

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTORTECH GMBH and MOTORTECH AMERICAS, LLC,

Petitioners,

- vs. -

ALTRONIC,

Patent Owner.

Case IPR2025-00398

U.S. Patent No. 7,401,603

**DECLARATION OF MARK EHSANI, Ph.D.
IN SUPPORT OF PETITION FOR *INTER PARTES*
REVIEW OF U.S. PATENT NO. 7,401,603**

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I, Mark Ehsani, Ph.D., hereby declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

1. I have been retained on behalf of MOTORTECH GmbH and MOTORTECH Americas, LLC (collectively, “Petitioners”) to provide my technical review, analysis, insights, and opinions concerning the validity of the claims of U.S. Patent No. 7,401,603 (EX1001; “the ’603 Patent”) entitled “High Tension Capacitive Discharge Ignition With Reinforcing Triggering Pulses.” The patent is assigned to Altronic, Inc. (“Patent Owner”).

2. I earned a Bachelor of Science degree in electrical engineering from the University of Texas at Austin in 1973. I obtained a Master of Science degree in electrical engineering from the University of Texas at Austin in 1974. I earned a Doctorate in electrical engineering from the University of Wisconsin-Madison in 1981. My doctorate work was focused on energy systems and control systems. Between obtaining my undergraduate and doctoral degree, I was a Research Engineer with the Fusion Research Center and the University of Texas doing research and spark gap power switching equipment development on high power supplies and power electronic and mechanical circuit breaker technology development. While obtaining my Doctorate, I was with Argonne National Laboratory, Argonne, Illinois, as a Resident Research Associate, developing similar and related power switching equipment and systems.

3. Since obtaining my Doctorate, I have been at Texas A&M University at College Station, where I am now the Robert M. Kennedy endowed Professor of Electrical Engineering and Director of the Power Electronics and Motor Drives Laboratory and the Advanced Vehicle Systems Research Program.

4. I am the author of over 500 publications in the areas of power circuit breakers, power electronics, energy systems, motor drives, and electric and hybrid electric vehicles, and other areas of control, storage, and use of electric power and energy systems. I was the recipient of the Prize Paper Awards in Static Power Converters and motor drives at the IEEE-Industry Applications Society 1985, 1987, and 1992 Annual Meetings, as well as over 140 other honors and recognitions. I am the co-author of twenty-three books on power electronics and motor drives. In addition to the above publications, I have over 30 granted or pending US and EP patents in the general field of power electronics. I have also been a consultant to over 60 companies, US government agencies and international organizations. My current research work is in power electronics, energy systems, motor drives, hybrid vehicles and their control systems, and sustainable energy engineering. During my over 40 years of employment at Texas A&M, I have originated and taught over eight different undergraduate and graduate electrical engineering courses on a variety of topics including power electronics, motor drives, dc power systems, electric and

hybrid electric vehicles, sustainable energy and transportation systems, and industrial practice of electrical and computer engineering.

5. I have been a co-founder and member of IEEE Power Electronics Society (PELS) AdCom, past Chairman of PELS Educational Affairs Committee, past Chairman of IEEE-IAS Industrial Power Converter Committee and past chairman of the IEEE Myron Zucker Student-Faculty Grant program. I was the General Chair of IEEE Power Electronics Specialist Conference for 1990. I am the founder of IEEE Power and Propulsion Conference, the founding chairman of the IEEE Vehicular Technology Society (“VTS”) Vehicle Power and Propulsion and chairman of Convergence Fellowship Committees. In 2002, I was elected to the Board of Governors of VTS. I have also served on the editorial board of several technical journals and was the associate editor of IEEE Transactions on Industrial Electronics and IEEE Transactions on Vehicular Technology. I am a Life Fellow of IEEE, a past and present IEEE Industrial Electronics Society and Vehicular Technology Society Distinguished Speaker, IEEE Industry Applications Society and Power Engineering Society Distinguished Lecturer. I was also the first IEEE fellow that was also elected as the Fellow of Society of Automotive Engineers, SAE. I am also a registered professional engineer in the State of Texas.

6. I attach my curriculum vitae, which includes a more detailed list of my qualifications, as Exhibit A. My curriculum vitae also contains a list of all other

cases in which, during the previous 4 years, I testified as an expert at trial or by deposition. My work on this case is being billed at a rate of \$500 per hour, with reimbursement for actual expenses. I have no direct financial interest in the dispute between Patent Owner and Petitioners, and my compensation is not contingent upon the outcome of this *Inter Partes* review.

II. UNDERSTANDING OF THE GOVERNING LAW

7. I am not an attorney and offer no legal opinions. For the purposes of this Declaration, I understand certain aspects of the law that are relevant to my analysis, as summarized below.

A. Interpreting Claims Before the Patent Office

8. I understand that the first step in an obviousness analysis involves construing the claims, as necessary, to determine their scope. Second, the construed claim language is then compared to the disclosures of the prior art. I am informed that claims are generally given their ordinary and customary meaning as understood by a person of ordinary skill in the art (“POSA”) at the time of the alleged invention, in light of a patent’s “specification.”

9. I understand that *Inter Partes* Review is a proceeding before the United States Patent & Trademark Office (“USPTO”) for evaluating the validity of issued patent claims. I understand that, in an *Inter Partes* Review, a claim term is interpreted in a manner consistent with the standard used in patent litigation, as set

forth in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). That standard generally construes the claims according to their “ordinary and customary” meaning in view of the claim language, specification, and file history, and where applicable, relevant other evidence.

10. I understand that a patent’s specification includes all the figures, discussion, and claims within the patent. I understand that the USPTO will look to the specification and prosecution history to see if there is a definition for a given claim term, and if not, will apply the ordinary and customary meaning from the perspective of a POSA at the time in which the alleged invention was made.

11. I understand that claim construction is a matter of law and that the final constructions for this proceeding will be determined by the Patent Trial and Appeal Board.

B. Invalidity Based on Obviousness

12. I understand that obviousness under 35 U.S.C. § 103 is analyzed from the perspective of a person of ordinary skill in the art (“POSA”) at the time of the alleged invention. I also understand that a POSA is presumed to have been aware of all pertinent prior art at the time of the alleged invention.

13. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention as a whole would have been obvious to a POSA in view of the prior art, and in light of the general

knowledge in the art at the time the invention was made. I also understand that the invention may be deemed obvious when a POSA would have reached the claimed invention through routine experimentation.

14. I understand that obviousness can be established by combining or modifying the disclosures of the prior art to achieve the claimed invention. It is also my understanding that where there is a reason to modify or combine the prior art to achieve the claimed invention, there must also be a reasonable expectation of success in so doing to render the claimed invention obvious. I understand that the reason to combine prior art references can come from a variety of sources, not just the prior art itself and need not be tied to the specific problem the patentee was trying to solve. I also understand that the references themselves need not provide a specific hint or suggestion of the alteration needed to arrive at the claimed invention; the analysis may include recourse to logic, judgment, and common sense available to a POSA.

15. I understand that when there is some recognized reason to solve a problem, and there are a finite number of identified, predictable solutions, a POSA has good reason to pursue the known options within his or her technical grasp. If such an approach leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In such a circumstance, when a patent simply arranges old elements with each performing the same function it had

been known to perform and yields no more than one would expect from such an arrangement, the combination is obvious.

16. I understand that when considering the obviousness of an invention, one should also consider whether there are any objective indicia that support the non-obviousness of the invention. I further understand that objective indicia of non-obviousness include failure of others, copying, unexpected results, information that “teaches away” from the claimed subject matter, perception in the industry, commercial success, and long-felt but unmet need. I also understand that in order for objective indicia of non-obviousness to be applicable, the indicia must have some sort of nexus to the subject matter in the claim that was not known in the art. I understand that this nexus includes a factual connection between the patentable subject matter of the claim and the objective indicia alleged. I also understand that an independently made invention that is made within a comparatively short period of time is evidence that the claimed invention was the product of ordinary skill.

17. Finally, I understand that patent examiners at the U.S. Patent and Trademark Office (“USPTO”) rely upon certain exemplary rationales in reviewing patent applications to understand whether the subject matter of the claims is obvious. I understand that the following is the list of exemplary rationales relied upon by patent examiners at the USPTO:

- (A) Combining prior art elements according to known methods to yield predictable results;
- (B) Simple substitution of one known element for another to obtain predictable results;
- (C) Use of a known technique to improve similar devices (methods, or products) in the same way;
- (D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- (E) “Obvious to try” – Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- (G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

III. MATERIALS RELIED ON IN FORMING MY OPINIONS

18. In forming the opinions expressed in this report, I have relied on my own knowledge, experience, and expertise, as well as the knowledge of a POSA in the relevant timeframe. In addition, I have reviewed and relied upon all documents referenced in this report and the following list of materials:

- The '603 Patent (EX1001);
- The prosecution history for the '603 Patent (EX1002);
- *Capacitor Discharge Ignition System*, Research Disclosure, database number 335026 (Mar. 1992) (“Research Disclosure”) (EX1005).
- U.S. Patent No. 4,181,112 (“Grather”) (EX1006);
- U.S. Patent No. 6,701,904 (“Lepley-I”) (EX1007);
- U.S. Patent No. 9,429,132 (“’132 Patent”) (EX1008);
- Claim Construction Order from Inv. No. 337-TA-1390 (EX1010); and
- Testimony from Investigation No. 337-TA-1390 (EX1011–EX1016).

19. I understand that on February 9, 2024, Petitioners received from the U.S. International Trade Commission (“ITC”), a Notice of Institution of Investigation based on a complaint served by Patent Owner alleging violations of section 337 based upon the importation into the United States, the sale for importation, and the sale within the United States after importation of certain capacitive discharge ignition systems, components thereof, and products containing

the same of alleged infringement of certain claims of the '603 Patent (the "ITC Proceeding"). EX1009, p. 1. I was present during the ITC Proceeding, including testimony from Patent Owner's technical witnesses, and I rely on portions of that testimony in support of my opinions set forth herein.

IV. BACKGROUND DISCUSSION OF THE RELEVANT TECHNOLOGY

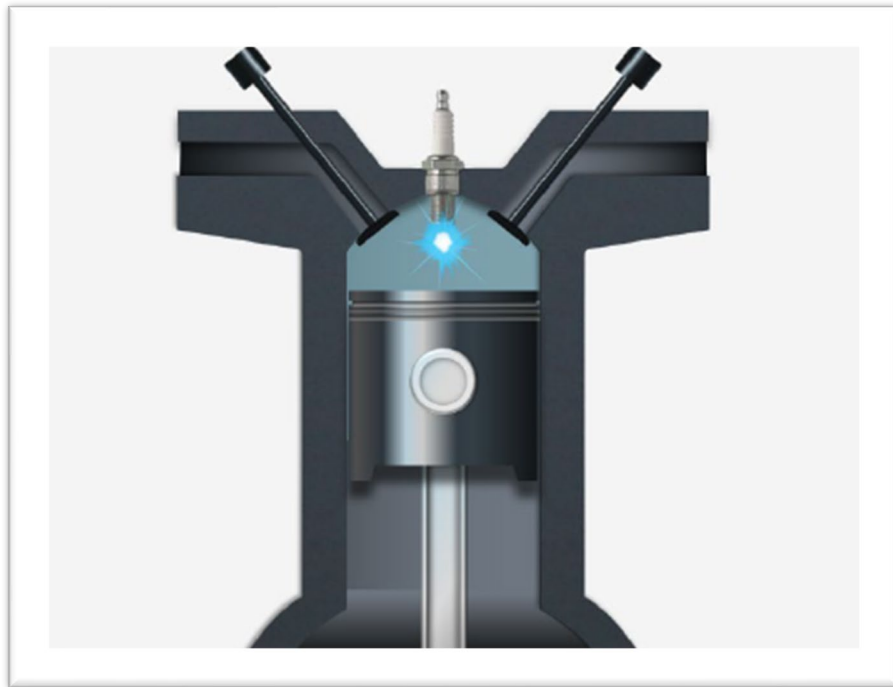
20. To better understand my opinions on the invalidity of the claims of the '603 Patent, I provide below some background on combustion engines with a particular focus on capacitive discharge ignition systems for internal combustion engines. All of the concepts discussed in this section were well known and used prior to the February 2, 2007 priority date for the '603 Patent.

A. Capacitive Discharge Ignition Systems for Internal Combustion Engines Were Ubiquitous

21. In this subsection I provide an introduction to conventional ignition systems for internal combustion engines, including an explanation of what capacitive discharge ignition systems are and how they work.

22. In general, ignition systems used in internal combustion engines provide a high-voltage spark into an engine's cylinder (shown below), which causes a fuel/air mixture within the cylinder to explode. The process begins by pumping a fuel/air mixture into a cylinder. The cylinder contains a piston, which is forced upward. The upward movement of the piston in the cylinder compresses the fuel/air mixture. The ignition system next generates a spark across the spark plug. Ideally,

the spark is maintained by the ignition system for a period of time known as the “spark duration.” The spark duration is long enough to ignite the fuel/air mixture. Igniting the fuel/air mixture releases energy that forces the piston back down. The downward movement of the piston, in turn, causes rotation of the crankshaft to operate the engine. It is important to time the ignition and corresponding movement of the piston to occur when the crankshaft is at a certain angle of its rotation in order to make the most efficient use of the energy in the system, with the goal of igniting all of the fuel/air mixture. This is sometimes referred to as operating “in synchronism” with the engine.



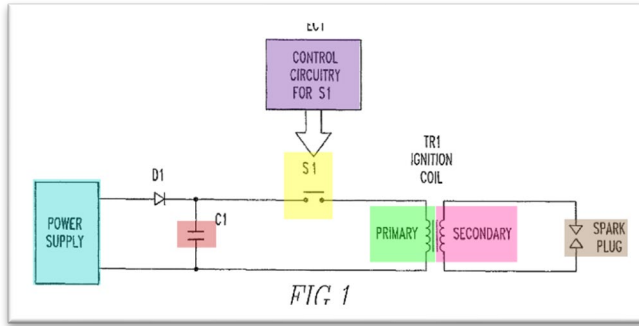
Operation of a Spark in an Engine

23. Ignition systems involve several basic electrical concepts. First, a spark plug includes a pair of electrodes that are spaced a certain distance apart. This space between the electrodes is sometimes referred to as an “air gap.” If only a small voltage were to be applied across the electrodes of the spark plug, the air gap between the electrodes would prevent any current from flowing. This state is sometimes referred to as an “open circuit” state because the electrodes are spaced apart from each other, resulting in the electrodes being disconnected from one another. This is the same concept as a switch having an open position (e.g., off / non-conducting) and a closed position (e.g. on / conducting). As a result, current cannot flow between the electrodes unless a spark is generated.

