceled N ..... Non-elected A ..... Appeal
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Claim	Date									
Final	Original									
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If more than 150 claims or 9 actions staple additional sheet here

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

US006557540B1

(12) **United States Patent**
Mianzo et al.

(10) **Patent No.: US 6,557,540 B1**
(45) **Date of Patent: May 6, 2003**

(54) **METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE**

(75) Inventors: **Lawrence A. Mianzo**, Plymouth, MI (US); **Brett D. Collins**, Ypsilanti, MI (US); **Ibrahim Haskara**, Brownstown, MI (US)

(73) Assignee: **Visteon Global Technologies, Inc.**, Dearborn, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/014,286**

(22) Filed: **Dec. 11, 2001**

(51) **Int. Cl.**[7] **F01L 1/34**
(52) **U.S. Cl.** **123/678**; 123/90.15; 701/103
(58) **Field of Search** 123/678, 90.15, 123/90.19; 701/103

(56) **References Cited**

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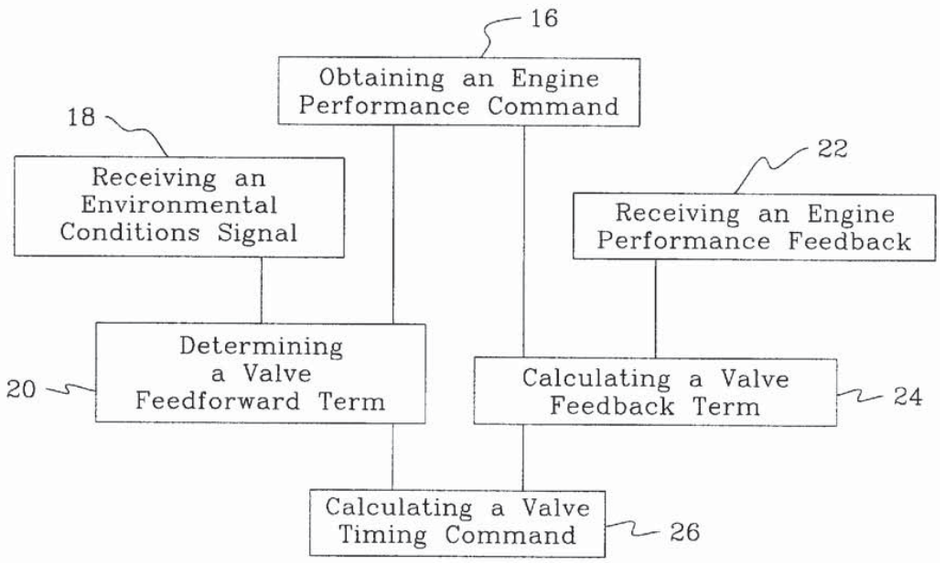
* cited by examiner

Primary Examiner—Erick Solis
(74) *Attorney, Agent, or Firm*—Brinks Hofer Gilson & Lione

(57) **ABSTRACT**

A method to calculate valve timing commands for an engine with variable valve timing is hereby disclosed. The method includes determining a valve feedforward term based on an engine performance command and an environmental conditions signal, calculating a valve feedback term based on the engine performance command and an engine performance feedback, and calculating a valve timing command based on the valve feedforward term and the valve feedback term.

16 Claims, 3 Drawing Sheets



PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

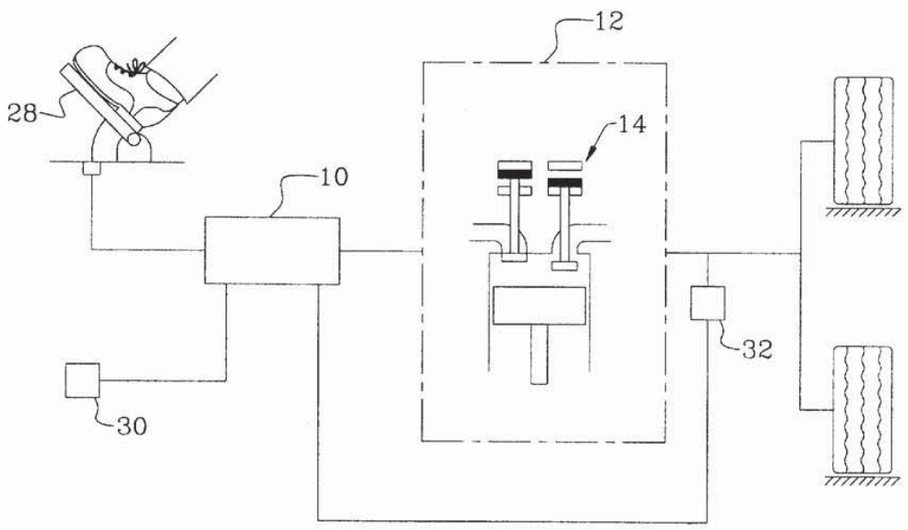


FIGURE 1

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US PATENT NO. 6,557,540

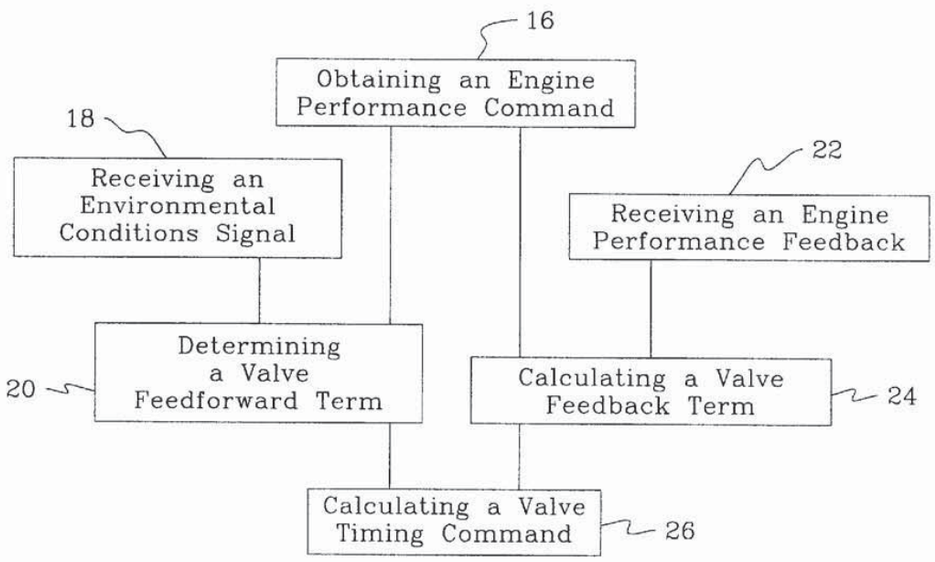


FIGURE 2

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

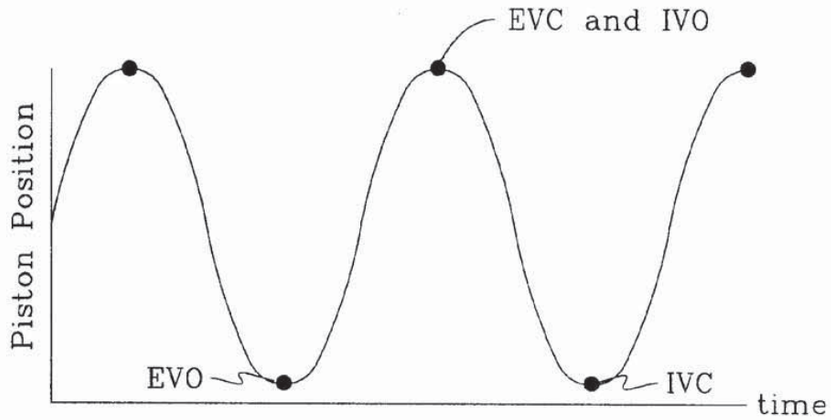


FIGURE 3A

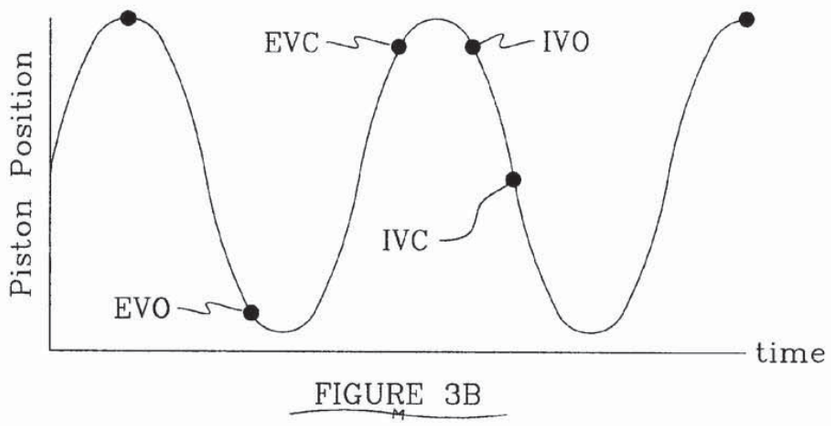


FIGURE 3B

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

METHOD OF CALCULATING A VALVE TIMING COMMAND FOR AN ENGINE

TECHNICAL FIELD

This invention relates generally to calculating commands for an engine and, more specifically, to calculating a valve timing command for an engine with variable timing valve actuators.

BACKGROUND

In gasoline engines of most vehicles, each cylinder of the engine cycles through four unique stages. In the first stage, an inlet valve opens and a piston draws air and fuel through the inlet valve and into the cylinder. The inlet valve closes and the piston reverses direction in the second stage to compress the air and fuel mixture. In the third stage, a spark combusts the mixture, which drives the piston (and powers the vehicle). An exhaust valve opens and the piston once again reverses direction, in the fourth stage, to push the combusted mixture through the exhaust valve and out of the cylinder.

The controlling of the inlet valve and the exhaust valve of each cylinder is a difficult task. The engine speed, which can exceed 6,000 rpm in most vehicles, dictates that the opening and closing of the inlet valve and the exhaust valve must be able to occur up to 50 times per second. In conventional engines, cams driven by the engine actuate the inlet valve and the exhaust valve. Modern research, however, has shown that fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine. Some variable valve timing engines have been proposed, but the theoretical fuel efficiency and output power of these engines have not yet been reached.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is schematic of a vehicle having an engine controlled with the method of the preferred embodiment;

FIG. **2** is a flowchart of the method of the preferred embodiment; and

FIG. **3** is two timing charts of the valves of an engine.

DESCRIPTION OF THE PREFERRED METHODS

The following description of the two preferred method of the invention is not intended to limit the invention to these preferred methods, but rather to enable any person skilled in the art of variable valve timing control to make and use this invention.

As shown in FIG. **1**, the preferred method of the invention has been specifically created to be performed by a control unit **10** to calculate valve timing commands for an engine **12** with electromagnetic valve actuators **14**. The method, however, may be performed by any suitable device to calculate valve timing commands for any suitable engine with any suitable variable timing valves.

As shown in FIG. **2**, the preferred method of the invention has six principle actions: obtaining an engine performance command **16**; receiving an environmental conditions signal **18**; determining a valve feedforward term **20**; receiving an engine performance feedback **22**; calculating a valve feedback term **24**; and calculating a valve timing command **26** based on the valve feedforward term and the valve feedback term. The method performed by the control unit may, of course, include other suitable actions before, during, or after these principle actions.

The action of obtaining an engine performance command **16** preferably includes receiving a vehicle performance command from a driver. Preferably, the vehicle performance command is received from the foot of a driver with the use of a conventional pedal **28**, as shown in FIG. **1**. Alternatively, the vehicle performance command could be received from the driver with the use of any suitable device. The action of obtaining an engine performance command also preferably includes deriving the engine performance command from the vehicle performance command. The engine performance command is preferably based on the vehicle performance command, but may alternatively be based on additional suitable factors, such as a traction control signal or a cruise control signal. The engine performance command is preferably a desired engine torque and, for this reason, the engine performance command may be thought of as an engine torque command. The engine performance command, however, may alternatively be another suitable variable, such as a desired engine acceleration.