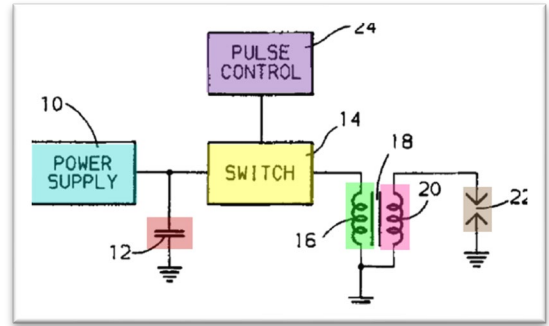
24. When the voltage across the spark plug electrodes reaches a sufficiently high level, a spark forms. The spark provides a conductive path that bridges the gap between the electrodes and allows current to flow. The minimum voltage required to generate the spark across the electrodes is called the “breakdown voltage.” When the voltage generated by the ignition system exceeds the breakdown voltage, then the spark (or electric arc) forms across the electrodes. Current continues to flow across the air gap and between the electrodes as long as the spark is present. When the spark goes out or is “quenched,” the current abruptly stops flowing and the spark plug returns to the open circuit state.

25. Capacitive discharge ignition (CDI) systems are a type of ignition system that were well known at the time of the '603 Patent. A CDI system uses a storage capacitor to temporarily store energy, and then quickly discharges that energy to feed the spark (the arc). More particularly, a CDI system includes a power source, a capacitor, a switch, and a transformer (also called an "ignition coil"). The transformer includes a primary winding and a secondary winding. The purpose of the transformer in the CDI system is to increase the voltage to the level needed to initiate the arc. As such, the transformer can be referred to as a step-up transformer, which converts a low voltage to a much higher voltage (greater than the breakdown voltage). The transformer is designed to do this by having a certain number of turns in the primary winding of the transformer, and many more turns in the secondary winding of the transformer. The voltage increase is proportional to the ratio of the number of turns in the secondary winding to the number of turns in the primary winding.

26. A basic CDI system is illustrated in FIG. 1 of the '603 Patent (EX1001) and also in the Figure of Research Disclosure (EX1005), reproduced below.



EX1001, Figure 1 (Annotated)



EX1005, Figure (Annotated)

27. Briefly, a power supply (blue) supplies power to charge the capacitor (red). A switch (yellow) is initially opened to prevent current from flowing to the transformer while the capacitor is being charged. At the appropriate time, a controller (purple) closes the switch. Once closed, energy in the capacitor is then discharged through the switch to the ignition coil's primary winding (green). This creates a high voltage in the secondary winding (pink), and if the voltage exceeds the breakdown voltage, it generates the spark at the spark plug (brown). Once the spark is generated, the voltage drives a current to the spark plug, and the current maintains the spark for the desired duration of time.

B. Circuit Synchronization and Pulse Arrangement Techniques Were Well-Known for Generating and Maintaining a Spark in Ignition Systems

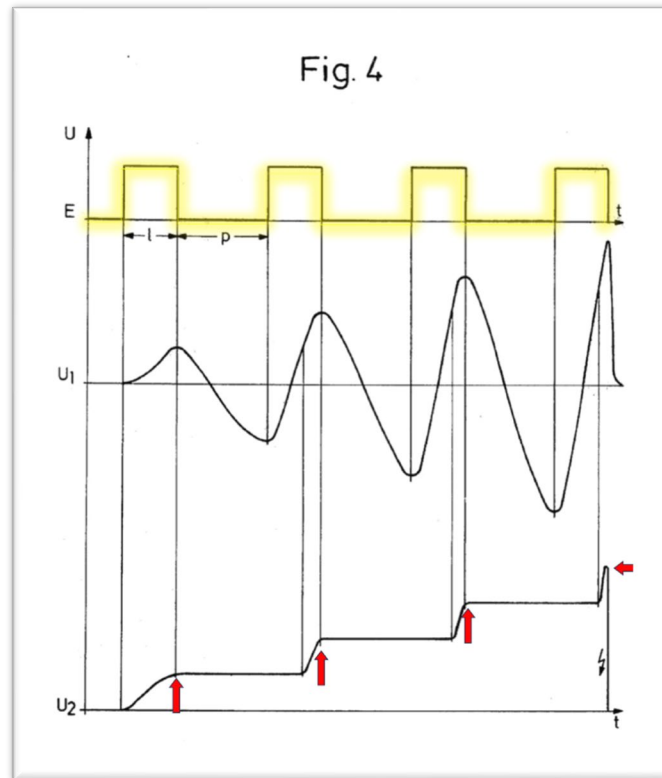
28. In a capacitive discharge ignition system, a controller commonly is used to synchronize the timing of the spark with the engine's crankshaft rotation. It is important that the spark be timed so that the piston has moved upward in the cylinder

and has compressed the fuel/air mixture, and also so that the crankshaft is at the proper angle of rotation to receive the air/fuel ignition energy applied to the piston.

29. It was well-known that capacitive discharge ignition systems commonly use a controller as a pulse control. *See e.g.*, EX1005, Figure at 3. Such pulse control mechanisms can control the switch to generate multiple sequentially generated pulse signals or “pulse trains.” *See e.g.*, EX1005, 2:12–18; EX1006, 1:60–65.

30. In a capacitive discharge ignition system, after the spark event, sequentially generated pulses can be applied to the spark gap to cause a build-up of charge accumulation that feeds energy to the spark (arc) to sustain it for the required duration. For example, a patent issued to Günter Gräther et al. (“Grather,” EX1006) in 1980 disclosed a “high-voltage ignition system” that “generate[s] a spark for an internal combustion engine, and method to generate the spark energy.” EX1006, Title. In this prior art system, “[a]n electronic system so adjusts the length of the signals [signal length, “l”] and the gaps between signals [signal pause, “p”] that a charge accumulation will occur at the spark gap of the spark plug until breakdown occurs.” EX1006, 1:62–65. The electronic system can generate “[c]harge accumulation” by “adjusting the signals of graph E” [illustrated in FIG. 4 below] “which control the opening and closing of the switch 18.” EX1006, 5:19–25, FIG.

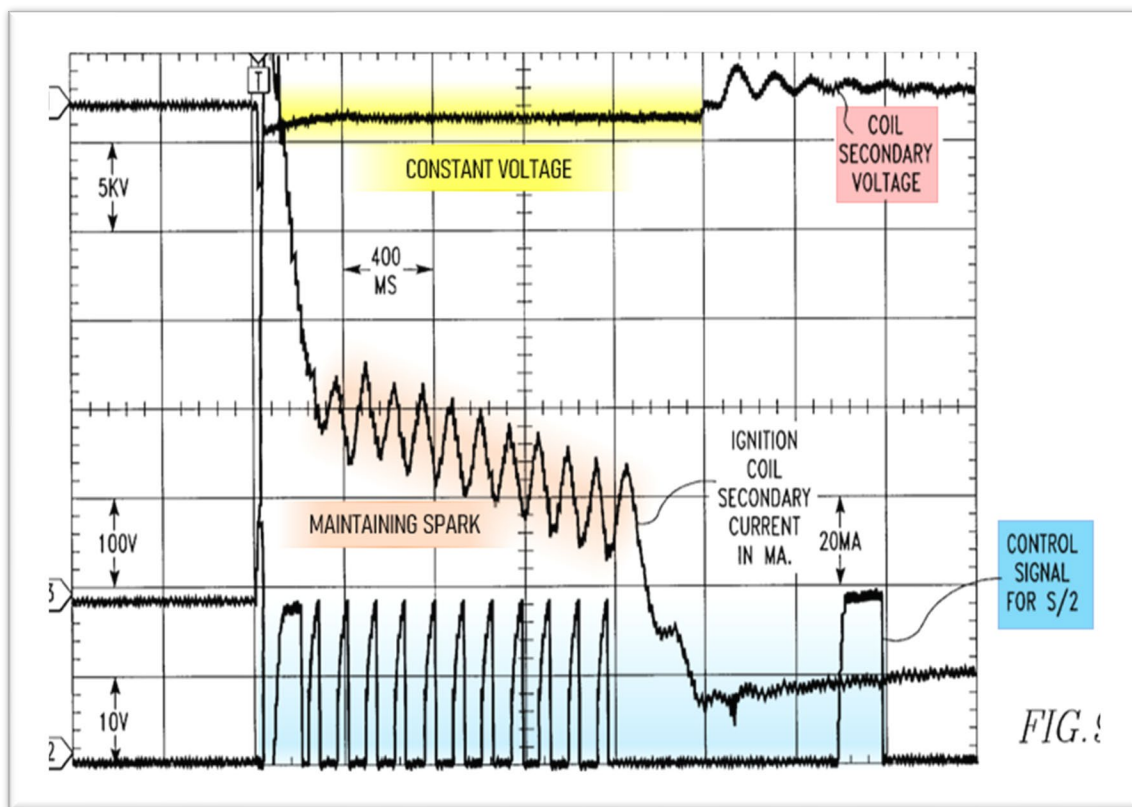
4. This results in a rise in voltage at the spark gap, which is depicted as trace “U2” in FIG. 4 below. EX1006, 5:33–37.



EX1006, Figure 4 (Annotated)

31. In a capacitive discharge ignition system, after the spark is established (or struck), sequentially generated current pulses can be applied to the spark gap to extend the magnitude or duration of the spark. For example, Lepley-I, a patent published in 2002 and naming the same inventor as the '603 Patent (“Lepley-I,” EX1007), disclosed a “capacitive discharge ignition system with extended duration spark.” EX1007, Title. A stated purpose of the invention was to generate a spark duration “three to six times longer than typical for the type of ignition coil in use.”

EX1007 at 1:12-16. This prior art system demonstrated that the spark duration can be increased by controlling either the number or width of sequentially generated pulses sent to the ignition transformer. EX1007, 1:53–56, 3:54–4:33. For example, Figure 9 below shows “twelve equally spaced reenergizing pulses” (highlighted in blue) that are “used to extend the spark duration” (highlighted in orange). EX1007, 4:25–26, FIG. 9.



EX1007, Figure 9 (Annotated)

32. When evaluating the performance of an ignition system, it is (and was at the time of the invention) common to measure various signals using an

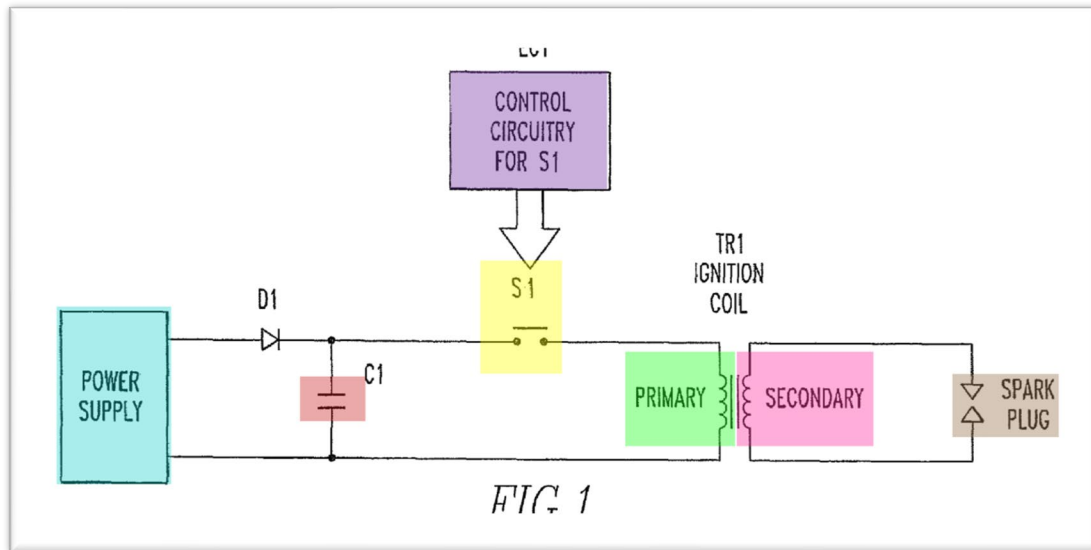
oscilloscope, as evidenced in the above figure from Lepley-I. An oscilloscope is an electronic instrument that graphically displays electrical signals. An oscilloscope can detect the voltage and current signals going into and resulting from the system, and then display graphical representations of the waveforms (sometimes referred to as “traces”) on the oscilloscope display. Patents and publications often include graphical representations of oscilloscope displays, which are sometimes referred to as “oscillograms.” Oscillograms can display various signals such as a control signal delivered to a switch; a voltage waveform at the primary or secondary winding; and current waveforms at the primary or secondary winding. For example, Figure 9 of Lepley-I, reproduced above, is an oscillogram that “shows extended capacitive discharge circuit waveforms . . . with long duration extension pulses and with higher arc current.” EX1007, 2:20–22.

V. OVERVIEW OF THE '603 PATENT

A. Specification of the '603 Patent

33. The '603 Patent relates to “capacitive discharge ignition systems” used to “deliver energy to the primary of an ignition coil (transformer) in synchronism with the rotation of the engine crank shaft” of an internal combustion engine. EX1001, 1:8–11.

34. The '603 Patent discloses the same “basic capacitive discharge circuit” as the prior art. EX1001, 3:32–33. Figure 1, reproduced below, shows a power supply (shown in blue) connected in series with a storage capacitor C1 (shown in red). EX1001, 3:32–35, FIG. 1. A controllable switch S1 (shown in yellow) is controlled by an electronic control circuit (EC1) (shown in purple). EX1001, 3:39–40, FIG. 1. As shown in FIG. 1, the primary winding (shown in green) is in series with the capacitor C1 and the switch S1, such that the capacitor is charged when the switch S1 is open. EX1001, 3:36–38, FIG. 1. When the switch S1 is closed, the capacitor C1 discharges to transfer energy (i.e., a voltage) across the primary winding of the ignition transformer TR1. EX1001, 3:41–46, FIG. 1. A spark plug (shown in brown) is connected in series with the secondary winding (shown in pink) of the ignition transformer TR1. EX1001, 3:38–39. The secondary winding of the ignition transformer TR1 subsequently creates a secondary voltage that is applied across the spark plug 22. EX1001, 3:67–4:2, FIG. 1. Provided that the secondary voltage exceeds the spark plug gap breakdown voltage threshold, a spark is then formed at the spark plug 22, at which time a secondary current flows through the spark plug. EX1001, 2:59:63, FIG. 1.

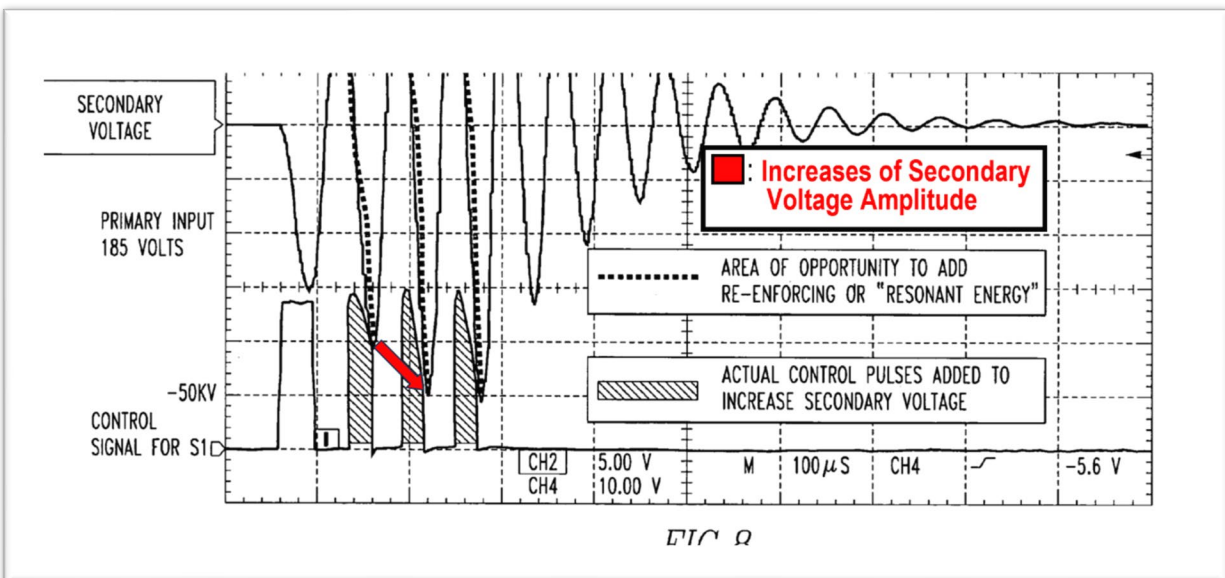


EX1001, Figure 1 (Annotated)

35. The '603 Patent explains that its “switch is controlled to create a train of pulses to the primary winding [of the ignition transformer that is] *timed to reinforce the ringing action of the ignition transformer.*” EX1001, Abstract. According to the '603 Patent, “it is an object . . . to provide a capacitive discharge ignition system capable of generating a spark discharge between the spark plug electrodes with a higher breakdown voltage capability, greater secondary current, and spark duration much longer than typical for the type of ignition [transformer] in use.” EX1001, 1:31–36.

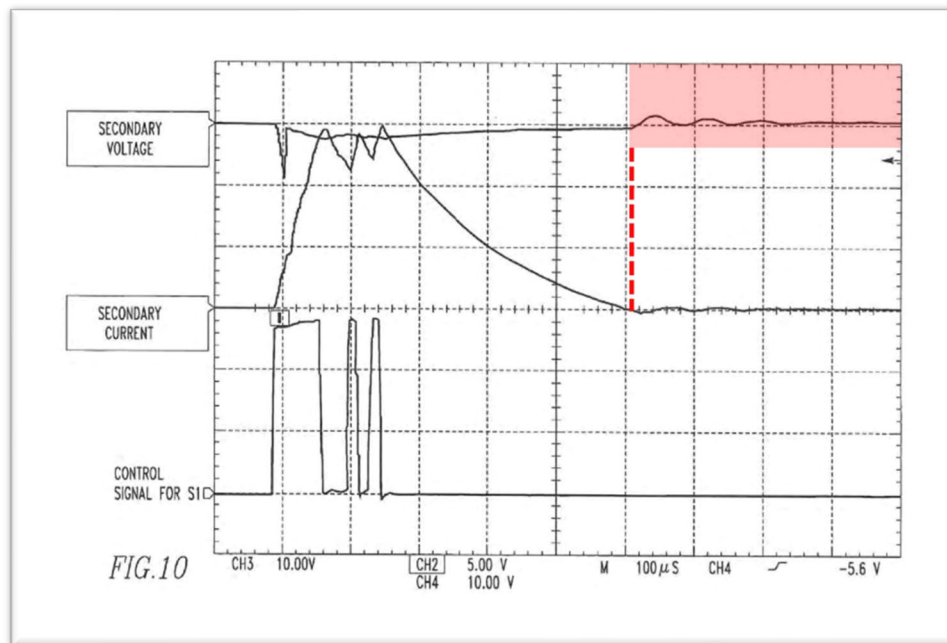
36. The timing of the control pulses is shown, for example, in Figure 8 of the '603 Patent, reproduced below. In Figure 8, a first control pulse signal (labeled as “Control Signal for S1”) creates the first oscillation of the secondary voltage

waveform shown at the top of the figure. EX1001, FIG. 8. Figure 8 depicts dotted lines labeled “Area of Opportunity to Add Re-Enforcing or ‘Resonant Energy,’” which correspond with specific portions of the secondary voltage waveform. EX1001, FIG. 8. Figure 8 also shows shaded portions of the control pulse signal that correspond with these “areas of opportunity” and identifies them as “Actual Control Pulses Added to Increase Secondary Voltage.” EX1001, FIG. 8. As shown by the red arrow in the annotated figure below, the effect of these subsequent control pulses is an increase of the voltage amplitude, seen by the spark plug. Thus, Figure 8 shows an example of control pulses arranged at a specific time of the secondary voltage waveform—during the “area of opportunity to add re-enforcing or ‘resonant energy’”—to increase the amplitude of the secondary voltage waveform. EX1001, FIG. 8.

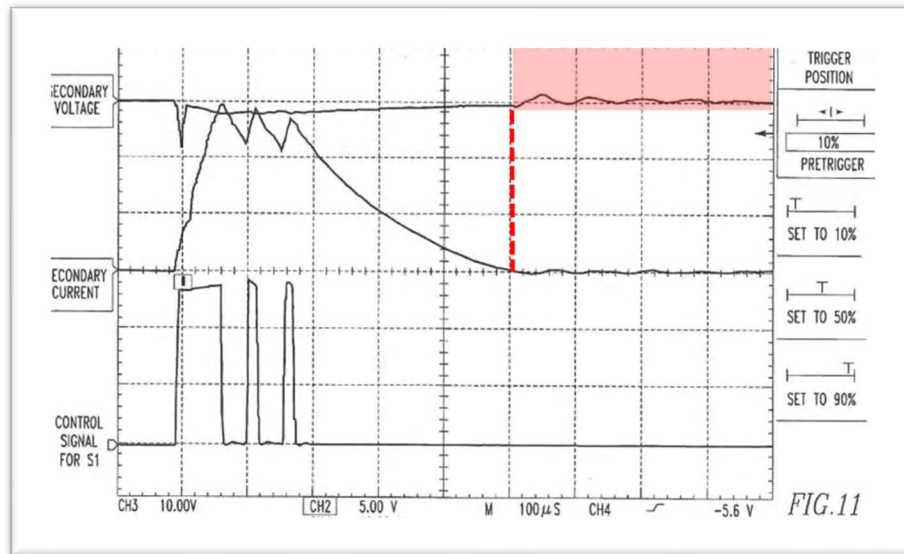


EX1001, Figure 8 (Annotated)

37. The '603 Patent also discloses that “specific timing of additional control pulse signals can increase the ‘duration and amplitude of the extended spark current’ created by the secondary winding of the ignition transformer,” though the nature of the specific timing is not disclosed by the specification. EX1001, 2:3–7, 6:19–36, FIGS. 10–11. For example, Figures 10 and 11 depict an embodiment in which control pulses are used “to control the shape of the secondary current waveform versus time.” EX1001, 6:22–23. Unlike the embodiments in Figures 2-8, which reflect open-circuit condition and show ringing secondary voltage waveforms, Figures 10 and 11 do not show reinforcement of the ringing action of the secondary voltage. EX1001, FIGS. 10–11. Instead, the secondary voltage waveform is “relatively flat” as shown below:



EX1001, Figure 10 (Annotated)



EX1001, Figure 11 (Annotated)

38. As Figures 10 and 11 show, the secondary voltage begins to oscillate or “rin[g] out” only when the secondary current falls to near zero, where the current is not sufficient to sustain the arc, (to the right of the dashed red line). EX1001, FIGS. 10–11. This ringing is caused by the abrupt interruption (quenching) of the arc because some residual current still exists in the secondary winding of the ignition transformer. *See e.g.*, EX1008, 2:18–32. It is the interruption of this residual current that causes the above oscillation in the transformer, due to its associated magnetic energy trapped in its leakage inductance oscillating back and forth with the transformer secondary interwinding capacitance. *See e.g.*, EX1008, 2:18–32. The specification explains:

Since the actual energy envelope is the integral of the power (the product of the secondary voltage and current waveforms) and since the secondary voltage waveform remains *fairly constant* over the time

period of interest, it is possible to say that the shape of the energy envelop is directly related to the shape of the secondary current wave form with respect to time. EX1001, 6:37–43 (emphasis added).

39. The '603 Patent provides limited explanation as to how to time pulses to take advantage of the “ringing action” identified by the inventor. The only disclosure provided for accomplishing this phenomenon relates to a “circuit provided to control the controllable switch in synchronism with the engine,” which the specification identifies as a part of the “present invention.” EX1001, 1:58–59. In discussing this “control circuit,” the '603 Patent only briefly explains how the alleged invention determines this specific pulse timing. It states that “in the present invention, an electronic means is used to drive each coil in a manner as to cause the increasing voltage either based upon measured behavior of the secondary (closed loop control) or based upon the use of an appropriate predefined drive pattern of primary pulses stored in a memory device (open loop control).” EX1001, 6:65–7:3. The patent provides no further disclosure of the “electronic means,” and no disclosure of how the control circuit determines pulse timing other than these “closed loop control” and “open loop control” methods.

40. The '603 Patent states that, according to one possible technical theory, the alleged invention employs a technique known as “forced resonance.” EX1001, 6:44–45, 6:50–52. It explains that “even though no discrete capacitor exists in the secondary circuit of the ignition coil [*i.e.*, the ‘transformer’], the parasitic distributed

capacitance of the coil winding, spark plug lead wire and spark plug can act as a capacitor for temporary energy storage during the time between pulses prior to breakdown.” EX1001, 6:46–50. The patent continues:

In forced resonance, the forcing function’s frequency is selected to be close to the natural frequency of the coil so that it will try to resonate. The forcing function adds primary drive energy at just the right moment during the secondary ring down cycle so that the secondary voltage change is reinforced. This makes the voltage amplitude of the coil secondary winding grow larger and larger. EX1001, 6:52–59.

B. The Claims of the ’603 Patent

41. The ’603 Patent includes 16 claims. EX1001, 7:8–8:64. Claims 1 and 8 are independent claims. Independent Claim 1 reads as follows:

1. In a capacitive discharge ignition system for an internal combustion engine comprising: a storage capacitor; a power supply connected in series with the storage capacitor; an ignition transformer having primary and secondary windings; and a controllable switch; the primary winding of the ignition transformer and the storage capacitor being connected in series through the controllable switch; a spark plug connected in series with the secondary winding of the ignition transformer; the improvement comprising an electronic control circuit for driving the controllable switch which is operating in synchronism with the engine such that the switch is initially closed for a period of time to transfer energy to the ignition coil primary, that after this time, the switch is then opened for a second period of time and then the switch is again closed creating a pulse train, such that the switch is controlled by a successive string of control pulses to the switch, each of the individual pulse times having a duration and spacing as determined by the control circuit, these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the open circuit breakdown voltage capability of the ignition transformer is increased. EX1001, 7:8–30.

42. Independent Claim 8 reads as follows:

8. In a capacitive discharge ignition system for an internal combustion engine comprising: a storage capacitor; a power supply connected in series with the storage capacitor; an ignition transformer having primary and secondary windings; and a controllable switch; the primary winding of the ignition transformer and the storage capacitor being connected in series through the controllable switch; a spark plug connected in series with the secondary winding of the ignition transformer; the improvement comprising an electronic control circuit for driving the controllable switch which is operating in synchronism with the engine such that the switch is initially closed for a period of time to transfer energy to the ignition coil primary, that after this time, the switch is then opened for a second period of time and then the switch is again closed creating a pulse train, such that the switch is controlled by a successive string of control pulses to the switch, each of the individual pulse times having a duration and spacing as determined by the control circuit, these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the secondary circuit current capability of the ignition transformer is increased. EX1001, 7:62–8:61.

43. Dependent Claims 2–7, and 9–16 recite additional limitations relating to the control circuit for the claimed system. EX1001, 7:31–61, 8:21–64. For example, Claim 6 recites that the “control circuit for the controllable switch operates in a closed loop manner by measuring the behavior of the circuit parameters to determine the exact wave shape of the pulse train sent to the controllable switch.” EX1001, 7:53–56.

C. The Prosecution History of the '603 Patent

44. The application that resulted in the '603 Patent was U.S. Patent Application No. 11/702,003 ("the '003 Application"). The '003 Application was filed on February 2, 2007.

45. On April 27, 2007, the Applicant filed a Preliminary Amendment amending some of the claims of the '003 Application. EX1002, pp. 52–58.

46. On May 6, 2008, the USPTO issued a Notice of Allowance for the '003 Application without rejection. EX1002, pp. 28–33. The Notice of Allowance stated that Claims 1-16 of the '003 Application were allowed and the examiner's reasons for allowance exclusively cited the claim limitation of "pulses timed to reinforce ringing of transformer secondary voltage resulting from prior primary pulses." EX1002, p. 32. The '003 Application issued as the '603 Patent on July 22, 2008.

D. The Priority Date of the '603 Patent

47. The '003 Application that resulted in the '603 Patent was filed on February 2, 2007, and I understand that this is the date to which the '003 Application claims its earliest priority. I have therefore been asked for purposes of this declaration to analyze invalidity as of February 2, 2007.

VI. STATE OF THE ART PRIOR TO THE '603 PATENT

A. The Person of Ordinary Skill in the Art

48. As discussed above, the claims of the '603 Patent are directed to a capacitive discharge ignition system as part of an internal combustion engine.

EX1001, 7:8–8:63. Based on this, it is my opinion that, as of February 2, 2007, a POSA would have had a working knowledge of the hardware and software of power electronics such as ignition controllers. A POSA also would have had a bachelor's degree in electrical engineering, or an equivalent degree, and at least four years of demonstrated real-world experience in the field of designing and/or testing circuits for ignition systems and/or power electronic systems. Further, it is my opinion that a person with additional education, but less professional experience may still qualify as a POSA, and a person with additional professional experience but less education may still qualify as a POSA.