The action of receiving an environmental conditions signal **18** preferably includes receiving an environmental conditions signal from an environmental sensor **30** in the vehicle. The environmental sensor **30** preferably senses the ambient temperature outside the vehicle and communicates this data to the control unit **10**, which uses the data to determine the valve feedforward term. Other information, such as the ambient pressure, may be useful in the determination of the valve feedforward term. For this reason, the environmental sensor **30** may alternatively sense other suitable information. The environmental sensor **30** is preferably a conventional environmental sensor, but may alternatively be any suitable device.

Similarly, the action of receiving an engine performance feedback **22** preferably includes receiving the engine performance feedback from an engine sensor **32** in the vehicle. The engine sensor **32** preferably senses the engine speed and communicates this data to the control unit **10**, which uses the data to determine the valve feedforward term and the valve feedback term. Other engine measurables, such as engine torque data, may be useful in the determination of the terms. For this reason, the engine sensor **32** may alternatively sense other suitable information. The engine sensor **32** is preferably a conventional engine sensor, but may alternatively be any suitable sensor.

The action of determining a valve feedforward term **20** preferably includes determining the valve feedforward term based on the engine torque command, the ambient temperature data, and the engine speed data. The determination, however, may be based on other suitable factors, such as engine torque data, air-fuel ratio data, engine combustion stability data, or ambient pressure data. The control unit **10** preferably includes a look-up table, which has been optimized for fuel efficiency, power output, and engine emissions based on various engine torque commands, various ambient temperature data, and various engine speed data (or engine torque data). The control unit **10** may alternatively be programmed to perform a real-time optimization of the fuel efficiency, power output, and engine emission (or any other suitable measurement) based on the engine torque command, the ambient temperature data, and the engine speed data (or any other suitable commands and measurables).

The action of calculating the valve feedback term **24** preferably includes comparing the engine performance com-

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mand and the engine performance feedback. By the definition of the term, the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any. The comparison and the calculation are preferably accomplished by the control unit **10**, but may alternatively be accomplished by a suitable separate device.

As shown in FIG. **3**A, the position of the piston in the cylinder can be traced as a sinusoidal wave over a time period. The events of the opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC") can be placed on this sinusoidal wave. As shown in FIG. **3**B, the events of the EVO, the EVC, the IVO, and the IVC may be shifted within the time period (note that the shift in the EVC and the IVO preferably mirror each another, but may alternatively be separately controlled). The adjustment of the timing of the EVO, the EVC/IVO, and the IVC when used partially, separately, or together may provide the desired fuel efficiency, power output, and emissions from the engine **12** of the vehicle. The action of calculating a valve timing command **26** preferably includes calculating an EVO command, an EVC/IVO command, and an IVC command. The control unit **10**, of course, may alternatively include other suitable parameters for the control of the variable timing valves.

The second preferred method of the invention includes the principle actions of the first preferred method and the additional principle action of receiving fuel conversion data and engine emissions data. These preferably include receiving the fuel conversion data and engine emissions data from suitable emission sensors (not shown) in the cylinder or the exhaust port of the engine **12**. The emission sensors preferably sense the amount of NO_x in the exhaust and communicates this data to the control unit **10**. The control unit **10** preferably uses this information to modify the output value from the look-up table, but may alternatively use this information to continually adjust the values in the look-up table. The control unit **10** may alternatively use this information as another factor in the determination of the valve feedback term. The emission sensors are preferably conventional emission sensors, but may alternatively be any suitable sensor.

As any person skilled in the art of variable valve engine control will recognize from the previous detailed description and from the figures and claims, modifications and changes can be made to the preferred methods without departing from the scope of this invention defined in the following claims.

We claim:

1. A method for calculating a valve timing command for an engine of a vehicle, comprising:

obtaining an engine performance command;

receiving an environmental conditions signal;

determining a valve feedforward term based on the engine performance command and the environmental conditions signal;

receiving an engine performance feedback;

calculating a valve feedback term based on the engine performance command and the engine performance feedback; and

calculating a valve timing command based on the valve feedforward term and the valve feedback term.

2. The method of claim **1** wherein said obtaining an engine performance command includes receiving a vehicle performance command from a driver of the vehicle and deriving the engine performance command based on the vehicle performance command.

3. The method of claim **1** wherein said receiving an environmental conditions signal includes receiving ambient temperature data.

4. The method of claim **3** wherein said determining a valve feedforward term includes determining the valve feedforward term based on the ambient temperature data.

5. The method of claim **4** wherein said determining a valve feedforward term includes determining the valve feedforward term based on the engine performance feedback.

6. The method of claim **5** wherein said determining a valve feedforward term includes referencing a look-up table with the engine performance command, the ambient temperature, and the engine performance feedback.

7. The method of claim **1** wherein said receiving an engine performance feedback includes receiving engine speed data.

8. The method of claim **1** wherein said obtaining an engine performance command includes obtaining an engine torque command; and wherein receiving an engine performance feedback includes receiving engine torque data.

9. The method of claim **8** wherein calculating a valve feedback term includes calculating a valve feedback term based on the engine torque command and the engine torque data.

10. The method of claim **1** wherein said calculating a valve timing command includes calculating an EVO command, an EVC/IVO command, and an IVC command.

11. The method of claim **1** further comprising receiving fuel conversion data.

12. The method of claim **11** wherein said determining a valve feedforward term includes determining a valve feedforward term based on the fuel conversion data.

13. The method of claim **11** wherein said calculating a valve feedback term includes calculating a valve feedback term based on the fuel conversion data.

14. The method of claim **1** further comprising receiving engine emissions data.

15. The method of claim **14** wherein said determining a valve feedforward term includes determining a valve feedforward term based on the engine emissions data.

16. The method of claim **11** wherein said calculating a valve feedback term includes calculating a valve feedback term based on the engine emissions data.

* * * * *

PETITIONER'S EXHIBIT 1002
US PATENT NO. 6,557,540

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.
Petitioner

v.

MICHIGAN MOTOR TECHNOLOGIES LLC
Patent Owner

Case IPR2020-00160
Patent 6,557,540

DECLARATION OF MARK EHSANI, PH.D. IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,557,540

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Alexandria, VA 22313-1450

VW EX1003
U.S. Patent No. 6,557,540

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I. Introduction

1. I, Dr. Mark Ehsani, declare as follows:

2. I have been retained on behalf of Volkswagen Group of America, Inc. ("VWGoA") for the above-captioned *inter partes* review proceeding to provide my expert opinions and expert knowledge. I understand that this proceeding involves U.S. Patent No. 6,557,540 ("the '540 patent") titled "Method of Calculating a Valve Timing Command for an Engine," and that the '540 patent is currently assigned to Michigan Motor Technologies LLC ("MMT"). I understand that the Petition submitted by VWGoA challenges claims 1 to 16 of the '540 patent.

3. The '540 patent is directed to the well-known technique of varying valve timing in an internal combustion engine. I am familiar with the technology described in the '540 patent as of its earliest possible priority date, December 11, 2001.

4. I have been asked to provide my independent technical review, analysis, insights, and opinions regarding the '540 patent and the references that form the basis for the grounds of unpatentability set forth in the Petition for *Inter Partes* Review of the '540 patent filed by VWGoA.

5. In preparing this Declaration, I have reviewed and am familiar with all the documents cited herein. I have reviewed and am familiar with the '540 patent and its file history. I confirm that to the best of my knowledge the accompanying exhibits are true and accurate copies of what they purport to be, and that an expert in

the field would reasonably rely on them to formulate opinions such as those set forth in this Declaration.

6. I am being compensated at my customary rate of $500 per hour for my work on this case. My compensation is not dependent upon my opinions, my testimony, or the outcome of this case.

II. Summary of Grounds

7. I understand that the Petition for *Inter Partes* Review of the ’540 patent filed by VWGoA asserts the following Grounds of unpatentability:

Ground	References	Basis	Claims Challenged
1	Yoshioka, Ohkubo	§103	1, 2, 7, 10-16
2	Yoshioka, Ohkubo, Reed	§103	3-6, 8, 9

III. Summary of Opinions

8. In my opinion, the challenged claims of the ’540 patent would have been obvious in view of the combinations of references VWGoA asserts.

9. Independent claim 1 of the ’540 patent recites a method for calculating a valve timing command for an engine of a vehicle. EX1001, 3:52-53. Specifically, the ’540 patent broadly claims a method of calculating a valve timing command that allegedly solves the problem of optimizing valve timing for a particular load on an engine. *Id.*, 1:30-33.

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10. As discussed in this Declaration, all the recited elements were basic, well-known techniques found in valve timing control systems as of December 11, 2001, which I understand is the earliest possible priority date for the ’540 patent. And as discussed in this Declaration, the known problem of optimizing fuel efficiency and power output of an engine by varying valve timing for a particular load on an engine had been accomplished by the prior art in exactly the same way as recited in claims 1-16 of the ’540 patent. Moreover, as further discussed in this Declaration, before the ’540 patent’s December 11, 2001 earliest possible priority date, a POSA would have had a good reason to combine the asserted prior art references and, in so doing, they would have had a reasonable expectation of success.

11. Therefore, it is my opinion that the challenged claims would have been obvious in view of the disclosures in the asserted prior art references, as described in detail below.

IV. Qualifications

12. In forming the opinions expressed in this Declaration, I have considered and relied upon my education, background, and experience. In addition, I have reviewed and relied upon additional materials in preparation of this Declaration, as described below.

13. My experience and education are detailed in my curriculum vitae (“CV”), a copy of which is provided as EX1004. My CV also lists publications on

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which I am a named author and identifies parties on behalf of whom I have previously provided expert testimony.

14. I am a professor of electrical engineering at Texas A&M University, in College Station, Texas. I have experience in a number of areas, and have particular expertise in electronics, power electronics, automotive electrical and electronic systems, and their related technologies, such as in automotive electrical systems, which includes engine control systems. This expertise is directly applicable to the technical area of the ’540 patent, which relates to controlling electrical current through a valve solenoid.

15. I received my Bachelors and Masters degrees, in electrical engineering, from the University of Texas at Austin in 1973 and 1974, respectively. After a few years of professional work and research, I received my Ph.D. in electrical engineering from University of Wisconsin-Madison, in 1981.

16. I hold several academic professorships at Texas A&M University, including the Robert M. Kennedy Endowed Professorship of Electrical Engineering. I founded one of the first university power electronics and motor drives teaching and research programs in the United States, which is considered to be in the top three in the U.S. and one of the best in the world. For this I received several awards and recognitions, such as the Institute of Electrical and Electronics Engineers (IEEE) Outstanding Teaching Award in 2003, which is the top academic award in this field.

17. I have organized two undergraduate and five graduate courses in power electronics, motors and drives at Texas A&M University. Many of these courses have been on the topic of power converters, electric motors, their controls and applications for various systems such as vehicles. I have also conducted research and supervised over 90 Ph.D. and M.S. theses on these topics.

18. I was one of the founders of the Institute of Electrical and Electronics Engineers, IEEE, Power Electronics Society in the early 1980's and served on its founding Administrative Council and chaired its committees for many years. This professional society is the main forum for power electronics and motor drives specialists, organizes several annual conferences, and has a journal for publication of state of the art papers in power electronics and motor drives. I have chaired many of these international conferences and have been a reviewer for the publications of this society for over three decades.