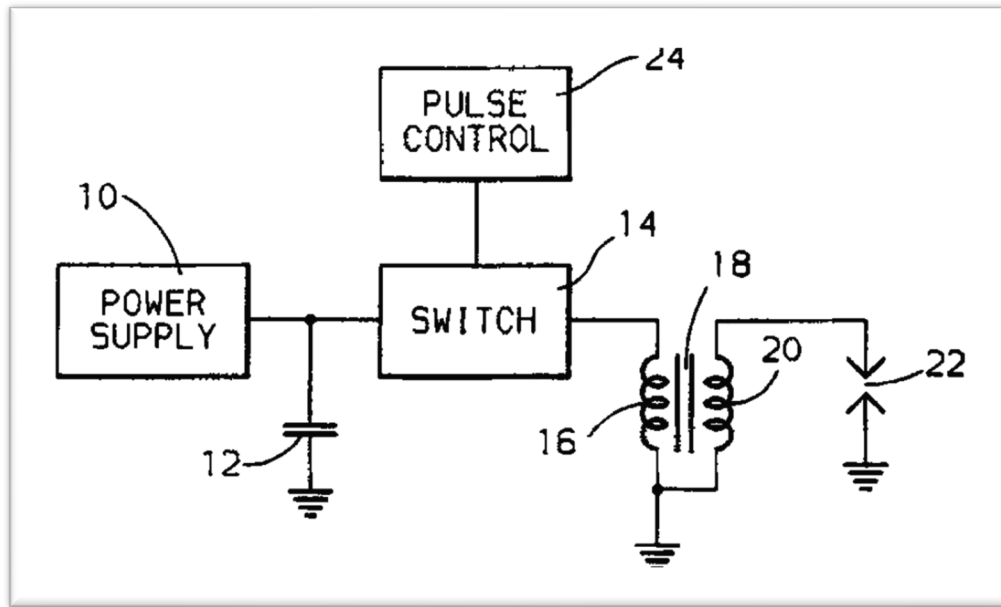
49. I believe that I qualify as understanding the knowledge and skills of a POSA as of February 2, 2007, and that I have a sufficient level of knowledge, experience, and expertise to provide an expert opinion in the field of the '603 Patent. EX1003.

B. Capacitor Discharge Ignition System, Research Disclosure, Database No. 335026 (Mar. 1992) ("Research Disclosure," EX1005).

50. I understand that Research Disclosure is prior art to the '603 Patent under 35 U.S.C. § 102(b) because Research Disclosure is a printed publication dated more than one year prior to the date of application for the '603 Patent. It is my opinion that Research Disclosure has indications on it that it would have been available to a POSA interested in locating it as of March 1992. For example,

Research Disclosure states that it is a monthly publication which provides an “industry standard disclosure publication service” whose purpose is to publish scientific literature such that it is “established as prior art” and “stops others from patenting the same invention anywhere in the world.” EX1005, 1. Research Disclosure includes an International Standard Serial Number (ISSN 0374-4353) identifying it, a March 1992 copyright date, and a statement that it was published by Kenneth Mason Publications Ltd. EX1005, 1. The cover page of Research Disclosure states that all inventions submitted to the service “are published in full in our paper journal,” and this particular publication was “[p]ublished in the March 1992 paper journal.” EX1005, 1. For at least these reasons, it is my understanding that Research Disclosure is prior art under pre-AIA 35 U.S.C. § 102(b).

51. Research Disclosure is directed to “[a] capacitor discharge ignition system for a spark ignited internal combustion engine.” EX1005, 2:1–2. As described, “[t]he system has a power supply 10 for charging capacitor 12. Capacitor 12 is connected to a semiconductor switch 14 and when switch 14 is conductive, capacitor 12 discharges through the primary winding 16 of an ignition coil 18. The secondary winding 20 of ignition coil 18 is connected to a spark plug 22 of a spark ignited internal combustion engine.” EX1005, 2:2–8. A figure of the circuit disclosed in Research Disclosure is below:



EX1005, Figure

52. According to Research Disclosure, “[t]he switch 14 is connected to a pulse control 24 which controls the switching of switch 14. The switching is controlled such that spark plug current flows for about 20 microseconds and can be controlled to provide spark plug currents having a duration in the range of 1 to 100 microseconds. Further, the number of current pulses that occur during an ignition event can vary in a range of 2 to 200. The resulting peak value of spark plug current may be 0.2 to 10 amps.” EX1005, 2:11–18.

53. “The pulse parameters yield two primary advantages. The relatively high plug current affords the ability to create igniting arcs across badly fouled plugs and the high peak power enhances the ability to ignite lean air/fuel mixtures and alternate fuels like alcohol. Pulses produced by the system are more efficient in

transferring energy into the gaseous air and fuel to be heated and ignited than are those with longer duration and shorter rise time.” EX1005, 2:21–29.

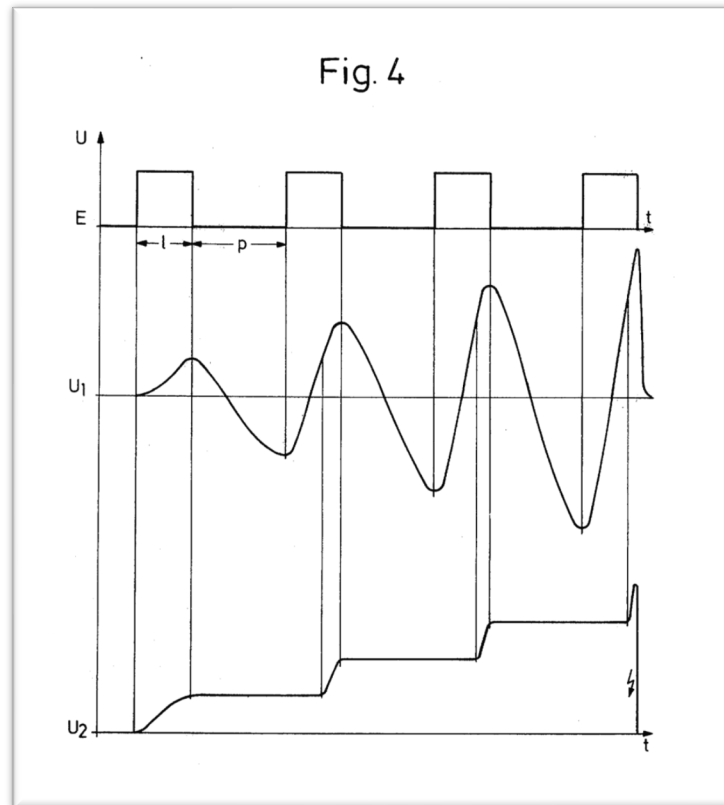
C. U.S. Patent No. 4,181,112 to Grather (“Grather,” EX1006)

54. I understand that Grather is prior art to the ’603 Patent under 35 U.S.C. § 102(b) because Grather is a printed publication dated more than one year prior to the date of application for the ’603 Patent. I understand that Grather has a filing date of March 11, 1977, and a grant date of January 1, 1980. Grather relates to a “high-voltage ignition system to generate a spark for an internal combustion engine, and method to generate the spark energy.” EX1006, Title. “[A]n electronic control switch is repetitively operated for each ignition event by multiple sequentially occurring ignition signals. An electronic system so adjusts the length of the signals and the gaps between signals that a charge accumulation will occur at the spark gap of the spark plug until breakdown occurs.” EX1006, 1:60–65.

55. “The pulse periods of the multiple ignition pulses, during any ignition event, are so arranged that the electronic switch is closed for a period of time corresponding to the pulse period, which is approximately that time which is needed to reach maximum voltage at the spark gap. The pauses, or time gaps between the pulses, during which the switch is opened, correspond in essence to the period of time which is necessary for the oscillatory swing-back of the circuit until the voltage

at the capacity of the winding of the secondary of the ignition coil has dropped to a minimum from a maximum.” EX1006, 2:21–32.

56. “The system can be so designed that the voltage during the first control pulse is just sufficient to effect ignition. Upon ignition failure, however, ignition will occur at the next pulse. Upon continued failure, ignition will occur at subsequently occurring pulses. The sequential charging, in steps, results in stepped increase in the ignition voltage.” EX1006, 3:15–22. “Charge accumulation, in accordance with a feature of the invention, is obtained by so adjusting the signals of graph E and graph D, respectively, which control the opening and closing of the switch 18, to have a predetermined signal length and signal pause and thereby effect build-up of charge accumulation, in the light of the electrical parameters of the system.” EX1006, 5:19–25, FIGS. 2–3. FIG. 4 illustrates pulses denoted by the graph E:



EX1006, Figure 4

57. “Voltage U_1 at the secondary winding of the ignition coil 22 rises during any signal as illustrated in graph E (FIG. 3), causing a rise in voltage U_2 at the spark gap 24 (see FIG. 4). The signal length l is so adjusted that the end of the signal will occur when the voltage U_2 approximately has reached its maximum, that is, when the capacities represented by the capacitors C_1 , C_2 have been charged through the leakage inductance L_s .” EX1006, 5:33–44.

58. “The interrupter switch 18 is opened during the subsequent signal pause. The charge of the capacity C_1 will thus oscillate back to the main inductance L_h . The duration of the signal pause p thus must be so determined that a new signal

will start when the voltage U1 has, approximately, reached its minimum. The timing of the signal pause p thus can be determined, approximately, by equation (2).” EX1006, 5:45–52.

59. “The equivalent capacity C2 of the ignition cable 23' cannot discharge during the signal pause due to the blocked high-voltage diode 23. Voltage U2 thus remains essentially constant. The next subsequent signal illustrated at graph E in FIG. 3 thus causes a rise in the voltage U1 until, again, a maximum or approximately a maximum has been reached. Due to the resonance effect of this oscillation, the maximum will be higher than the maximum of the preceding wave of the oscillation. When the voltage exceeds the level of the voltage at which U2 previously had been held, then voltage U2 will rise, parallel to voltage U1, until, at the next gap between pulses, a level will be established as previously described. This accumulation of charge, or accumulation of voltage, at the spark gap 24 continues until the voltage U2 reaches a value which causes breakdown of the spark gap, that is, which is sufficient to cause firing of the spark plug. The cycle will then repeat if signals E are still present. The system can operate differently as well, with different system parameters” EX1006, 5:53–6:5.

D. U.S. Patent No. 6,701,904 to Lepley (“Lepley-I,” EX1007)

60. I understand that Lepley-I is prior art to the '603 Patent under 35 U.S.C. § 102(b) because Lepley-I is a printed publication dated more than one year prior to

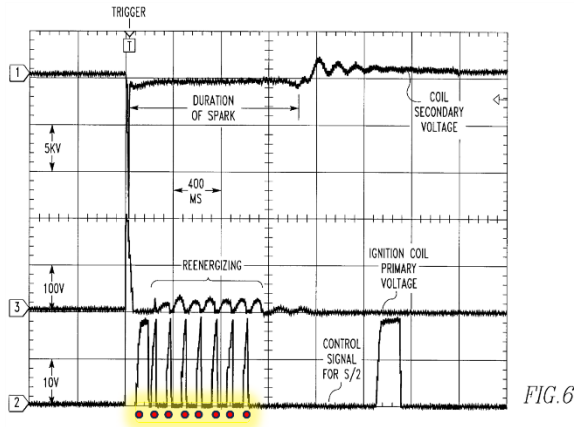
the date of application for the '603 Patent. I understand that Lepley-I was filed on April 22, 2002, published on November 21, 2002, and granted on March 9, 2004.

61. Lepley-I relates to a “capacitive discharge ignition system with extended duration spark.” EX1007, Title. “It is an object, according to the present invention, to provide a capacitive discharge ignition system capable of generating an arc discharge between the spark plug electrodes with a duration three to six times longer than typical for the type of ignition coil in use. It is a further object, according to the present invention, to be able to adjustably and selectively modify or disable the extended duration spark to obtain the best possible spark plug life.” EX1007, 1:11–20. “When engine operation conditions require spark durations previously unavailable from capacitive discharge ignitions, the extended spark can be enabled. This allows the use of a capacitive spark ignition system where inductive-type ignition systems were the only practical choice.” EX1007, 1:21–25.

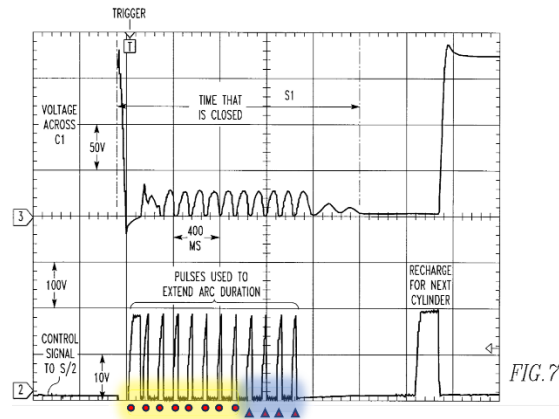
62. “The first switch is closed to discharge the storage capacitor to the primary of the ignition coil. The second switch is reopened to transfer energy stored in the converter transformer to the primary of the ignition transformer to prolong the current in the secondary of the ignition transformer. The number of times N the second switch is reopened and closed and the time period T for which the second switch remains closed is controlled to control the duration and amplitude of the extended arc current.” EX1007, 1:48–57.

63. “FIGS. 4 and 5 illustrate that with applicant’s invention, the spark duration is not dependent on the conditions of the spark gap. FIGS. 6 and 7 illustrate that the duration of the spark may be controlled by controlling the number of reenergizing pulses. FIGS. 8 and 9 illustrate that the current during the extended spark duration can be controlled by controlling the width of the reenergizing pulses.” EX1007, 4:32–38.

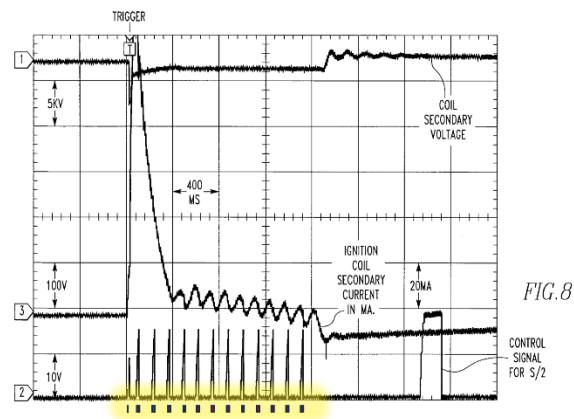
64. As shown in Figures 6–9, the bottom trace is the control signal for switch S2 with reenergizing pulses, the top trace is the secondary coil voltage, and the middle trace is the secondary current in the ignition coil. EX1007, 4:17–29, FIGS. 6–9. Figures 6 and 7 illustrate “the duration of the spark may be controlled by controlling the number of reenergizing pulses.” EX1007, 4:34–36, FIGS. 6–7 (emphasis added). Figures 8 and 9 illustrate “the current during the extended spark duration can be controlled by controlling the width of the reenergizing pulses.” EX1007, 4:32–38 (emphasis added). Lepley-I explains that the difference between Figures 8 and 9 are the wider pulses from switch S2 in Figure 9 that permit current to flow in the primary of the converter transformer, generating current peaks at about 40 milliamps. EX1007, 4:26–29.



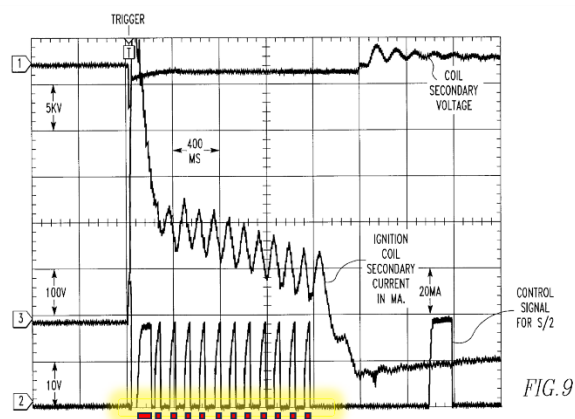
EX1007, Figure 6 (Annotated)



EX1007, Figure 7 (Annotated)



EX1007, Figure 8 (Annotated)



EX1007, Figure 9 (Annotated)

VII. CLAIM CONSTRUCTION

65. It is my understanding that claim terms in an IPR must be given their ordinary and customary meaning as understood by a POSA at the time of the invention in light of the specification and the prosecution history pertaining to the patent. *See* 37 C.F.R. § 42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13 (Fed. Cir. 2015) (en banc). It is also my understanding that terms not specifically

construed have their plain and ordinary meaning as understood by a POSA. I understand that the Board applies the same claim construction standard used in civil actions in the federal district court and proceedings before the ITC.

66. After reviewing the claims of the '603 Patent, it is my opinion that one claim limitation in Claim 1 and one claim limitation in Claim 8 require construction in order to help understand them. These limitations have been referred to as the “arranged in time” limitations of Claims 1 and 8. I discuss the constructions of them individually below.

- **“these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the open circuit breakdown voltage capability of the ignition transformer is increased” (Claim 1)**

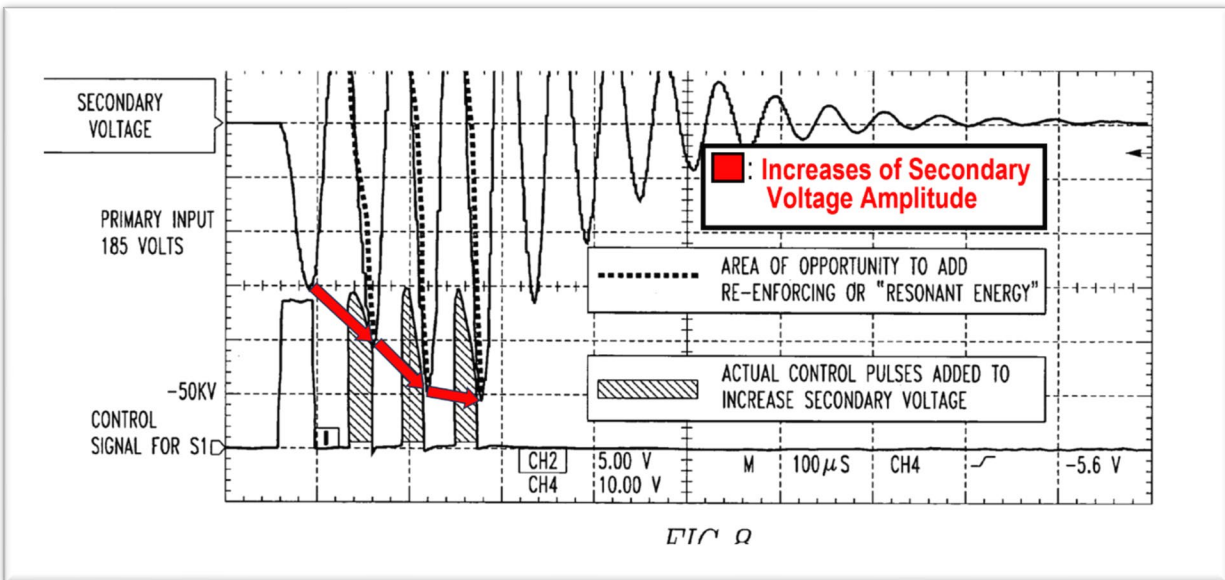
67. It is my opinion that the “arranged in time” limitation of Claim 1 should be construed as follows:

Claim Term	Petitioners’ Proposed Construction
“these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the open circuit breakdown voltage capability of the ignition transformer is increased”	“these pulses being arranged at a specific time of the ignition transformer secondary voltage waveform to increase the amplitude of the secondary voltage over the previous oscillation of the voltage waveform, such that the open circuit breakdown voltage capability of the ignition transformer is increased above what was generated by the previous control pulse”

68. The first part of this construction is supported by the description of the alleged invention in the '603 Patent, which consistently discloses pulses as occurring during the “specific” or “certain” time of the secondary voltage waveform that reinforces the ringing action of the waveform, thereby increasing the voltage amplitude compared to the amplitude produced by previous pulses. EX1001, 1:61–2:2, 5:1–7, 6:54–59, FIGS. 2, 7, 8. For example, the “Summary of the Invention” describes the “present invention” as including “specific” pulse timing. It explains that after the “first pulse from the storage capacitor to the primary of the ignition coil[,] [t]he switch is reopened at a specific time during the damped sinusoidal voltage waveform . . . to avoid doing negative work.” EX1001, 1:61–64. Then, per this description, “[t]he subsequent pulse is supplied at a specific time or phase of the secondary voltage waveform by the controllable switch and capacitor to reinforce the voltage created by the previous ‘ON’ state of the switch delivering the first pulse.” EX1001, 1:66–2:2.

69. Further, every figure that depicts reinforcing the secondary voltage waveform’s ringing action shows that pulses occur during a specific time of that waveform—namely, a down cycle of the ringing of the secondary voltage. EX1001, FIGS. 2, 6–8. For instance, Figure 8 (reproduced below) shows an ignition transformer secondary voltage waveform with dotted lines to identify “area[s] of opportunity to add re-enforcing or ‘resonant energy’” to the waveform. EX1001,

FIG. 8. Control pulses (i.e., “Control Signal for S1”) occur at specific times of the waveform—within the “area[s] of opportunity”—to increase the secondary voltage amplitude. EX1001, FIG. 8.



EX1001, Figure 8 (Annotated)

70. Further, the specification’s comparison of the alleged invention to prior art techniques also shows the arrangement of pulses at “specific times.” EX1001, 3:66–4:6, 4:13–33. Figures 3–5 depict oscilloscope graphs for “the typical open circuit output voltage for . . . ignition coil[s] driven in the standard manner” of varying the width of a single control pulse. EX1001, 3:66–4:6, 4:13–33. By contrast, Figures 2 and 7, which depict embodiments of the alleged invention, show successive pulses occurring at specific times to reinforce the ringing action of the secondary voltage waveform. EX1001, 4:38–48, 5:1–3. The patent explains the alleged invention’s “technical theory of operation”: “The forcing function adds

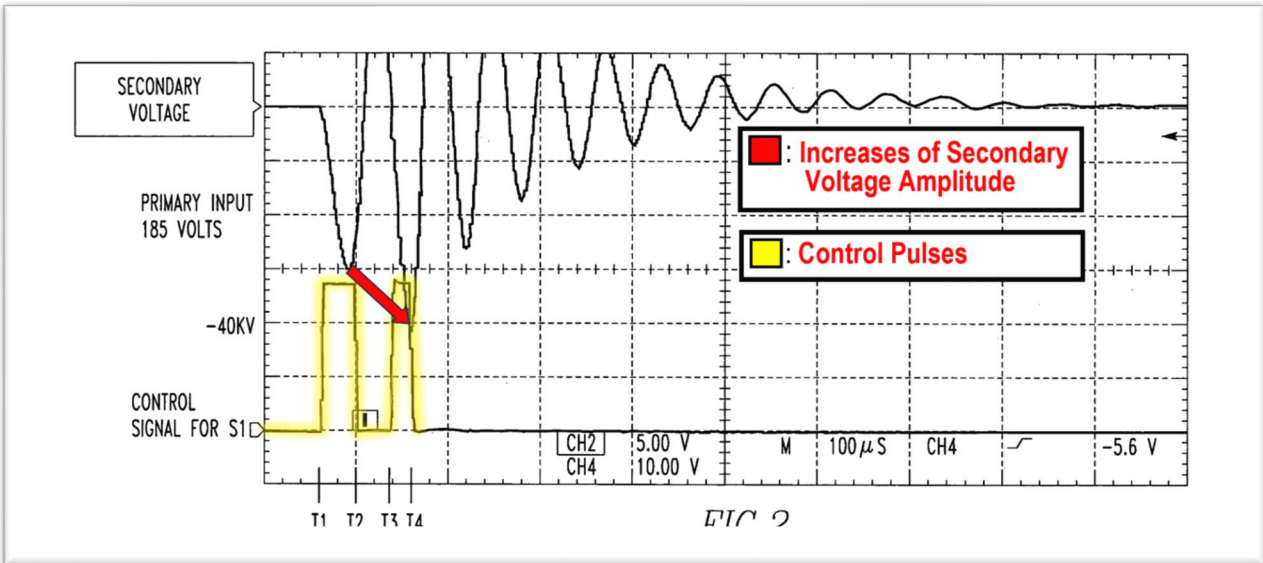
primary drive energy *at just the right moment* during the secondary ring down cycle so that the secondary voltage change is reinforced. This makes the voltage amplitude of the coil secondary winding grow larger and larger.” EX1001, 6:54–59 (emphasis added).

71. Moreover, “reinforc[ing] the ringing action of the secondary voltage waveform” means “increas[ing] the amplitude of the secondary voltage over the previous oscillation of the voltage waveform.” Again, the patent’s discussion of its “technical theory of operation” is instructive: “The forcing function adds primary drive energy at just the right moment during the secondary ring down cycle *so that the secondary voltage change is reinforced*. This makes the *voltage amplitude of the coil secondary winding grow larger and larger*.” EX1001, 6:54–59 (emphasis added). Likewise, each of the figures that depict “reinforcing the ringing action” show an increase in amplitude of the secondary voltage waveform and that the increase is “over the previous oscillation” of the secondary voltage waveform, as shown above in Figure 8. EX1001, 4:38–42, FIGS. 2, 7–8. Further, Claims 1 and 8 each recite, “when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses,” which indicates to a POSA that the increase is over the previous oscillation of the secondary voltage. EX1001, 1:61–2:2, 7:26–28, 8:16–18. With respect to Figure 7, the patent

explains that “each pulse reinforces the secondary effects of the previous pulse.”

EX1001, 5:13–18, FIG. 7.

72. In addition, the clause “the open circuit breakdown voltage capability is increased” works in tandem with the previous clause in this limitation, and it should be construed to mean “the open circuit breakdown voltage capability of the ignition transformer is increased above what was generated by the previous control pulse.” This is supported by the disclosure of the ’603 Patent specification. EX1001, 4:7–5:33, 6:54–59. For example, the second pulse shown in Figure 2 (reproduced below) increases the secondary voltage amplitude above the amplitude generated by the first pulse (an increase from -30,000 volts to -40,000 volts). EX1001, FIG. 2. Figures 6–8 also show that each successive control pulse increases the amplitude of the secondary voltage above the level resulting from the previous pulse. EX1001, FIGS. 6–8. The specification explains that “add[ing] primary drive energy at just the right moment during the secondary ring down cycle so that the secondary voltage change is reinforced. . . makes the voltage amplitude of the coil secondary winding grow larger and larger.” EX1001, 6:54–59.



EX1001, Figure 2 (Annotated)

73. I understand that, in the ITC Proceeding between the Parties involving this patent, the Tribunal adopted a different construction for the “arranged in time” limitation of Claim 1. The ITC Tribunal used the following construction, which was agreed to by the Parties: “these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses by adding energy during the ignition transformer secondary voltage ringing down cycle, such that the open circuit breakdown voltage capability of the ignition transformer is increased as compared to the open circuit breakdown voltage capability of the ignition transformer at the time of the first closing of the switch after the second period of time.” EX1010, p. 8. I would select my proposed construction over the construction from the ITC Proceeding because my construction more closely aligns with the disclosure of the

alleged invention in the '603 Patent's specification and figures. Nonetheless, my opinions on the obviousness of Claim 1 (and claims that depend from Claim 1) are the same under either construction, or if the "arranged in time" limitation is given its plain and ordinary meaning.

- **"these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the secondary circuit current capability of the ignition transformer is increased" (Claim 8)**

74. It is my opinion that the "arranged in time" limitation of Claim 8 should be construed as follows:

Claim Term	Petitioners' Proposed Construction
"these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the secondary circuit current capability of the ignition transformer is increased"	"these pulses being arranged at a specific time of the ignition transformer secondary voltage waveform to increase the amplitude of the secondary voltage over the previous oscillation of the voltage waveform, such that the amplitude or duration of the secondary circuit current generated by the ignition transformer is increased above what was generated by the previous control pulse"

75. The first clause of this limitation ("these pulses arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage") is the same as the first clause in the "arranged in time" limitation

of Claim 1. It is my opinion that this clause should be given the same meaning for the reasons discussed above for Claim 1.

76. The second clause of this limitation (“such that the secondary circuit current capability of the ignition transformer is increased”) means “such that the amplitude or duration of the secondary circuit current generated by the ignition transformer is increased above what was generated by the previous control pulse.” The claims and the specification support this definition because they disclose an increase in either the amplitude or duration of the secondary circuit current. For example, dependent Claim 9 recites controlling “the amplitude of the extended arc current [i.e., the secondary circuit current],” dependent Claims 10-12 recite “driv[ing] the secondary current higher [i.e., increasing the amplitude],” and dependent Claim 15 recites controlling “the duration and amplitude of the extended arc current of the spark.” EX1001, 8:21–44, 8:55–59; *see id.* at 1:29–48 (specification disclosing the claimed embodiments). Further, the “Summary of the Invention” describes increasing “the secondary circuit current capability” by increasing the duration and amplitude of the extended spark current.” EX1001, 2:3–7; *see id.* at 2:59–63. The specification also states that it is “an object, according to the present invention, to provide a capacitive discharge ignition system capable of generating a spark discharge between the spark plug electrodes with a higher voltage capability, greater secondary current, and spark duration [which is driven by the

secondary current] . . .” EX1001, 1:31–36. Figures 10–11 of the ’603 Patent support this construction by showing that additional control pulses increase the amplitude or duration (or both) of the secondary current. EX1001, FIGS. 10–11.