19. I have also served in positions of leadership in power electronics, motor drives and its applications in other professional societies, including IEEE Industry Application Society, IEEE Industrial Electronics Society, IEEE Vehicular Technology Society, and Society of Automotive Engineers (SAE). I have received numerous honors and awards from these societies for my contributions to power electronics and motor drives technologies and its state of the art, such as the Avant Garde Award from IEEE Vehicular Technology Society. I have been elected Life

Fellow of both IEEE and Fellow of SAE, which is the highest ranking given to a fraction of one percent of the membership of these professional societies.

20. I have been a consulting engineer to over 60 companies in the U.S. and internationally, in power electronics and its applications, over the past thirty-five years. I have also given numerous power electronics short courses and seminars in the U.S. and all over the world for continuing education of power electronics and motor drive engineers in companies and government agencies.

21. I am the author or co-author of over four hundred published papers, eighteen books, and over twenty-four patents in power electronics, motor drives, and its applications. A list of publications that I have authored over the last thirty-eight years is included in my professional CV, which is attached as EX1004.

22. The following are a sample of my publications in the field. I am co-author of the book "Vehicular Electric Power Systems," Marcel Dekker, Inc., 2004, and the book "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – Fundamentals, Theory, and Design, " M. Ehsani, Y. Gao, S. Longo, K. Ebrahimi, CRC Press, 3rd Edition, 2018. I am a contributor to "Handbook of Automotive Power Electronics and Motor Drives," CRC Press, 2005. I taught a short course, "Pulse Width Modulation (PWM) Techniques," at IEEE Applied Power Electronics Conference and Exposition (APEC '91), Dallas, March 1991. Furthermore, I am the inventor of U.S. Patent No. 7,095,205 titled "System and Method For Inductance

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Based Position Encoding Sensorless SRM Drive," which was issued on August 22, 2006.

23. Therefore, based on my education, professional experience of forty-one years, and scholarly books and publications, I am an expert in the relevant field of the '540 patent at issue here and have been an expert in this field since before the '540 patent was filed with the United States Patent and Trademark Office ("USPTO"). I am intimately familiar with how a person having ordinary skill in the art would have understood and used the terminology found in the '540 patent at the time of its filing.

V. Materials Considered

24. In formulating my opinions, I have relied upon my training, knowledge, and experience that are relevant to the '540 patent. Furthermore, I have specifically considered the following documents, in addition to any other documents cited in this Declaration:

Exhibit #	***Description***
1001	U.S. Patent No. 6,557,540 B1 to Mianzo *et al.* ("'540 Patent")
1002	Prosecution File History of U.S. Patent No. 6,557,540 B1 ("'540 history")
1005	U.S. Patent No. 5,713,317 to Yoshioka, titled "Method of Continuously and Variably Controlling Valve Timing of Internal Combustion Engine," issued February 3, 1998 ("Yoshioka")
1006	U.S. Patent No. 4,995,351 to Ohkubo *et al.*, titled "Valve Timing Control Apparatus for an Internal Combustion Engine," issued February 26, 1991 ("Ohkubo")
1007	U.S. Patent No. 6,308,671 to Reed *et al.*, titled "Method of Increasing Torque and/or Reducing Emissions by Varying The

Exhibit #	*Description*
	Timing of Intake and/or Exhaust Valves," issued October 30, 2001 ("Reed")
1008	"Torque Management of Engines with Variable Cam Timing," M. Jankovic, F. Frischmuth, A. Stefanopoulou, and J. A. Cook, IEEE Control Systems, October 1998 ("Jankovic")
1009	"Bosch Fuel Injection Systems," F. Aird, Berkeley Publishing Group, 2001, ISBN 1-55788-365-3 ("Aird")
1010	McGraw-Hill Electronics Dictionary, 6th ed. By Neil Sclater and John Markus © 1997 Mcgraw-Hill Inc., ISBN 0-07-057837-0.
1011	"Automotive Encyclopedia," W. Toboldt & L. Johnson, Goodheart-Wilcox Co. Inc., 1979, ISBN 0-87006-268-9 ("Toboldt")
1012	"Bosch Automotive Handbook," Robert Bosch GmbH, 2000, ISBN 0-7680-0669-4 ("Bosch")
1013	"Modeling and Control of Advanced Technology Engines," A. Stefanopoulou, U. Mich., 1996 ("Stefanopoulou")
1014	U.S. Patent No. 4,220,120 to Jackson *et al.*, titled "Internal Combustion Engine System and Operation," issued September 2, 1980 ("Jackson")
1015	"Automotive Electronics Handbook," R. Jurgen, McGraw-Hill, Inc., ISBN0-07-033189-8, 1994 ("Jurgen")
1016	"Bosch Fuel Injection & Engine Management," C. O. Probst, Robert Bentley, Inc., 1992, ISBN-978-0-8376-0300-1 ("Probst")

VI. Legal Standards

25. I have also relied upon various legal principles (as explained to me by Volkswagen's counsel) in formulating my opinions. My understanding of these principles is summarized below.

26. I have been told the following legal principles apply to analysis of patentability. I also have been told that, in an *inter partes* review proceeding, a

patent claim may be deemed unpatentable if it is shown by a preponderance of the evidence that the claim is anticipated by one prior art reference under 35 U.S.C. § 102, or rendered obvious by one or more prior art references under 35 U.S.C. § 103.

27. I understand that documents and materials such as printed publications or patents that qualify as prior art can be used to render a patent claim as anticipated or as obvious.

28. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation or obviousness of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

A. My Understanding of Claim Construction

29. I understand that during an *inter partes* review proceeding, claims are to be construed in light of the specification as would be read by a person of ordinary skill in the relevant art at the time of the purported priority date. I understand that claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the relevant art in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In this case, the claim term will receive the definition set forth in the patent.

B. A Person of Ordinary Skill in the Art

30. I understand that a person of ordinary skill in the relevant art (herein "POSA") is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity—not an automaton.

31. I have been asked to consider the level of ordinary skill in the field that someone would have had at the time the alleged invention was made. In deciding the level of ordinary skill, I considered the following:

- the levels of education and experience of persons working in the field;
- the types of problems encountered in the field; and
- the sophistication of the technology.

32. I understand that the relevant time for considering whether a claim would have been obvious to a POSA is at the time of the alleged invention, which I have been told to assume for this case is December 11, 2001.

33. Regardless if I use "I" or "POSA" during my technical analysis below, all of my statements and opinions are to be understood to be based on how a POSA would have understood or read a document at the time of the alleged invention.

C. My Understanding of Obviousness

34. I understand that a patent claim is unpatentable if the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the alleged invention. I understand that this means that even if all of the elements of the

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claim cannot be found in a single prior art reference that would anticipate the claim, the claim can still be unpatentable.

35. It is my understanding that to obtain a patent, a claimed invention must have been, as of its earliest possible priority date, non-obvious in view of the prior art in the field. I understand that a patent claim is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time the alleged invention was made.

36. When considering the issues of obviousness, I have been told that I am to do the following:

- Determine the scope and content of the prior art;
- Ascertain the differences between the prior art and the claims at issue;
- Resolve the level of ordinary skill in the pertinent art; and
- Consider evidence of secondary indicia of non-obviousness (if available).

37. With respect to determining the proper scope of prior art to examine, I understand that in order for a prior art reference to be properly used in an obviousness ground under 35 U.S.C. § 103, the prior art reference must be analogous art to the claimed invention. I have been told that a reference is analogous art to the claimed invention only if: (1) the reference is from the same field of

endeavor as the claimed invention; or (2) the reference is reasonably pertinent to the particular problem solved by the inventor.

38. I understand that factors relevant to determining the proper field of endeavor include the inventor's explanations of the subject matter (including the patent specification), as well as the claimed invention's structure and function. And I further understand that to be reasonably pertinent to the particular problem solved by the inventor, a prior art reference must logically commend itself to the inventor's attention in considering his or her problem.

39. I have been told that an analogous reference may be modified or combined with other analogous references or with the POSA's own knowledge if the person would have found the modification or combination obvious. I have also been told that a POSA is presumed to know all relevant, analogous prior art, and the obviousness analysis may take into account the inferences and creative steps that a POSA would employ.

40. In determining whether a prior art reference would have been combined with another prior art reference or other information known to a POSA, I have been told that the following principles may be considered:

- A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;
- The simple substitution of one known element for another is likely to be obvious if it yields predictable results;

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- The use of a known technique to improve similar devices, products, or methods in the same way is likely to be obvious if it yields predictable results;
- The application of a known technique to a prior art reference that is ready for improvement is likely obvious if it yields predictable results;
- Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- A skilled artisan often will be able to fit the teachings of multiple references together like a puzzle; and
- The proper analysis of obviousness requires a determination of whether a POSA would have a "reasonable expectation of success"—not "absolute predictability" of success—in achieving the claimed invention by combining prior art references.

41. I understand that whether a prior art reference renders a claim unpatentable as obvious is determined from the perspective of a POSA. I have also been told that, while there is no requirement for the prior art to contain an express suggestion to combine known elements to achieve the claimed invention, a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually, as filtered through the knowledge of one skilled in the art. In addition, I have been told the inferences and creative steps a

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person of ordinary skill in the art would employ are also relevant to the determination of obviousness.

42. I also understand that when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. I have also been told that if a POSA can implement a predictable variation and would see the benefit of doing so, that variation is likely to be obvious. I have been told that in many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. I have been told that, when there is a design need or market pressure and there are a finite number of predictable solutions, a POSA has good reason to pursue those known options.

43. I have been told there is no rigid rule prescribing that a reference or combination of references must contain a "teaching, suggestion, or motivation" to combine references. But I also have been told that the "teaching, suggestion, or motivation" test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been told this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

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VII. Level of Ordinary Skill in the Art

44. In my opinion, a person of ordinary skill in the art ("POSA") in the context of the '540 patent as of December 11, 2001 (the earliest possible priority date of the '540 patent) would have had a B.S. degree in Electrical Engineering or Mechanical Engineering (or equivalent), as well as at least 2–4 years of academic or industry experience in the relevant field of engine control systems.

45. I am well qualified to determine the level of ordinary skill in the art. First, I am very familiar with the technology of the '540 patent as of the December 11, 2001 timeframe. As mentioned above, by December 11, 2001, I had acquired extensive experience relating to engine control systems. Specifically, by December 11, 2001, I had over 23 years of experience working with engine control systems. *See supra* Section IV; EX1004.

VIII. Overview of the '540 Patent

A. Technology Overview

46. The '540 patent is titled "Method of Calculating a Valve Timing Command for an Engine." The '540 patent issued on May 6, 2003 from U.S. Application No. 10/014,286, which was filed on December 11, 2001. EX1001, '540 Patent, (21), (22), (45).

47. The '540 patent relates to the well-known technique of varying valve timing in an internal combustion engine. In particular, the '540 patent is directed to a method of calculating a valve timing to allegedly solve the problem of optimizing

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valve timing for a particular load on an engine. EX1001, 1:30-33. However, well before the ’540 patent, it was known that competing objectives are present in internal combustion engines, for example, achieving maximum power output while attaining efficient fuel consumption and minimizing exhaust byproducts. To achieve these objectives, electrical engine controls manage various aspects of engines including valve timing.