77. Further, the construction of the second clause gives a reference point from which to measure the “increase” in the secondary circuit current capability—the increase must be “above what was generated by the previous control pulse.” The dependent claims also support this part of the construction. For example, dependent Claims 10–12 recite “send[ing] additional pulses to drive the secondary current higher.” EX1001, 8:25–44. Likewise, the specification discloses that “the control circuit for the controllable switch causes the pulse train to continue to send additional pulses to drive the secondary current higher until a desired secondary current level is reached.” EX1001, 2:26–48. A POSA would have understood this language to mean the secondary current increases over the current level generated by the previous pulse.

78. Further, it is my understanding that the Tribunal adopted the following construction of the “arranged in time” limitation of Claim 8 during the ITC Proceeding: “these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses by adding energy during the ignition transformer secondary voltage ringing down cycle, such that the secondary circuit current

capability of the ignition transformer is increased as compared to the secondary circuit current capability of the ignition transformer at the time of the first closing of the switch after the second period of time.” EX1010, pp. 9–16. I understand that the Parties agreed to that construction for purposes of the ITC Proceeding. The Tribunal also determined in the ITC Proceeding that the phrase “secondary circuit current capability of the ignition transformer” means “the magnitude of the secondary current in the ignition transformer, the duration of the secondary current in the ignition transformer, the spark duration created from the secondary current of the ignition transformer, or any combination thereof.” EX1010, p. 16. I would select my proposed construction over the construction from the ITC Proceeding because my construction more closely aligns with the disclosure of the invention in the ’603 Patent’s specification and figures. Nonetheless, my opinions on the obviousness of Claim 8 (and claims that depend from Claim 8) are the same under either construction, or if the “arranged in time” limitation is given its plain and ordinary meaning.

VIII. GROUNDS OF INVALIDITY

A. Claims 1–7 of the ’603 Patent are obvious over admitted prior art including Research Disclosure in view of Grather.

79. It is further my opinion that a POSA would have found Claims 1–7 of the ’603 Patent obvious over Research Disclosure in view of Grather, and the

knowledge of a POSA. My opinions set forth below demonstrate the invalidity of Claims 1–7.

a. **Claim 1**

[1.pre] In a capacitive discharge ignition system for an internal combustion engine comprising: a storage capacitor; a power supply connected in series with the storage capacitor; an ignition transformer having primary and secondary windings; and a controllable switch; the primary winding of the ignition transformer and the storage capacitor being connected in series through the controllable switch; a spark plug connected in series with the secondary winding of the ignition transformer

80. It is my opinion that the capacitive discharge ignition circuit recited in Claim 1 was known in the art before the priority date for the '603 Patent. It is my understanding that independent Claim 1 is written in what is called “Jepson” format. Further, it is my understanding that a Jepson claim recites elements that are known in the art as part of its preamble, followed by the phrase “the improvement comprising” and a description of the claimed improvement. EX1001, 7:8–30; 7:63–8:20. Moreover, the '603 Patent admits that the claimed capacitive discharge ignition circuit was known in the art. For example, the '603 Patent refers to the circuit of Figure 1 as a “basic circuit of a high tension capacitive discharge ignition system” EX1001, 3:6–10, 3:32–40, FIG. 1. In the ITC Proceeding, the inventor and Patent Owner’s own expert testified that the capacitive discharge ignition circuit that is shown in Figure 1 of the '603 Patent was “known in the art.” EX1011, 144:19–146:16, 1277:24–1278:5.

81. Further, it is my opinion that Element [1.pre] is disclosed or rendered obvious by Research Disclosure. *Compare* EX1001, FIG. 1 *with* EX1005, Figure at 3. Research Disclosure is related to a “capacitor discharge ignition system for a spark ignited internal combustion engine.” EX1005, 2:1–2. Furthermore, Research Disclosure provides, “[t]he system has a power supply 10 for charging capacitor 12.” EX1005, 2:2–3. A POSA would have understood that the charging capacitor 12 is a storage capacitor that stores the charge to be sent through the switch to the primary winding of the ignition transformer.

82. As shown by the figure in Research Disclosure, the power supply 10 is connected with the charging capacitor 12 in the same configuration shown in the ’603 Patent. EX1005, Figure at p. 3. According to Research Disclosure, “[c]apacitor 12 is connected to a semiconductor switch 14 and when switch 14 is conductive, capacitor 12 discharges through the primary winding 16 of an ignition coil 18. The secondary winding 20 of ignition coil 18 is connected to a spark plug 22 of a spark ignited internal combustion engine.” EX1005, 2:3–8. Therefore, the ignition coil 18 (e.g., ignition transformer) has primary windings 16 and secondary windings 20.

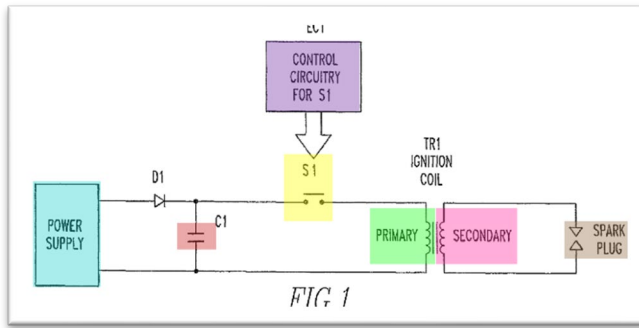
83. Research Disclosure explains, “[t]he switch 14 is connected to a pulse control 24 which controls the switching of switch 14. The switching is controlled such that spark plug current flows for about 20 microseconds and can be controlled to provide spark plug currents having a duration in the range of 1 to 100

microseconds.” EX1005, 2:12–16. Therefore, Research Disclosure discloses a controllable switch.

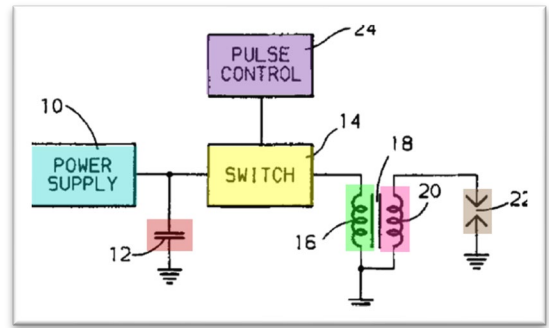
84. As shown by the Research Disclosure Figure, when the switch 14 is closed, the primary winding 16 of the ignition transformer 18 and the capacitor 12 are connected through the switch 14 in the same configuration shown in the '603 Patent. EX1005, Figure at 3. Moreover, Research Disclosure provides, “[t]he secondary winding 20 of ignition coil 18 is connected to a spark plug 22 of a spark ignited internal combustion engine.” EX1005, 2:6–8. Therefore, Research Disclosure discloses a primary winding 16 of the ignition coil 18 (i.e., ignition transformer) and the storage capacitor being connected through the controllable switch 14 in the same configuration shown in the '603 Patent.

85. As shown by the Research Disclosure Figure, the spark plug 22 and the secondary winding 20 of the ignition transformer 18 are connected in the same configuration shown in the '603 Patent. EX1005, Figure at 3. Therefore, the spark plug is connected with the secondary winding of the ignition transformer in the same configuration shown in the '603 Patent.

86. A side-by-side of the circuit diagram provided by the '603 Patent and the “conventional capacitor discharge ignition system” disclosed in Research Disclosure is reproduced below:



EX1001, Figure 1 (Annotated)



EX1005, Figure (Annotated)

[1.1] the improvement comprising an electronic control circuit for driving the controllable switch which is operating in synchronism with the engine such that the switch is initially closed for a period of time to transfer energy to the ignition coil primary, that after this time, the switch is then opened for a second period of time and then the switch is again closed creating a pulse train,

87. It is my opinion that the control circuit recited in limitation [1.1] was known or obvious to a POSA in light of Research Disclosure and Grather. For example, the pulse control 24 disclosed in Research Disclosure is an electronic control circuit for driving the controllable switch. Research Disclosure explains that the pulse control 24 controls the switch 14 to provide current pulses (i.e., a “pulse train”) from the capacitor 12 to the primary winding 16 of the ignition transformer 18. Research Disclosure states the following:

The switch 14 is connected to a pulse control 24 which controls the switching of switch 14. The switching is controlled such that spark plug current flows for about 20 microseconds and can be controlled to provide spark plug currents having a duration in the range of 1 to 100 microseconds. Further, the number of current pulses that occur during an ignition event can vary in a range of 2 to 200. EX1005, 2:12–18.

A POSA would have understood that the pulse train created by the control circuit disclosed in Research Disclosure results from closing the switch for a period of time to transfer energy to the ignition coil primary, opening the switch for a second period of time, and then closing the switch again.

88. It is my opinion that controlling the switch to provide spark plug currents having a duration for about 20 microseconds or within the range of 1 to 100 microseconds is conventional. For example, even the '603 Patent describes switch S1 "ON" time within this range (e.g., about 40 microseconds (FIG. 3); about 80 microseconds (FIG. 4); about 100 microseconds (FIGS. 5 and 7); about 70 microseconds (FIG. 6)). EX1001, 3:65–4:2, 4:16, 4:24–25, 4:60, –5:4.

89. Further, Grather teaches an electronic control circuit that creates a pulse train used by its circuit to generate a spark. EX1006, 1:60–65, 2:56–66, 3:50–4:14, 9:24–30, 10:19–55, 10:56–11:2, FIGS. 2–3. For example, Grather teaches an electronic control controlling a switch that is closed for a period of time to transfer energy to the ignition coil primary, opened for a second period of time, and then closed again to create a pulse train: "[A]n electronic control switch is repetitively operated for each ignition event by multiple sequentially occurring ignition signals. An electronic system so adjusts the length of the signals and the gaps between signals that a charge accumulation will occur at the spark gap of the spark plug until breakdown occurs." EX1006, 1:60–65.

90. Furthermore, Grather teaches that an electronic control circuit drives the switch in synchronism with the engine: “The signal generator is connected to control opening and closing of the switch. The signal generator has a fixed relationship of signal or pulse length to signal or pulse gap. The ignition events, themselves, are triggered by a control system, preferably including an electronic control Element which is triggered by the crankshaft of the engine.” EX1006, 2:60–66. For example, Grather discloses that an output pulse may be generated when “the crankshaft has reached a predetermined angular position with respect to the upper dead center (UDC) position of a piston thereof.” EX1006, 3:50–56. A POSA would have understood these teachings in Grather to refer to the Grather system operating in synchronism with the engine, as this is the way to maximize efficiency in creating a spark and optimizing the combustion of the air/fuel mixture.

91. In view of the above, it is my opinion that the combination of Research Disclosure and Grather discloses or renders obvious Element [1.1]. Moreover, as described further in connection with Element [1.3], a POSA would have had a motivation to combine the teachings of Research Disclosure and Grather.

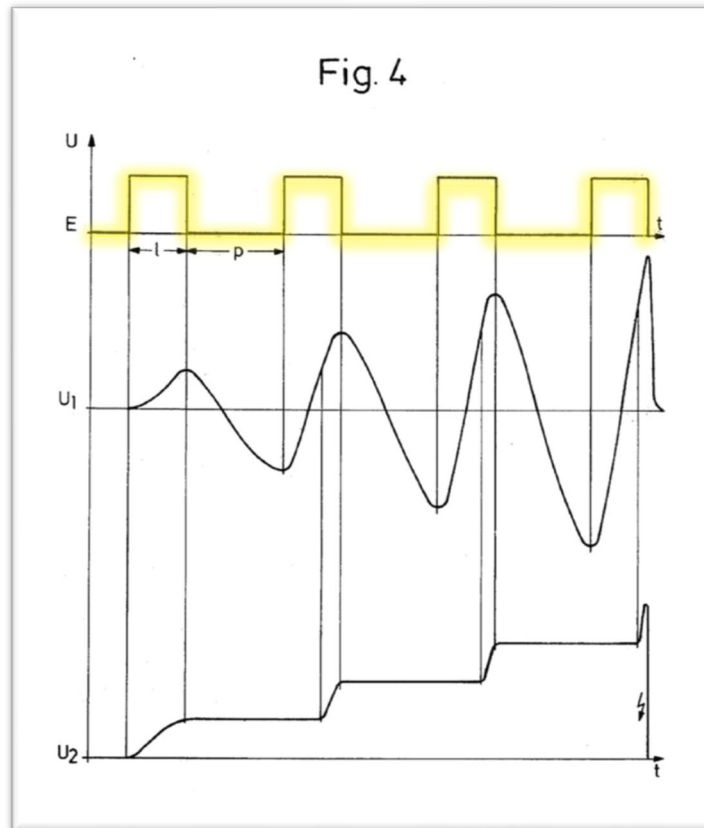
[1.2] such that the switch is controlled by a successive string of control pulses to the switch, each of the individual pulse times having a duration and spacing as determined by the control circuit,

92. It is my opinion that Research Disclosure or Grather discloses or renders obvious Element [1.2]. Research Disclosure teaches that the switch is

controlled by the pulse control 24 (as discussed with respect to Element [1.1]) to send a successive string of control pulses, each of the individual pulse times have a duration and spacing as determined by the pulse control 24. EX1005, 2:12–18.

93. Moreover, the system described in Grather uses the combination of a transducer (10), wave-shaping circuit (11), and ignition timing circuit (12) to create inputs to an electronic control system (19). EX1006, 3:50–4:14. The control system opens and closes a controllable switch (18) that is also connected to a power supply (20). EX1006, 4:14–24.

94. Grather further teaches using the controllable switch (18) to time control pulses (labelled as “E” in annotated FIG. 4, below), with each pulse having a duration and spacing as determined by the control circuit. EX1006, FIG. 4. For instance, Grather states, “[t]he signal length 1 is so adjusted that the end of the signal will occur when the voltage U2 approximately has reached its maximum. . . The duration of the signal pause p thus must be so determined that a new signal will start when the voltage U1 has, approximately, reached its minimum.” EX1006, 5:37–39, 5:47–50.