48. As one example, Jankovic explains that known variable cam timing (VCT) systems utilized an electro-hydraulic mechanism to rotate the camshaft relative to the crankshaft in order to retard the cam timing with respect to the intake and exhaust strokes of the engine, as illustrated below:

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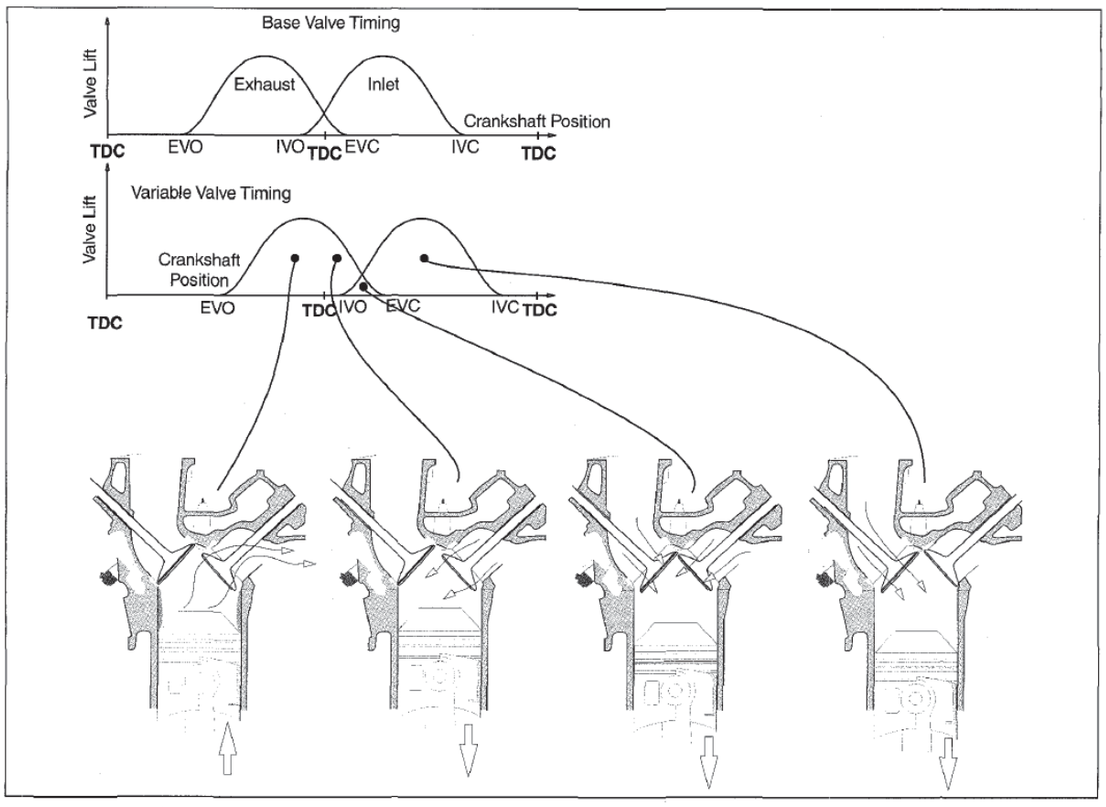


Fig. 1. Valve lift profiles of conventional and VCT engines. By retarding the cam phasing, the exhaust valve stays open during the intake event for a longer time period, retaining otherwise unburned HC and reducing the combustion temperature due to the dilution of the inert gas.

EX1008, Jankovic, 34-35.

49. According to Jankovic, it was known that varying intake and exhaust valve timing permits an engine designer to optimize valve timing over a wide range of engine operating conditions including emission and torque. The background of the '540 patent itself also admits that "fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine." EX1001, 1:30-33. Jankovic also recognized that there are multiple types of known variable cam timing (VCT) systems including: phasing only the intake cam (intake only), phasing only the exhaust cam (exhaust only), phasing the intake and

exhaust cams equally (dual equal), and phasing the two camshafts independently (dual independent). EX1008, 35. According to Jankovic, "intake valve timing and exhaust valve timing are advanced or retarded equally, gives the best overall performance in terms of emissions and fuel economy." *Id.* A POSA would have thus been aware of and considered varying valve timing as a known technique to improve engine performance (*e.g.*, improve fuel economy and reduce emissions).

50. As another example, Stefanopoulou described in 1996 that:

> Variable cam timing schemes have been studied extensively and have been found to reduce emissions [45, 79] increase fuel economy [21, 41, 26] and improve full load performance [40]. The primary emphasis of this work is on reducing emissions while satisfying drivability requirements at part load and medium engine speed. Variable cam timing can inhibit the production of oxides of nitrogen (NO_x) and reduce the amount of unburned hydrocarbons (*HC*) emitted to the exhaust system [45]. By retarding the cam timing, combustion products which would otherwise be expelled during the exhaust stroke are retained in the cylinder during the subsequent intake stroke. The contribution of this diluent to the mixture in the cylinder reduces the combustion temperature and suppresses NO_x formation. In addition, this process often reduces *HC* emissions since the internally recirculated exhaust gas subjected to the additional combustion cycle is generally from the crevice volumes at the piston/cylinder wall interface and is rich in unburned *HC*. The effect is to reduce the base *HC* and NO_x emission levels of the engine with respect to a conventional powerplant, resulting in lower tailpipe emissions at

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> equivalent catalytic converter efficiencies. Of course, VCT obviates the requirement for external exhaust gas recirculation (EGR) systems commonly used for NO_x reduction. Furthermore, by retarding the cam phasing, the amount of fresh air into the cylinder is reduced. This results in the need for a higher manifold pressure in order to maintain the same load. Operation in high manifold pressure is advantageous since it is associated with reduced intake stroke pumping work [31, 83], and therefore, increased fuel economy. One type of VCT engine utilizes a hydraulically actuated mechanism to rotate the camshaft relative to the crankshaft and advance the valve timing with respect to the engine induction and exhaust strokes. This is illustrated in the valve lift profiles shown in Fig. 3.1.

EX1013, Stefanopoulou, 33.

51. Stefanopoulou recognized that the goal of variable cam timing for an engine "is to keep emissions as low as possible, by maintaining air fuel ratio (*A/F*) close to stoichiometry, and minimizing feedgas NO_x and *HC* emissions, while providing good driveability during rapid throttle movements." *Id.*, 47.

52. Yoshioka, Ohkubo, and Reed, described in detail below, also disclose control systems for varying valve timing. For example, Yoshioka discloses "a method of and an apparatus for optimizing valve timing according to atmospheric pressure for a continuously variable valve timing mechanism of an internal combustion engine." EX1005, 1:40-43. According to Yoshioka, this improves "the output of an engine at high altitudes under high load, as well as reducing fuel

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consumption and improving exhaust purifying performance at high altitudes under low/medium load." *Id.*, 1:44-47.

53. Indeed, a POSA would have known that engine performance is dependent on various environmental conditions including ambient pressure and temperature. The number of air molecules present in an engine during combustion, for example, varies according to air density, which depends on these two environmental factors. Specifically, air density is directly related to temperature and pressure per the ideal gas law: pv=nRT. Here, p is the pressure, v is the volume, n is the number of moles of gas molecules, T is the temperature, and R is a constant. EX1012, Bosch, 59. Thus as the pressure increases at a constant temperature, the number of molecules n available to the engine will increase, and if the temperature increases at a constant pressure, the number of molecules n available to the engine will decrease. Both of these changes in environmental conditions impact engine performance.

54. For example, Probst described in 1992 that:

> What constitutes a combustible mixture depends on air temperature, the volatility of the gasoline, altitude, barometric pressure and humidity.

EX1016, Probst, 2:8.

55. Accordingly, Probst described using an air temperature sensor to adjust for air density changes:

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> With the air cleaner removed, you can see the Air Temperature Sensor in the air-flow sensor, as shown in figure 2-34. Known as he NTC1, this sensor also has a negative temperature coefficient. Remember, the control unit sends a signal which is changed by the air temperature sensor. Cold air, weighing more, needs more fuel, so a cold air signal also adds fuel to the basic pulse time. The air fuel ratio relates weight of air to weight of fuel. The combination input signals of volume (from the air flow sensor), corrected for temperature are the same as inputs of weight or mass of air passing into the engine.

Id., 3:16-17.

56. And Jurgen describes the use of pressure sensors in 1994 to compensate for altitude changes. EX1015, Jurgen, 2.7 ("The need for barometric pressure is often desirable in MAF systems to provide altitude information to the engine control computer.").

57. Ohkubo also recognized a decade before the '540 patent that it was "well known that changing the opening and closed timings for the intake and exhaust valves of an engine depending upon the engine operating ranges results in improvements in the operating performance of the engine." EX1006, Ohkubo, 1:33-37. In particular, Ohkubo described "a valve timing control apparatus for an internal combustion engine which is able to improve the air-intake and exhaust-discharge efficiency of the engine, thereby increasing engine output power." *Id.*, 1:55-59.

58. Reed similarly recognized that variable cam timing (VCT) "allows the timing of the camshafts, and thus the opening and closing of the valves, to be

optimized over a wider range of operating conditions" for "improved performance at medium to full loads coupled with reduced emissions and improvements in fuel economy." EX1007, 4:54-59. Reed, for example, stated that it was "well known that use of a VCT mechanism on only the intake camshaft 71 improves engine operation" and that the benefits of doing so were also known: "it reduces NOx emissions," "it reduces HC emissions," and "increases the torque output by the engine at medium to high speeds, improves fuel economy and enables the engine to be operated more stably at idle." *Id.*, 5:63-6:27. And it was "also well known that use of a VCT mechanism on only the exhaust camshaft 81 has a significant effect on emissions" and provided similar benefits. *Id.*, 6:28-53.

B. Alleged Problem in the Prior Art

59. The '540 patent is directed to the problem of optimizing fuel efficiency and power output of an engine by varying valve timing for a particular load on an engine. EX1001, 1:30-36. However, long before the '540 patent, the problem of optimizing efficiency and power output of an engine was well-known, as were solutions for varying valve timing to optimize efficiency and power output of an engine as I noted above. Specifically, Yoshioka, Ohkubo, and Reed recognized this problem. *See* EX1005, 1:9-14, 1:44-47; EX1006, 1:33-37; EX1007, 4:54-59.

60. Stefanopoulou also recognized that the goal of variable cam timing for an engine "is to keep emissions as low as possible, by maintaining air fuel ratio (*A/F*) close to stoichiometry, and minimizing feedgas NO_x and *HC* emissions, while

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providing good driveability during rapid throttle movements." EX1013, 47. And as I discuss below, the '540 patent does not add anything to what were previously known solutions.

C. Alleged Invention of the '540 Patent

61. The '540 patent admits that it was known "that fuel efficiency and power output of the engine may be optimized with an adjustment of the valve timing for a particular load on the engine" and that variable valve timing engines were known in the prior art. EX1001, 1:30-33. According to the '540 patent, however, the known variable valve timing engines somehow could not achieve "the theoretical fuel efficiency and output power of these engines." *Id.*, 1:33-36.

62. The '540 patent does not explain why the known variable valve timing engines could not achieve "the theoretical fuel efficiency and output power of these engines." Yet, the '540 patent allegedly provides an inventive method for calculating valve timing commands. *Id.*, 1:7-10. To apparently solve the known problem of optimizing efficiency and power output by controlling valve timing, the '540 patent provides a six step method, which includes:

63. (1) obtaining an engine performance command 16;

64. (2) receiving an environmental conditions signal 18;

65. (3) determining a valve feedforward term 20;

66. (4) receiving an engine performance feedback 22;

67. (5) calculating a valve feedback term 24; and

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68. (6) calculating a valve timing command 26 based on the valve feedforward term and the valve feedback term.

Id., 1:61-2:1, FIG. 2.

69. As I discuss below, the '540 patent acknowledges that these steps are performed using what it refers to as "conventional" components (*e.g.*, an accelerator pedal and common sensor).