EX1006, Figure 4 (Annotated)

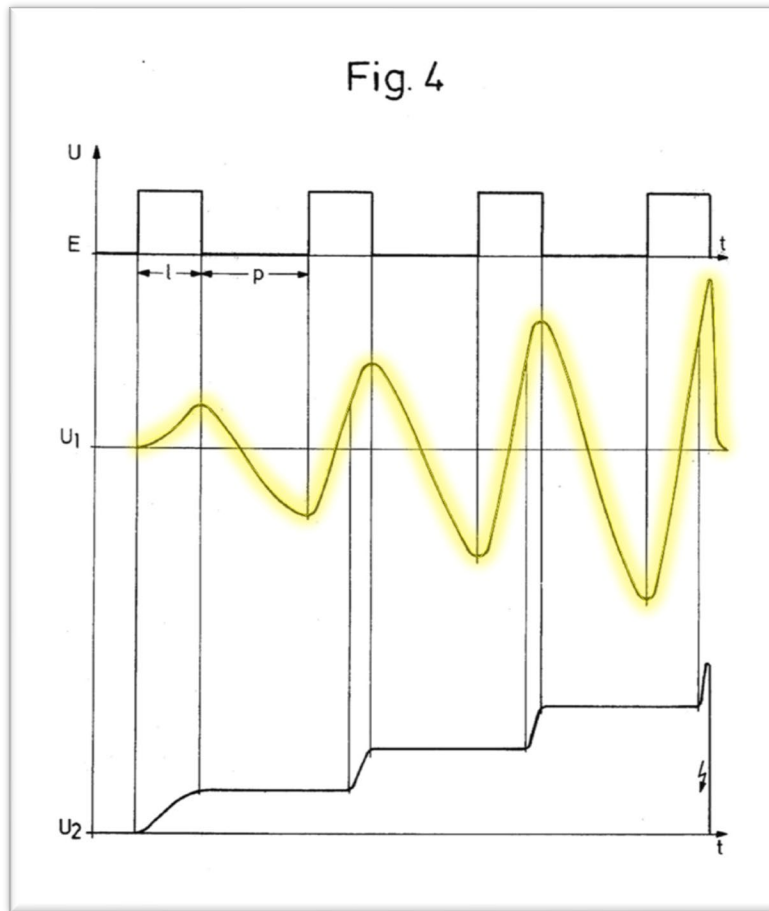
95. In view of the above, it is my opinion that Research Disclosure or Grather discloses or renders obvious Element [1.2]. Moreover, as described further in connection with Element [1.3], a POSA would have had a motivation to combine the teachings of Research Disclosure and Grather.

[1.3] these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the open circuit breakdown voltage capability of the ignition transformer is increased.

96. It is my opinion the Element [1.3] is rendered obvious by Grather.

EX1006, 1:45–44, 2:21–32, 3:15–27, 5:33–6:3, 6:20–7:10, 9:31–37, 9:38–43, 12:4–

37, FIGS. 4, 8. For example, as shown below in annotated Figure 4, Grather times its control pulses “E” to take advantage of the “resonance” shown by oscillating waveform “U1” to create a charge accumulation that will increase the breakdown voltage capability of the system. “Due to the resonance effect of this oscillation, the maximum will be higher than the maximum of the preceding wave of the oscillation. When the voltage exceeds the level of the voltage at which U2 previously had been held, then voltage U2 will rise, parallel to voltage U1, until, at the next gap between pulses, a level will be established as previously described.” EX1006, 5:59–66. “This accumulation of [capacitor] charge, or [equivalently,] accumulation of voltage, at the spark gap 24 continues until the voltage U2 reaches a value which causes breakdown of the spark gap, that is, which is sufficient to cause firing of the spark plug. The cycle will then repeat if signals E are still present.” EX1006, 5:66–6:3.



EX1006, Figure 4 (Annotated)

97. In the technical parlance of electronics that is known to a POSA, aspects of Grather teach “constructive resonance” that is achieved by a “phase locked loop”, synchronizing the pulses of the pulse train to the down cycle of the secondary voltage waveform (phase locking) that is fed to the spark plug. This is analogous to enhancing the amplitude of oscillation of a swing, or pendulum (a resonant system), by pushing, or force pulsating, the swing with appropriate timing and duration of the force pulses while the swing is moving forward (phase locking to the rising phase of the resonant movement or signal).

98. As taught by Grather, the second, third, and fourth pulses, denoted by the graph E in Figure 4, reinforce the ringing action of the voltage U1 at the secondary winding of the ignition coil resulting from the previous primary pulse. Compared to the '603 Patent, Figure 4 of Grather shows voltage U1 with flipped polarity such that the positive peaks that increase in amplitude in Grather are equivalent to negative peaks that increase in amplitude in the '603 Patent. From the perspective of a POSA, the flipped polarity oscilloscope showing of the reinforcing pulses in Grather does not change the fact that they have the same effect on the system as disclosed in the '603 Patent. The reinforcing pulses in Grather cause a rise in voltage U2 at the spark gap, thereby increasing the open circuit breakdown voltage capability of the ignition coil (i.e., ignition transformer). Sending control pulses on the ringing downcycle of U1 (which is toward during the peak) is reinforcement of ringing action, which meets the first half of the “arranged in time” limitation, and the charge accumulation at U2 is a resulting increase in breakdown voltage capability at the time of the first closing of the switch after the second period of time, which meets the second half of the limitation. Notably, it is immaterial that the circuit disclosed in Grather has diode 23 position between ignition cable 23', ignition coil 22, and spark gap 24 because Grather explains that “[v]oltage U2 at the secondary winding of the ignition coil 22 rises during any signal . . . causing a rise in voltage U2 at the spark gap.” EX1006, 5:33–36. Grather also explains that

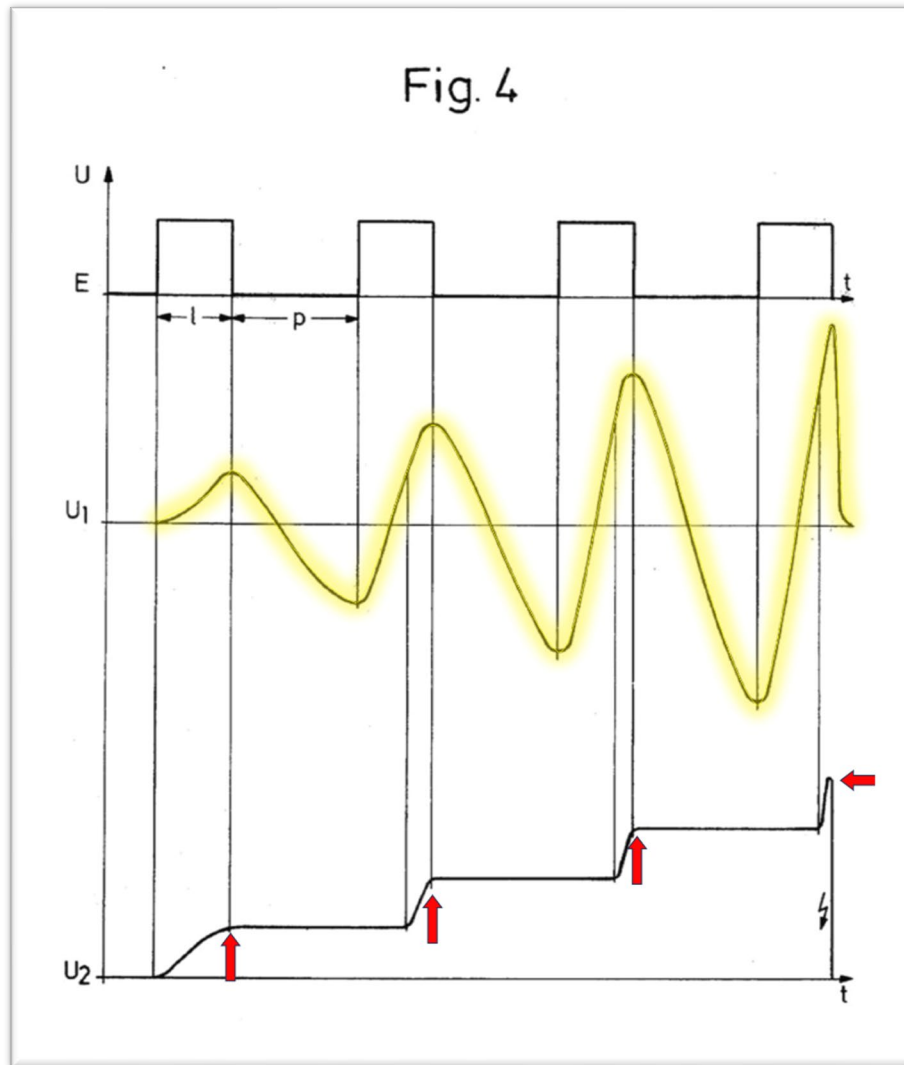
“[d]uring the rise in current, voltage U2 across the spark gap 24 also rises.” EX1006, 6:61–62.

99. I understand that Patent Owner argued in the ITC Proceeding that Grather is limited to pulses with fixed timing and does not disclose or teach unevenly spaced pulses. However, it is my opinion that it is not a distinction (or accurate) that Grather relates only to constant frequency pulses while the claims of the '603 Patent are directed only to arbitrary frequency pulses. Moreover, pulse frequency is not a limitation of Claim 1. Instead, the '603 Patent includes a discussion of a single, constant frequency of its “forcing function.” EX1001, 6:52–54. Moreover, Figures 6–8 disclose constant frequency. EX1001, FIGS. 6–8.

100. Further, to the extent the Board adopts the construction of the “arranged in time” limitation used in the ITC Proceeding, Grather discloses that the pulses are arranged in time to occur when it is possible to reinforce the ringing action of the secondary voltage resulting from the previous primary pulses by adding energy during the ignition transformer secondary voltage ringing down cycle. This is also what is known in the art and by the POSA as “constructive resonance.” For example, Grather explains that the signal length for a pulse “is so adjusted that the end of the signal will occur when the voltage U2 approximately has reached its maximum” EX1006, 5:37–39. Grather further describes that subsequent pulses “thus caus[e] a rise in the voltage U1 until, again, a maximum or approximately a maximum has

been reached.” EX1006, 5:56–58. By inverting the presentation of the waveform U1 in Figure 4, it is apparent that Grather teaches that the pulses denoted by graph E add energy during the ringing down cycle of the voltage U1. It is my opinion that a POSA would have understood that there would be no change to the teachings of Grather by inverting the presentation of the waveform U1. As such, it is my opinion that Grather teaches that each of the second, third, and fourth pulses denoted in the graph E add energy during the ringing down cycle of voltage U1.

101. Further, it is my opinion that Grather demonstrates that the open circuit breakdown voltage capability is increased as compared to the open circuit breakdown voltage capability of the ignition transformer at the time of the first closing of the switch after the second period of time. For example, Figure 4 of Grather (reproduced below) shows that U2 is increased as compared to its prior value at the time of the first closing of the switch after the second period of time. Moreover, Grather states, “[d]ue to the resonance effect of this oscillation, the maximum will be higher than the maximum of the preceding wave of the oscillation. When the voltage exceeds the level of the voltage at which U2 previously had been held, then voltage U2 will rise, parallel to voltage U1, until, at the next gap between pulses, a level will be established as previously described.” EX1006, 5:59–66.



EX1006, Figure 4 (Annotated)

102. With respect to the motivation to combine the teachings of Grather with the disclosure of Research Disclosure, it is my opinion that a POSA would have had a motivation to make this combination. For example, Research Disclosure and Grather are analogous art to the '603 Patent and to one another. Each of Research Disclosure, Grather, and the '603 Patent belong to the field of spark generation in an

internal combustion engine. EX1001, 1:31–36; EX1005, 2:1–39; EX1006, 1:17–26.

Moreover, each of Research Disclosure, Grather, and the '603 Patent address a common problem—namely, increasing the energy provided to a spark plug to ensure combustion at the spark plug gap even when spark plug conditions may vary. EX1001, 1:42–47, 5:22–33; EX1005, 2:23–3:7; EX1006, 1:17–26, 1:45–50.

103. Further, both Research Disclosure and Grather use a switch to generate pulses that provide energy to an ignition transformer. EX1005, 2:12–19; EX1006, 4:14–24, 4:68–5:3, FIG. 3. Both Research Disclosure and Grather include a secondary winding of the ignition transformer connected in series with the spark plug. EX1005, 2:6–8; EX1006, 4:24–28, FIG. 1. Both Research Disclosure and Grather teach that the timing of pulses can be controlled. EX1005, 2:13–18; EX1006, 1:60–65, 5:19–25, FIG. 3. Both Research Disclosure and Grather disclose that the pulses provided to the ignition transformer increase the energy provided to the spark plug. EX1005, 2:29–32; EX1006, 2:8–14, 3:15–27. Both Research Disclosure and Grather describe using pulses to provide sufficiently high energy to create a spark when there exist unfavorable conditions at the spark plug, such as worn-out spark plugs. EX1005, 2:23–27; EX1006, 2:8–14. Both Research Disclosure and Grather demonstrate that the pulses increase the efficiency of providing energy to the spark plug. EX1005, 2:29–32; EX1006, 2:51–55, 3:15–27.

104. Moreover, a POSA viewing Research Disclosure and Grather would have had a reasonable expectation of success in modifying the pulses of Research Disclosure according to the pulse timing taught by Grather. For example, the pulse timing taught by Grather takes advantage of the “resonance effect of [the] oscillation” in the secondary circuit. EX1006, 5:59–6:3, FIG. 4. A POSA would have recognized that this resonance is an intrinsic law of nature, not something unique to the teachings of Grather. Indeed, the resonance of Grather is a product of intrinsic equivalent capacitances and inductances of the ignition transformer 22 and the lead cable 23’, both of which are present in the circuit taught by Research Disclosure. EX1005, 2:1–10, Figure at p. 3; EX1006, 4:34–52, 5:26–6:3. Therefore, a POSA would have recognized that the resonance explained in Grather may also be present in the secondary circuit of Research Disclosure. As such, a POSA would have had a reasonable expectation of success in modifying the pulses taught by Research Disclosure according to the pulse timing taught by Grather to take advantage of the resonance effect and increase the voltage at the spark gap.

105. Moreover, a POSA, viewing the improvement to ignition capability due to the pulse timing taught by Grather, would have recognized that the ignition capability of the system in Research Disclosure could be improved in a similar and predictable way. For example, whereas Research Disclosure discloses a pulse train, Grather teaches how to time these pulses. EX1005, 2:12–18; EX1006, FIGS. 3–4.

Given the structural similarity of the secondary circuits in Research Disclosure and Grather, a POSA would expect similar secondary circuit waveforms in the systems of Research Disclosure and Grather. *Compare* EX1005 Figure Elements 20 and 22, *with* EX1006 at FIG. 1, Elements 22, 23, and 24. Therefore, a POSA would have expected that pulses of Research Disclosure, modified by the pulse timing taught by Grather, would have a similar effect of increasing secondary circuit energy as shown by Grather. Indeed, it would have been common sense for a POSA to modify the pulses of Research Disclosure in this way after reading Grather.

b. **Claim 2**

[2.0] A device according to claim 1, wherein the control circuit for the controllable switch causes the switch to be opened and closed a variable number of times during each firing event until a spark breakdown is sensed.