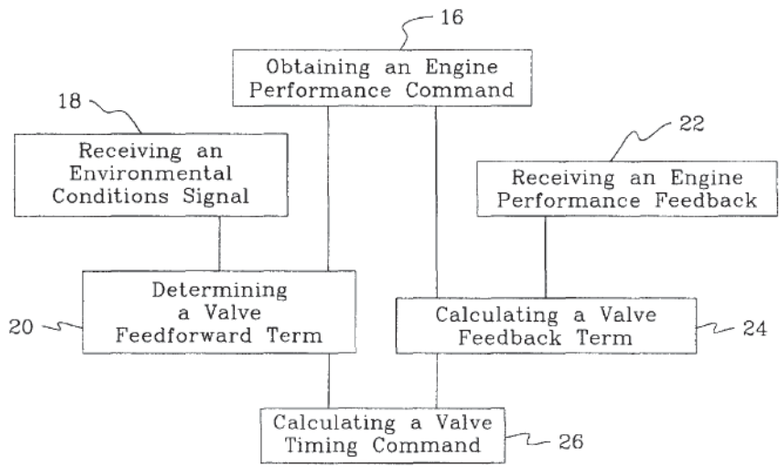


FIGURE 2

EX1001, FIG. 2.

70. The '540 patent discloses that the "engine performance command" (received at 16) is preferably based on a vehicle performance command from a driver (*e.g.*, by pressing down on a ***conventional*** pedal 28), but can also be a desired

engine torque, desired engine acceleration, or other suitable variables. EX1001, 2:4-22[1].

71. The "environmental conditions signal" (received at 18) is preferably based on a signal from a ***conventional*** environmental sensor 30 (*e.g.*, ambient temperature, ambient pressure). *Id.*, 2:23-35.

72. The engine performance feedback (received at 22) is based on a signal from a ***conventional*** engine sensor 32 (*e.g.*, engine speed, engine torque data, "engine measurable," or "other suitable information"). *Id.*, 2:36-47.

73. The '540 patent admits that conventional components are used to perform these steps of the methods of the '540 patent.

74. Based on the received "engine performance command" (*e.g.*, engine torque) and "environmental conditions signal" (*e.g.*, temperature), the '540 patent discloses that the "valve feedforward term" is determined by a control unit 10. *Id.*, 2:48-51. In other words, the "valve feedforward term" is determined using known information from conventional components and sensors. As one example, the "valve feedforward term" can be determined by the control unit 10 using additional engine measurements and a conventional look-up table. *Id.*, 2:51-65.

75. Based on the received "engine performance command" and "engine performance feedback," the '540 patent discloses that the "valve feedback term" is determined. *Id.*, 2:66-3:1. Specifically, the '540 patent states that "the valve

[1] Emphasis added unless indicated.

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feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any." *Id.*, 3:1-4. This comparison can be performed by the control unit 10 or another device. *Id.*, 3:4-7.

76. The "valve timing command" is then calculated based on the "valve feedforward term" and the "valve feedback term." *Id.*, 1:61-2:1. In some embodiments, calculating the "valve timing command" can include adjusting the timing of the opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC"). *Id.*, 3:21-24.

77. Well before the '540 patent, however, this known problem had been solved in the same way. Yoshioka and others, for example, optimized valve timing based on environmental conditions (*e.g.*, atmospheric pressure) to improve fuel consumption and reduce emissions. EX1005, 1:9-14, 1:44-47; *see also* EX1006; EX1007. I have also included below a chart showing examples of how these claimed terms were disclosed in the prior art:

Term	**'540 Patent Disclosure**	**Exemplary Prior Art Disclosure**
"engine performance command"	Any suitable engine performance variable, *e.g.*, by depressing a conventional	Quantity of intake air, engine speed, throttle valve position of Yoshioka

	accelerator pedal, a desired engine torque, a desired engine acceleration	*See infra* Section X.B.2
"environmental conditions signal"	Any measureable environmental condition, *e.g.*, ambient pressure, temperature	Ambient pressure of Yoshioka Temperature of Reed *See infra* Section X.B.3
"engine performance feedback"	Any measureable information relating to engine performance, *e.g.*, engine speed, engine torque	Actual valve timing displacement of Yoshioka and Ohkubo *See infra* Section X.B.5
"valve feedforward term"	Determined based on "engine performance command" and "environmental conditions signal," *e.g.*, using a conventional look-up table	Target valve timing displacement of Yoshioka *See infra* Section X.B.4
"valve feedback term"	Based on the "engine performance command" and "engine performance feedback," *e.g.*, by comparing	Feedback control of valve timing of Yoshioka Valve timing correction of Ohkubo

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	the "engine performance command" with the "engine performance feedback" to calculate a correction term based on the difference, if any	*See infra* Section X.B.6
"valve timing command"	Based on the "valve feedforward term" and the "valve feedback term," *e.g.*, adjusting the timing of the opening of the exhaust valve ("EVO"), the closing of the exhaust valve ("EVC"), the opening of the inlet valve ("IVO"), and the closing of the inlet valve ("IVC")	Valve timing adjustment of Yoshioka *See infra* Section X.B.7

78. Thus, the '540 patent claims recite nothing more than what was already taught in the prior art and well-known to POSAs.

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79. Accordingly, because, in my opinion, the ’540 patent claims are unpatentable, it is my opinion that the Board should institute trial on the grounds set forth herein.

D. Prosecution History Summary

80. From my review of the ’540 patent’s prosecution history, I note that the United States Patent and Trademark Office issued a Notice of Allowance for the application that became the ’540 patent without a single Office Action. *See generally* EX1002. It is my understanding that none of the references relied upon in VWGoA’s Petition were before the examiner during prosecution of the ’540 patent.

E. Claim Construction

81. It is my understanding that the challenged claims of the ’540 patent are to be given their ordinary and customary meaning as understood by one of ordinary skill in the art at the time of the alleged invention in light of the specification and the prosecution history pertaining to the patent. In my opinion, for purposes of this proceeding, the Board should construe the following claim terms in the following manner.

1. “calculating a valve feedback term” (claim 1)

82. Claim 1 recites “calculating a valve feedback term.” EX1001, 4:2. The ’540 patent states that:

> By the definition of the term, the valve feedback term functions to compare the input with the output and to calculate a correction term based on the difference, if any.

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Id., 2:66-3:7. It is my opinion that a POSA reading the ’540 patent would have thus understood the phrase “calculating a valve feedback term” to mean “calculating a correction based on a comparison of an input and an output.”

IX. Summary of the Applied References

83. Each applied reference discloses a control system for valve timing and thus is from the same field of endeavor as the ’540 patent.

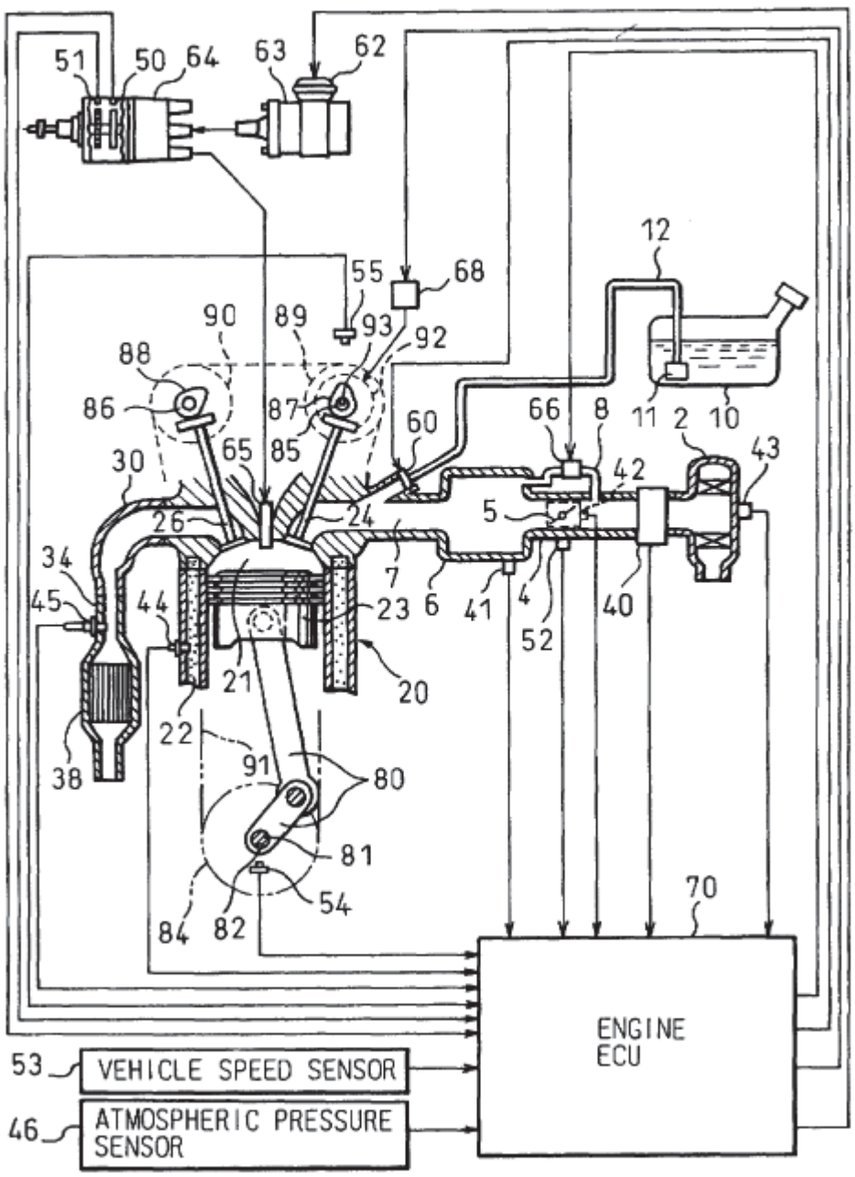
A. Yoshioka

84. Yoshioka is directed to a method and apparatus for continuously and variably controlling valve timing of an internal combustion engine, just like the ’540 patent. EX1005, Abstract. Yoshioka, in particular, discloses using a two-dimensional map of engine load and engine revolution speed to continuously control the open/close timing of the intake valve, thereby smoothing the torque characteristics with respect to the engine load and the throttle opening. *Id.*, 9:22-27.

85. Figure 1 of Yoshioka, illustrated below, shows an electronically controlled internal combustion engine that continuously and variably controls the open/close timing of a valve. *Id.*, 4:6-10. Yoshioka’s engine includes a throttle valve 5 in a throttle body 4 that adjusts the quantity of intake air; an airflow meter 40 that measures the mass flow rate of intake air; a temperature sensor 43 that detects the temperature of intake air; an atmospheric pressure sensor 46; and a throttle sensor 42 that detects the opening of the throttle valve 5, as shown in Figure 1. *Id.*, 4:13-23. Intake duct 7 mixes fuel with air, which is drawn into a combustion chamber 21 of

cylinder 20 through an intake valve 24, and combusted, and an exhaust valve 26 discharges exhaust gas of the combusted air-fuel mixture into an exhaust manifold 30 connected to an exhaust pipe 34. *Id.*, 4:29-33, 4:48-50.

Fig. 1



EX1005, FIG. 1.

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86. Yoshioka's engine further includes a crankshaft 81 to drive cam shafts 85 and 86 to open and close the intake valve 24 and exhaust valve 26 at predetermined crank angles. EX1005, 4:59-5:4. A continuously variable mechanism 92 is arranged between the cam shaft 85 and a timing pulley 89 to determine the open/close timing of the intake valve 24. *Id.*, 5:10-13. Specifically, the mechanism 92 uses the cam shaft 85 and timing pulley 89 as external gears and connects them to each other through an intermediate helical gear, which is axially moved by hydraulic pressure controlled by a control valve 68, to drive the cam shaft 85 and timing pulley 89 relative to each other. *Id.*, 5:13-20.

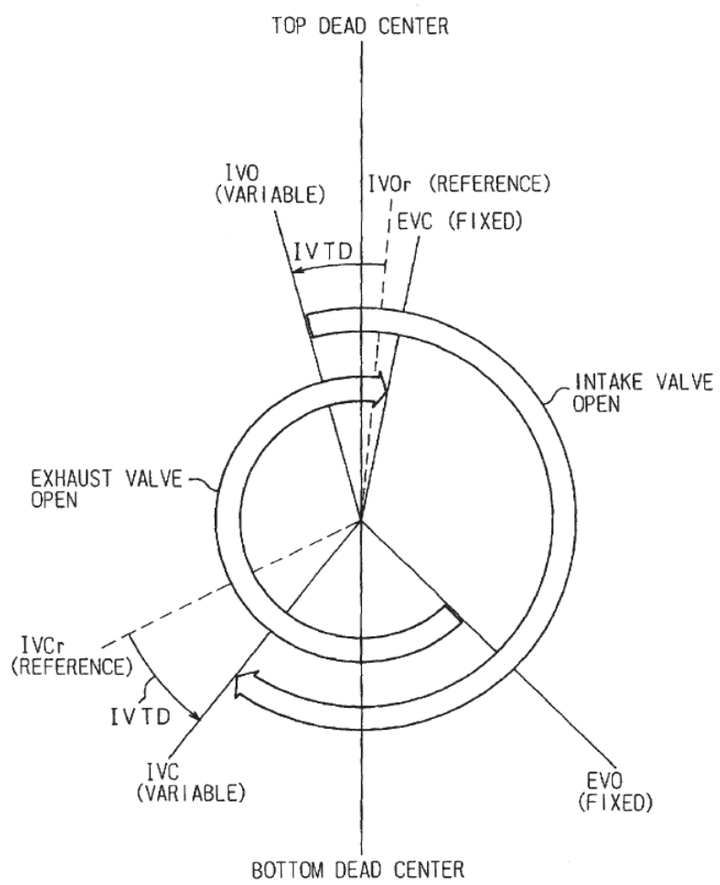
87. Yoshioka's engine also includes an electronic engine control unit (ECU) 70—a microcomputer—to control various aspects of the engine including the open/close timing of the intake valve 24 according to various operating conditions by controlling the continuously variable mechanism 92. *Id.*, 5:21-24. More precisely, the ECU feedback-controls the hydraulic pressure control valve 68 according to signals from first and second magnetic sensors 54 and 55 so that the cam shaft 85 of the intake valve 24 maintains a required rotational phase with respect to the crankshaft 81. *Id.*, 6:6-15.

88. Figure 3 of Yoshioka, illustrated below, shows a timing chart showing crank angles corresponding to the open/close timing of the intake and exhaust valves 24 and 26, including: intake valve 24 opening timing IVO and close timing IVC, and exhaust valve 26 opening timing EVO and close timing EVC. *Id.*, 6:16-37. Figure 3

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also illustrates a valve timing displacement IVTD, which serves as an adjustable target for valve open/close timing. *Id.*, 6:27-28.

Fig. 3



EX1005, FIG. 3.

89. As one example, Yoshioka discloses utilizing a map to determine the timing displacement IVTD for optimizing open/close timing of the intake valve 24 according to an engine revolution speed NE and an engine load GN, *i.e.*, the mass of

intake air per engine revolution. EX1005, 6:38-42. Figure 4 below illustrates this map:

Fig. 4

ENGINE REVOLUTION SPEED NE [rpm]

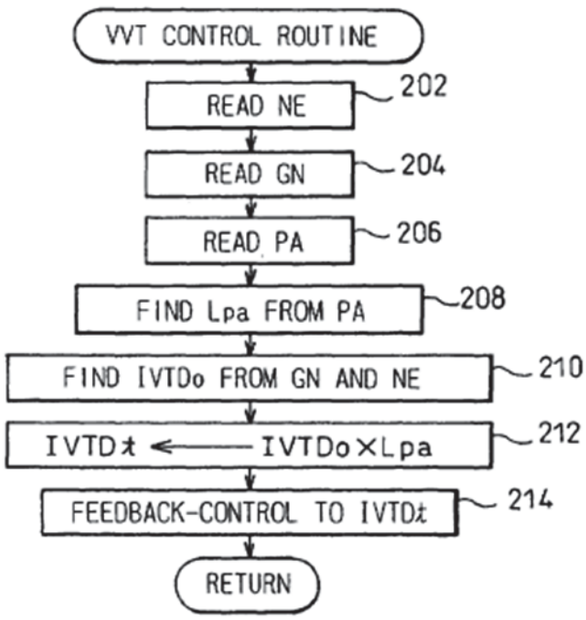
ENGINE LOAD GN [g/rev.]	800	1200	1600	2000	~	6000	6400
0.2	0	0	0	0	~	0	0
0.4	0	5	10	10	~	5	5
0.6	5	20	30	30	~	10	10
0.8	20	40	50	50	~	20	20
1.0	35	55	60	60	~	20	20
1.2	40	60	60	60	~	10	10
1.4	30	55	60	60	~	5	5
1.6	30	50	50	50	~	5	5
1.8	30	50	40	40	~	5	0
2.0	30	50	40	40	~	5	0

EX1005, FIG. 4.

90. Figure 9 of Yoshioka illustrates, below, a method of setting a target displacement for the open/close timing of the intake valve 24 according to a detected engine load and atmospheric pressure:

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Fig. 9



EX1005, FIG. 9.

91. First, an engine revolution speed NE is calculated according to the output of the crank angle sensor 51 (at step 202); an engine load GN (the mass of intake air per engine revolution) is calculated according to the mass flow rate of intake air detected by the airflow meter 40 and the engine revolution speed provided by the crank angle sensor 51 (at step 204); and an atmospheric pressure PA is detected by the atmospheric pressure sensor 46 (at step 206). EX1005, 7:18-25, 7:55-56. In my opinion, a POSA would have known that the throttle valve and the

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opening of the throttle is controlled by the driver to control the desired acceleration, *e.g.*, by depressing the accelerator pedal.

92. For example, Toboldt described in 1979 that:

> The throttle valve is a device for varying the amount of air–fuel mixture that enters the intake manifold. This control is necessary so the speed of the vehicle can be changed. The throttle valve, Fig. 21-5, is simply a round disk mounted on a shaft, so that it can be tilted at various angles in the carburetor throttle valve body. It is connected by means of suitable linkage to the accelerator pedal in the driving compartment of the vehicle. **Depressing the pedal opens the throttle valve, permitting an increased amount of air-fuel mixture to reach the manifold**.

EX1011, Toboldt, 239.

93. Bosch similarly described that in "conventional injection systems, the driver directly controls the opening of the throttle valve by depressing the accelerator pedal" and that the "driver uses the accelerator pedal to vary the throttle valve's aperture so that the airflow into the engine is varied and with it the engine's power output." EX1012, 452, 460, *see also* 478 ("At full load, the accelerator pedal is depressed fully and the throttle is wide open (WOT)."), 498 ("In order to set the operating state desired by the driver (main function), the position of the gas pedal is converted by the microprocessor into a setpoint value for the engine torque."), 499 ("Systems with ETC (electronic throttle control, integrated in the engine control unit for ignition, injection and other auxiliary functions) detect the position of the

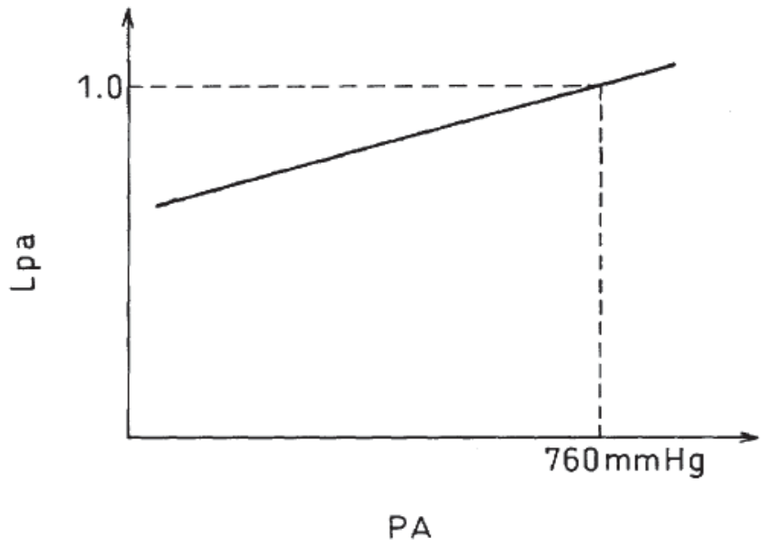
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accelerator pedal with a pedal-travel sensor (potentiometer). Taking into account the current engine operating status, the ECU calculates how far the throttle valve needs to open and actuated the throttle-valve drive accordingly (see Fig.). A throttle-valve angle sensor (potentiometer) monitors exact compliance with the desired throttle-valve position."), 507 ("The most important torque demand derives from the vehicle-operator command generated by the accelerator pedal, from the position of which the engine-management system interprets the demand to be made on the IC engine for a particular torque.")

94. Second, the ECU determines (at step 208) a correction coefficient Lpa based on the atmospheric pressure PA using a map stored in ROM 73 of the ECU. EX1005, 7:57-60. An example of this map is shown in Figure 10:

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Fig. 10



EX1005, FIG. 10.

95. Third, the ECU determines (at step 210) an initial valve displacement IVTD0 based on the engine load GN and engine speed NE. EX1005, 7:63-67. Here, the engine load GN is "the mass of intake air per engine revolution" calculated according to the mass flow rate of intake air detected by the air flow meter 40 and controlled based on the opening of the throttle valve 5. *Id.*, 7:20-24, 7:55-56, 6:38-42, 5:43-46. IVTD0 is determined according to the map shown in Figure 4:

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Fig. 4

ENGINE REVOLUTION SPEED NE [rpm]

ENGINE LOAD GN [g/rev.]	800	1200	1600	2000	~	6000	6400
0.2	0	0	0	0	~	0	0
0.4	0	5	10	10	~	5	5
0.6	5	20	30	30	~	10	10
0.8	20	40	50	50	~	20	20
1.0	35	55	60	60	~	20	20
1.2	40	60	60	60	~	10	10
1.4	30	55	60	60	~	5	5
1.6	30	50	50	50	~	5	5
1.8	30	50	40	40	~	5	0
2.0	30	50	40	40	~	5	0

EX1005, FIG. 4.

96. Fourth, the ECU 70 corrects the displacement IVTD0 to provide a target displacement IVTDt based on the atmospheric correction coefficient Lpa. EX1005, 8:1-5. Lastly, the ECU 70 brings the actual displacement of the intake valve 24 to the target displacement IVTDt by feedback-controlling the hydraulic control valve 68. *Id.*, 8:6-8.

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B. Ohkubo

97. Ohkubo is similarly directed to a valve timing control system for an internal combustion engine, like Yoshioka, which controls the opening and closing of intake and exhaust valves. EX1006, 1:6-10. Figure 1 of Ohkubo illustrates the valve timing control apparatus having:

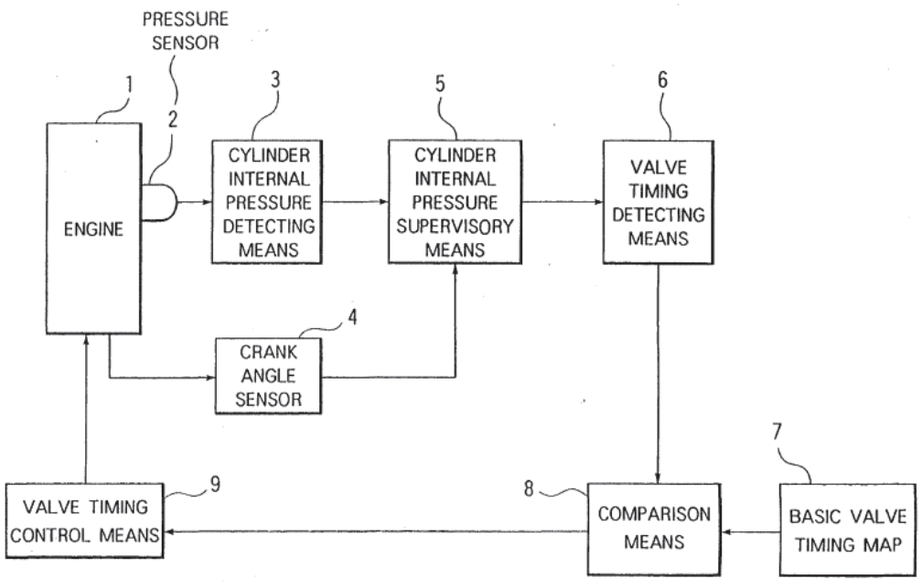
- a pressure sensor 2 for sensing the internal pressure in the engine cylinder 1;
- a pressure detecting means 3 for detecting the internal pressure in the engine cylinder 2;
- a crank angle sensor 4;
- a cylinder pressure supervisory means or disabling means 5 for supervising the internal pressure in the engine cylinder 1;
- a valve timing detecting means 6 for detecting the opening and closing timings of the intake and exhaust valves of the engine;
- a basic valve timing map 7;
- a comparison means 8 for comparing the valve opening and closing timings detected by the valve timing detecting means 6 with the basic valve timing map 7; and

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- a valve timing control means 8 for controlling the opening and closing timings of the intake and exhaust valves based on the output of the comparison means 8.

Id., 2:61-3:44.

FIG. 1

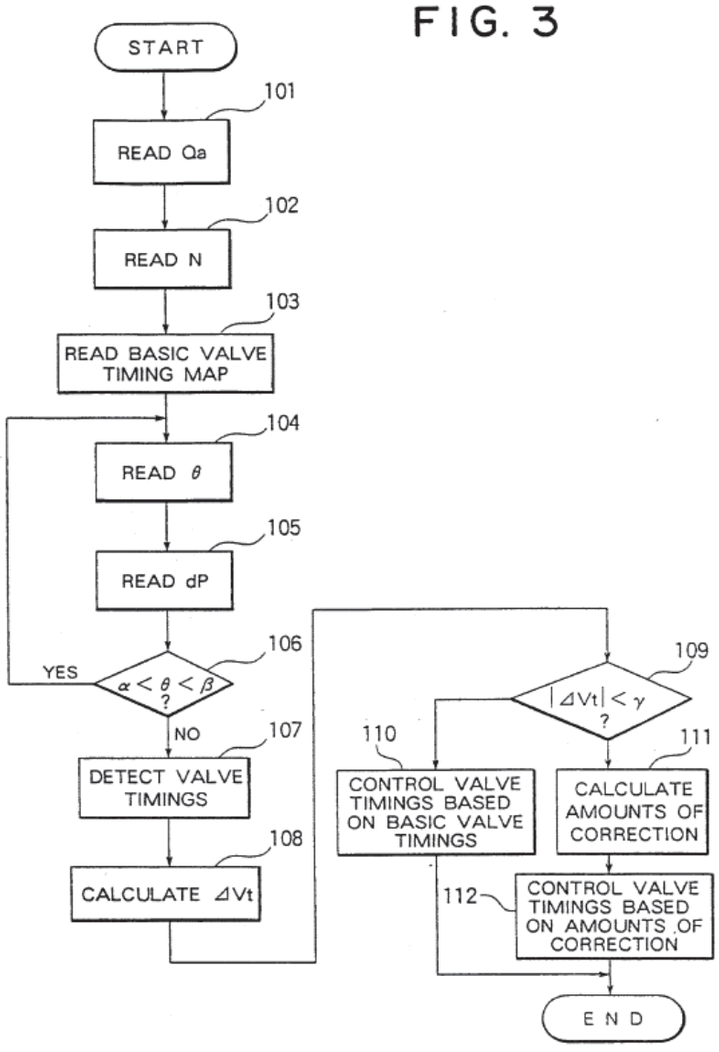


EX1006, FIG. 1.

98. Figure 3 of Ohkubo illustrates the operation of the valve timing control system including: reading the quantity of intake air Qa (step 101); calculating the engine revolution speed N (step 102); reading open/close timing values for the intake and exhaust valves from a map (step 103); detecting the valve open/close times (step 107) depending on the crank angle Θ, calculating a deviation ΔVt between the predetermined open/close times and detected valve

open/close times (step 108); calculating a correction for the timing(s) if the deviation ΔVt is outside an allowable range (step 111); and controlling the valve opening and closing times based on the corrected amounts in a feedback manner (step 112). EX1006, 4:66-5:57.

FIG. 3



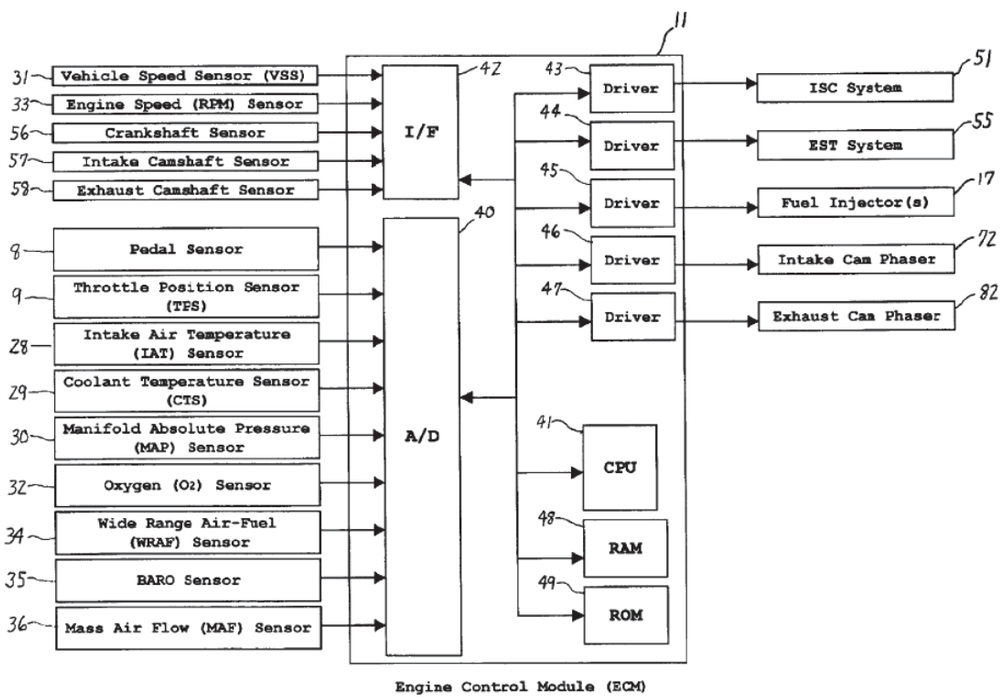
EX1006, FIG. 3.

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C. Reed

99. Reed is also directed to variable cam timing to vary the phasing of intake valves and/or exhaust valves so as to achieve lower gas emissions and improved fuel economy while delivering as closely as possible desired torque, just like Yoshioka and Ohkubo. EX1007, Abstract. Figure 2 of Reed illustrates the electronic control module (ECM) 11 controlling two continuously variable cam timing mechanisms 72 and 82, one for the intake valves and the other for the exhaust valves. *Id.*, 5:13-22.

FIGURE 2



EX1007, FIG. 2.

100. Reed further discloses that the ECM varies the intake valve and exhaust valve timing based on temperature and pressure. EX1007, 12:45-59, 15:28-41.

X. Ground 1: The combination of Yoshioka and Ohkubo renders obvious claims 1, 2, 7, and 10-16.

A. Rationale for combining Yoshioka with Ohkubo

101. In my opinion, a POSA would have been motivated to combine the teachings of Yoshioka and Ohkubo for multiple reasons, thus rendering the claims obvious.

102. First, Yoshioka and Ohkubo are from the same field of endeavor—control systems for valve timing for an internal combustion engine. Yoshioka and Ohkubo, in particular, are directed to analogous valve timing control systems. Yoshioka discloses "a method of and apparatus for controlling a continuously variable valve timing mechanism of an internal combustion engine, to continuously and variably control the open/close timing of an intake or exhaust valve of the engine according to a target timing." EX1005, 1:9-14. Ohkubo similarly discloses "a valve timing control system for an internal combustion engine which controls the opening and closing of intake and exhaust ….". EX1006, 1:6-10. Moreover, Yoshioka and Ohkubo's analogous valve timing control systems are both directed to improving power output of an engine by optimizing valve timing. EX1005, 2:32-34 ("The first and second aspects of the present invention are capable of

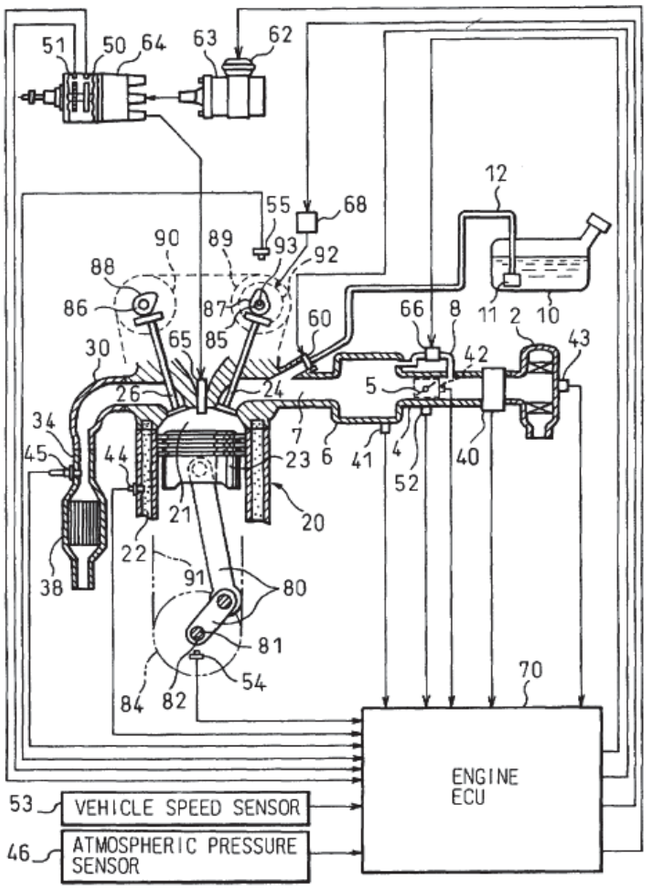
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optimizing valve timing to maintain the output of the engine at high altitudes."); EX1006, 1:55-59 ("Another object of the present invention is to provide a valve timing control apparatus for an internal combustion engine which is able to improve the air-intake and exhaust-discharge efficiency of the engine, thereby increasing engine output power."). The engines and control systems of Yoshioka and Ohkubo also include analogous components:

Yoshioka	Ohkubo
Electronic Control Unit (ECU) 70	Control Unit 25
Intake Valve 24	Intake Valve 12
Exhaust Valve 26	Exhaust Valve 14
Airflow Meter 40	Airflow Meter 17
Crank Angle Sensor 51	Crank Angle Sensor 21
O_2 (Oxygen) Sensor 45	Oxygen Sensor 24

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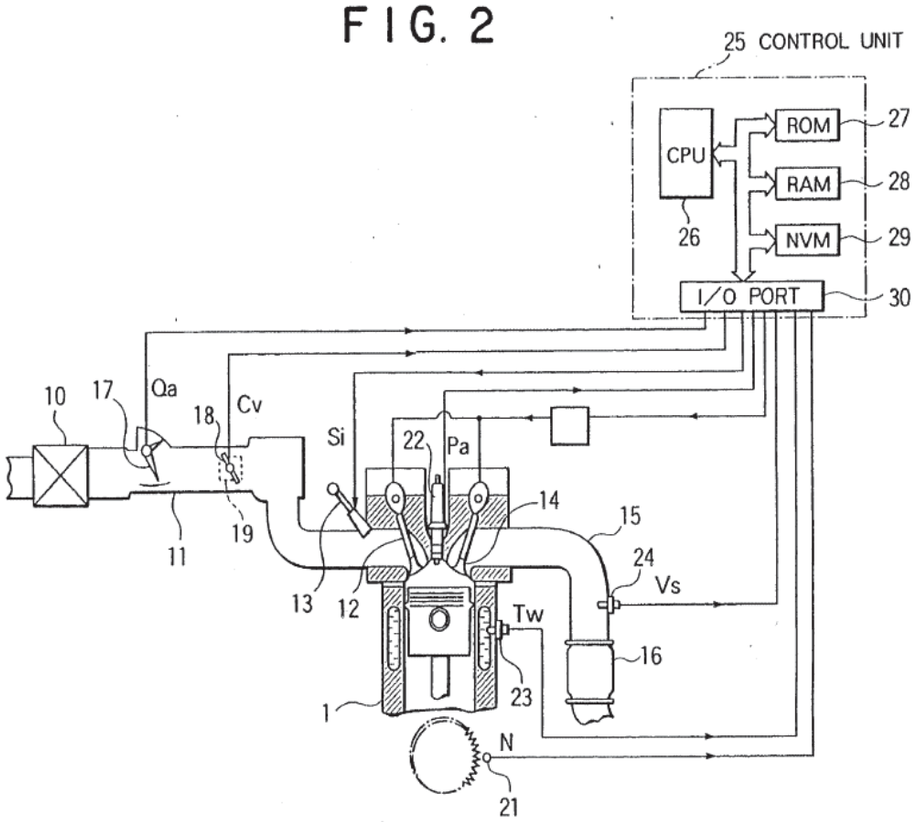
Fig. 1



EX1005, FIG. 1.

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FIG. 2

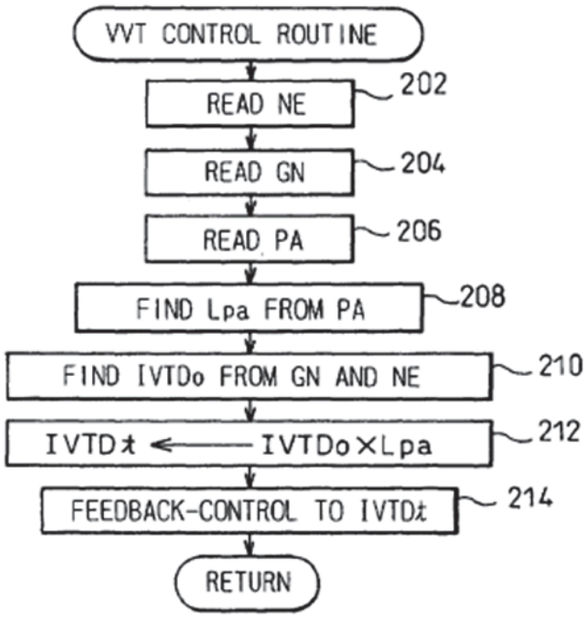


EX1006, FIG. 2.

103. Yoshioka and Ohkubo also both disclose similar methods of controlling valve timing, including: measuring aspects of engine performance (*e.g.*, engine revolution speed), determining target valve timings, detecting actual valve timings, and correcting valve timings in a feedback manner. EX1005, 7:16-8:8; EX1006, 4:66-5:57.

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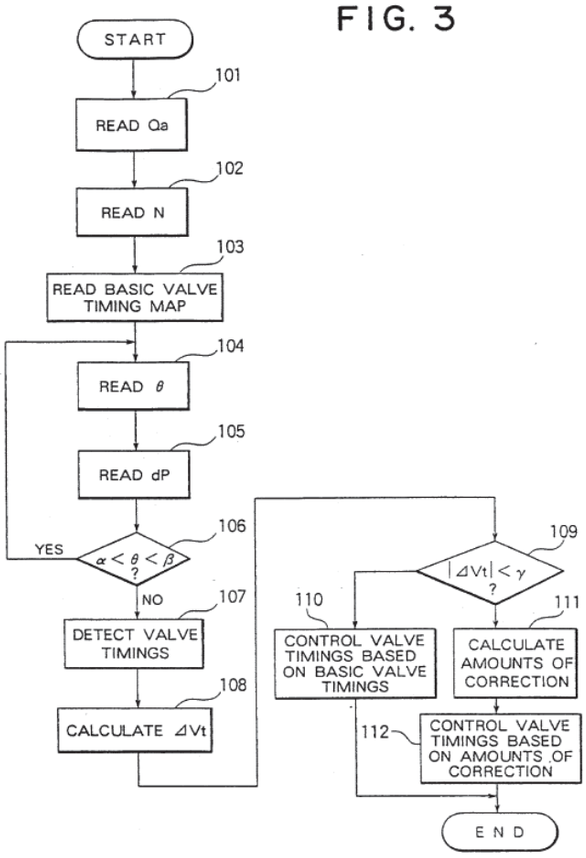
Fig. 9



EX1005, FIG. 9.

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FIG. 3



EX1006, FIG. 3.

104. Further, Ohkubo discloses specific implementation details of controlling valve timing that would have been readily applicable to Yoshioka's ECU 70 for controlling valve timing. Ohkubo, in particular, discloses that the control unit 25 calculates a deviation ΔVt between target valve timing and actual valve timing, and, if the ΔVt is outside of the allowable range γ, an appropriate amount of correction for the valve timing(s) is calculated. EX1006, 5:51-54. Ohkubo also recognized that by controlling the valve opening and closing

timings—including EVO, EVC, IVO, and IVC—in this feedback manner in accordance with the deviations between the detected values of the valve opening and closing timings and the predetermined values, the accuracy of controlling the valve opening and closing timings is improved and "the air-intake efficiency and the exhaust-discharge efficiency of the engine can be improved, thus increasing the output power of the engine." *Id.*, 6:13-22.

105. Yoshioka, like Ohkubo, discloses "bring[ing] the actual displacement of the intake valve 24 to the target displacement IVTDt" but does not explicitly state how the actual displacement of the intake (or exhaust) valve is brought to the target displacement IVTDt. EX1005, 8:6-8. Because Yoshioka is silent on this implementation detail, it is my opinion that a POSA would have thus sought out these details, provided by Ohkubo's analogous valve control system. In my opinion, combining the teachings of Yoshioka and Ohkubo would have yielded predictable benefits and results—for example, precise control of valve timing to "bring the actual displacement of the intake valve 24 to the target displacement IVTDt." *Id.*. And doing so would have merely been applying a known technique in a similar, known device in the same way.

106. In my opinion, a POSA would have also had a reasonable expectation of success combining Yoshioka and Ohkubo. Specifically, a POSA would have recognized that there are only a finite number of ways to "bring the actual

displacement of the intake valve 24 to the target displacement IVTDt" as described by Yoshioka (*Id.*, 8:6-8), including calculating a deviation between the actual valve timing displacement and the target valve timing displacement and a correction. Ohkubo's disclosed technique for bringing actual valve timing displacement to the target valve timing displacement was a predictable solution readily applicable to Yoshioka's ECU 70.

107. In my opinion, a POSA would have also understood how to combine the teachings of Yoshioka and Ohkubo to control the valve timing. A POSA would have simply used Ohkubo's implementation details, for example, calculating a deviation ΔVt between target valve timing and actual valve timing and calculating an appropriate amount of correction for the valve timing(s), in order to accurately control Yoshioka's valve timings. This would have been routine for a POSA.

108. In my opinion, a POSA would have further understood that Ohkubo's valve timing correction technique would have been combined in a known way to provide the predictable benefits disclosed in Ohkubo to improve the accuracy of controlling the valve opening and closing timings such that "the air-intake efficiency and the exhaust-discharge efficiency of the engine can be improved, thus increasing the output power of the engine."

109. Accordingly, it is my opinion that it would have been obvious to combine the teachings of Yoshioka and Ohkubo.

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B. Yoshioka and Ohkubo renders obvious claim 1.

1. [1.P] "A method for calculating a valve timing command for an engine of a vehicle"

110. Yoshioka discloses a "method for calculating a valve timing command for an engine of a vehicle." Specifically, Yoshioka discloses "a method . . . for optimizing valve timing according to atmospheric pressure for a continuously variable valve timing mechanism . . . " and aims to "improve the output of an engine at high altitudes under high load, as well as reducing fuel consumption and improving exhaust purifying performance at high altitudes under low/medium load." EX1005, 1:40-47, *see also* 2:30-34, 6:65-7:1, cl. 1 ("A method of controlling a continuously variable valve timing mechanism of an internal combustion engine").

111. In my opinion, it would have been apparent to a POSA that Yoshioka's methods include "calculating" a valve timing command. Thus, Yoshioka discloses [1.P].

2. [1.A] "obtaining an engine performance command;"

112. The '540 patent broadly characterizes the claimed "engine performance command" as encompassing any variable related to engine performance, including for example, an engine torque command. EX1001, 2:4-22 ("The action of obtaining an engine performance command 16 preferably includes receiving a vehicle performance command from a driver. Preferably, the vehicle

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performance command is received from the foot of a driver with the use of a conventional pedal 28, as shown in FIG. 1. Alternatively, the vehicle performance command could be received from the driver with the use of any suitable device. The action of obtaining an engine performance command also preferably includes deriving the engine performance command from the vehicle performance command. **The engine performance command** is preferably based on the vehicle performance command, but **may alternatively be based on additional suitable factors**, such as a traction control signal or a cruise control signal. The engine performance command is preferably a desired engine torque and, for this reason, the engine performance command may be thought of as an engine torque command. **The engine performance command**, however, **may alternatively be another suitable variable**, such as a desired engine acceleration."). In my opinion, a POSA would have thus understood that the claimed "engine performance command" includes any variable related to engine performance and is not limited to the "preferred" variables (*e.g.*, an engine torque command).

113. Yoshioka discloses "obtaining an engine performance command." For example, Yoshioka's ECU 70 receives a signal from the crank angle sensor 51 indicating the engine revolution speed NE, a signal from the airflow meter 40 indicating the mass flow rate of intake air, and a signal from the throttle opening

sensor 42, each of which corresponds to the claimed "obtaining an engine performance command."

114. In particular, Yoshioka discloses an electronically controlled internal combustion engine equipped with a throttle valve, a throttle sensor, and an electronic engine control unit (ECU). EX1005, 3:19-22, 5:21-34. Figure 1 of Yoshioka illustrates the engine, including: a "throttle valve 5 arranged in the throttle body 4," which "adjusts the quantity of intake air" (*id.*, 4:13-14); an airflow meter 40, which "measures the mass flow rate of intake air" (*id.*, 4:14-15); a throttle sensor 42, which "detects the opening of the throttle valve 5" (*id.*, 4:20-21); a crank angle sensor 51, which calculates "an engine revolution speed NE" (*id.*, 7:18-20); and an electronic engine control unit (ECU) 70, which is a "microcomputer to control fuel injection, ignition timing, idling speed, and in addition, the open/close timing of a valve." *Id.*, 5:22-25.