106. It is my opinion that Claim 2 is obvious in view of Research Disclosure and Grather.

107. Grather discloses that the control circuit causes the switch to be opened and closed a variable number of times during each firing event until a spark breakdown is sensed. EX1006, 1:60–65, 2:26–32. For example, Grather discloses “[a]n electronic system so adjusts the length of the signals and the gaps between signals that a charge accumulation will occur at the spark gap of the spark plug until breakdown occurs.” EX1006, 1:60–65. A POSA would have understood this

statement to mean that Grather's electronic system opens and closes the switch as many times as needed to achieve spark breakdown.

c. **Claim 3**

[3.0] A device according to claim 1, wherein the control circuit for the controllable switch causes the switch to be opened and closed a variable number of times up to a maximum number during each firing event to limit the highest available breakdown voltage of the coil.

108. It is my opinion that Claim 3 is obvious in view of Research Disclosure and Grather because Grather discloses that the control circuit causes the switch to be opened and closed a variable number of times up to a maximum number during each firing event to limit the highest available breakdown voltage of the coil. EX1006, 2:21–32. For example, in addition to the disclosure discussed above for Claim 2, Grather discloses “the electronic switch is closed for a period of time corresponding to the pulse period, which is approximately that time which is needed to reach maximum voltage at the spark gap.” EX, 2:23–26.

109. In addition, it is my opinion that it would have been obvious to a POSA to add reasonable limits to the control circuit to prevent pulsing of the switch such that the maximum possible voltage would not increase beyond the maximum safe operating level of the coil.

d. **Claim 4**

[4.0] A device according to claim 1, wherein the control circuit for the controllable switch causes the switch to be opened and closed a variable number of times during each firing event until a spark breakdown is

sensed and the secondary breakdown voltage required by the engine is estimated by counting the number of reinforcing primary pulses sent before the breakdown event is sensed.

110. It is my opinion that Claim 4 is obvious in view of Research Disclosure and Grather.

111. Grather further discloses that the control circuit causes the switch to be opened and closed a variable number of times during each firing event until a spark breakdown is sensed and the secondary breakdown voltage required by the engine is estimated by counting the number of reinforcing primary pulses sent before the breakdown event is sensed. EX1006, 1:60–65, 2:63–66. For example, Figure 4 of Grather depicts the “voltage U1 at the secondary winding of the ignition coil 22 rises during any signal . . . causing a rise in voltage U2 at the spark gap 24.” EX1006, 5:33–36, FIG. 4. Grather further explains “accumulation of voltage[] at the spark gap 24 continues until the voltage U2 reaches a value which causes breakdown of the spark gap, that is, which is sufficient to cause firing of the spark plug.” EX1006, 5:66–6:2. It is my opinion that it would have been obvious to a POSA from this disclosure in Grather to estimate the secondary breakdown voltage required by the engine by counting the number of reinforcing primary pulses sent before the breakdown event is sensed because doing so would allow the system to log pulses and track the health of a spark plug over time.

e. **Claim 5**

[5.0] A device according to claim 1, wherein the control circuit for the controllable switch drives the switch at an adjustable rate during the reinforcing time periods available so as to improve the resolution of the voltage sensing function.

112. It is my opinion that Claim 5 is obvious in view of Research Disclosure and Grather.

113. Grather discloses that the control circuit drives the switch at an adjustable rate during the reinforcing time periods available. EX1006, 5:37–41, FIG. 4. For example, Grather describes “[t]he signal length 1 is so adjusted that the end of the signal will occur when the voltage U2 approximately has reached its maximum, that is, when the capacities represented by the capacitors C1, C2 have been charged through the leakage inductance Ls.” EX1006, 5:37–41.

114. Moreover, it is my opinion that it would have been obvious to a POSA from this disclosure in Grather to adjust the rate of pulses so as to improve the resolution of the voltage sensing function. This efficiency of the operation of the system is improved by improving the sensing of the voltage to better understand the timing of the pulses necessary to achieve voltage breakdown.

f. **Claim 6**

[6.0] A device according to claims 1, 2, 3, 4 or 5, wherein the control circuit for the controllable switch operates in a closed loop manner by measuring the behavior of the circuit parameters to determine the exact wave shape of the pulse train sent to the controllable switch.

115. It is my opinion that Claim 6 is obvious in view of Research Disclosure and Grather. For example, Grather discloses that the control circuit measures “system parameters” to determine the “timing of the spark pulses” sent to the controllable switch. EX1006, Abstract, 3:50–4:1, 7:11–23, FIG. 3. Further, Figure 3 of Grather discloses measuring control signals that indicate various measurements of the behavior of a system. EX1006, FIG. 3. A POSA would have understood these disclosures to teach that Grather’s system operates in a closed loop manner by measuring the system parameters and using the measurement to determine the exact wave shape of the pulse train to be sent. Further, a POSA would have known that there are two methods of taking these measurements and using them to determine the wave shape of the pulse train. One of them is a closed loop feedback method that measures the parameters and provides the feedback to the control circuit to make decisions on the timing and shape of additional pulses.

g. Claim 7

[7.0] A device according to claims 1, 2, 3, 4 or 5, wherein the control circuit for the controllable switch (S1) operates in an open loop manner by using a stored memory map to determine the exact wave shape of the pulse train sent to the controllable switch.

116. It is my opinion that Claim 7 is obvious in view of Research Disclosure and Grather because it would have been obvious to a POSA from these references to operate the control circuit in an open loop manner by using a stored memory map to determine the exact wave shape of the pulse train sent to the controllable switch.

A POSA would have understood that it is efficient to measure the behavior of the circuit parameters and use those measurements to determine the wave shape of future pulse trains to be sent to the controllable switch. Further, a POSA would have known that one way to implement this is known as open loop control, where the circuit measures system parameters and uses those measurements to create instructions for programming the control circuit to use in the future to make decisions on the timing and shape of additional pulses.

B. Claims 8–16 of the '603 Patent are obvious over Lepley-I in view of Research Disclosure.

117. It is further my opinion that a POSA would have found Claims 8–16 of the '603 Patent obvious over Lepley-I in view of Research Disclosure, and the knowledge of a POSA. My opinions set forth below demonstrate the invalidity of Claims 8–16.

a. Claim 8

[8.pre] In a capacitive discharge ignition system for an internal combustion engine comprising: a storage capacitor; a power supply connected in series with the storage capacitor; an ignition transformer having primary and secondary windings; and a controllable switch; the primary winding of the ignition transformer and the storage capacitor being connected in series through the controllable switch; a spark plug connected in series with the secondary winding of the ignition transformer

118. Similar to my opinions with Element [1.pre] of Ground 1, it is my opinion that the Jepson format of Claim 8 indicates that the capacitive discharge

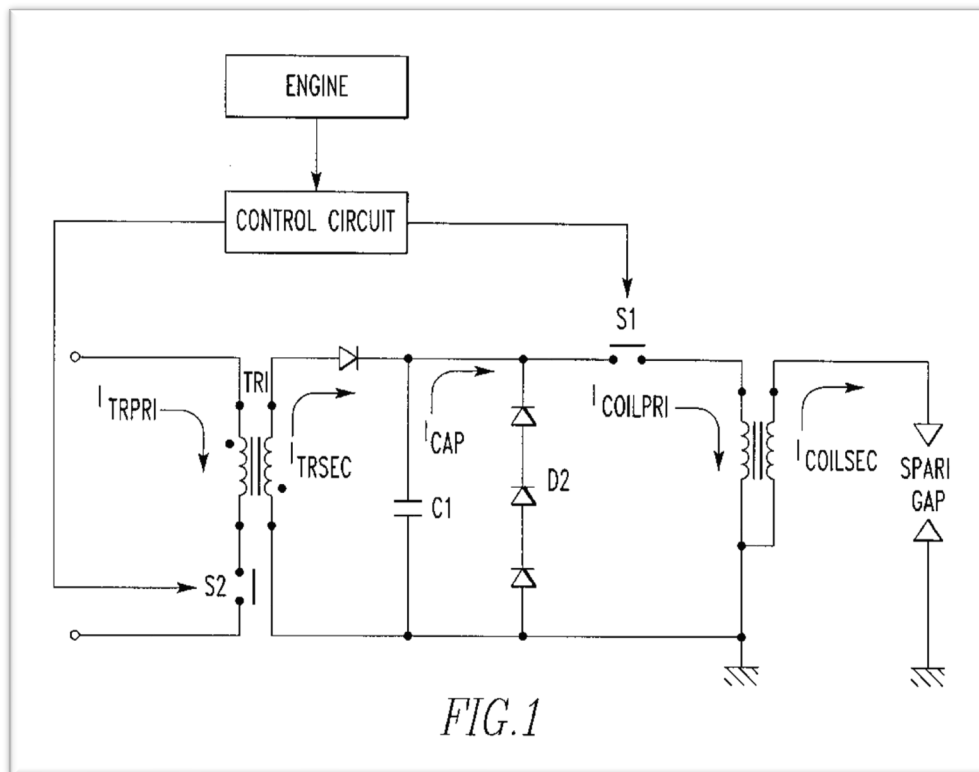
ignition circuit recited in Element [8.pre] was known in the art before the priority date for the '603 Patent. Moreover, the '603 Patent admits that capacitive discharge ignition systems for internal combustion engines were known in the art. EX1001, 3:6–10, 3:32–40, FIG. 1. For example, the '603 Patent refers to the circuit of FIG. 1 as a “basic circuit of a high tension capacitive discharge ignition system” EX1001, 3:6–10, FIG. 1. In the ITC Proceeding, the inventor and Patent Owner’s own expert testified that the capacitive discharge ignition circuit that is shown in Figure 1 of the '603 Patent was “known in the art.” EX1011, 145:15–146:16, 1277:24–1278:5.

119. It is further my opinion that Element [8.pre] is disclosed or rendered obvious by Research Disclosure for the reasons set forth in connection with Element [1.pre].

120. Moreover, Lepley-I teaches, or renders obvious, Element [8.pre], as Lepley-I relates to a “capacitive discharge ignition system for an internal combustion engine” EX1007, 1:30–31. Furthermore, Lepley-I discloses or renders obvious the capacitive discharge ignition circuit recited in claim 8. For example, in describing its Figure 1, Lepley-I discloses the following components:

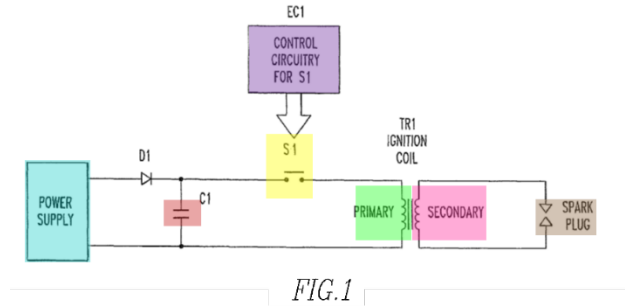
a storage capacitor and diode in series therewith, a converter transformer having primary and secondary windings, the secondary winding thereof connected in series with the storage capacitor and diode, an ignition transformer having primary and secondary windings,

a first triggerable switch, the primary winding of the ignition transformer and the storage capacitor being connected in series through the first triggerable switch, a spark plug connected in series with the secondary winding of the ignition transformer, a source of direct current, and a second triggerable switch connected in series with the primary of the converter transformer. EX1007, 1:32–42.

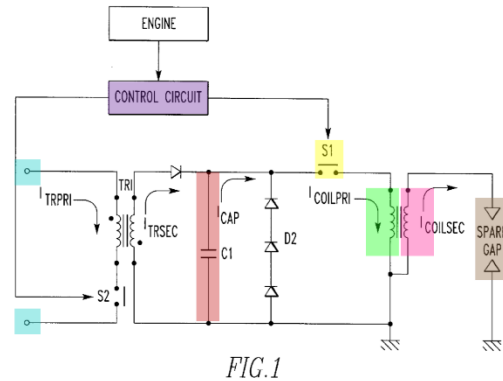


EX1007, Figure 1

A side-by-side of the circuit diagrams provided by the '603 Patent and by Lepley-I is shown below:



EX1001, Figure 1 (Annotated)



EX1007, Figure 1 (Annotated)

121. With reference to its Figure 1, Lepley-I explains that the direct current source, switch S2, and the converter transformer act together as a power supply to charge the storage capacitor C1. EX1007, 1:42–50, 2:47–58, FIG. 1. The patent explains that “while the first switch [S1] is open, the second switch [S2] is closed for a period to store energy in the converter transformer [from the direct current source shown in blue] and then opened to transfer energy to the storage capacitor followed by again closing of the second switch.” EX1007, 1:42–48. The patent further states that “[w]hen sufficient energy is stored in the primary of the first transformer TR1, switch S2 is opened and energy from the collapsing magnetic field across the secondary winding of the first transformer TR1 causes secondary current I_{TRSEC} to flow through diode D1 and charge storage capacitor C1.” EX1007, 2:53–58, FIG. 1. These disclosures from Lepley-I demonstrate that the storage capacitor

C1 is in series with the power supply formed by the combination of the direct current source, switch S2, and the converter transformer.

122. Further, Lepley-I discloses that its capacitive discharge circuit has “an ignition transformer having primary and secondary windings.” EX1007, 4:51–52.

123. Lepley-I also discloses that its capacitive discharge circuit has “triggerable switches” S1 and S2. EX1007, 4:61–5:6. It is my understanding that in a claim such as Claim 8 that uses the term “comprising,” the indefinite “a” means “one or more.” Therefore, “a controllable switch” means “one or more controllable switches,” which is what is taught by Lepley-I. Further, it is my opinion that a POSA would have known, or found it obvious, that the combination of triggerable switches S1 and S2 in Lepley-I have the claimed features of the controllable switch[es] of Claim 8. For example, each of the switches S1 and S2 are opened and closed to provide energy to the primary winding of the ignition coil. EX1007, 3:29–30, 3:33–37, 3:54–62. Switch S1 connects the primary winding of the ignition transformer with the capacitor, and the opening and closing of switch S2 provides reenergizing pulses to the ignition transformer. EX1007, Abstract, 3:29–30, FIGS. 1, 4–9.

124. In addition, Lepley-I discloses “the primary winding of the ignition transformer and the storage capacitor being connected in series through the triggerable switch [S1]” and that the spark plug (which would be in the location

designated “spark gap” in Figure 1, is connected in series with the secondary winding of the ignition transformer. EX1007, Abstract, 2:44–46.

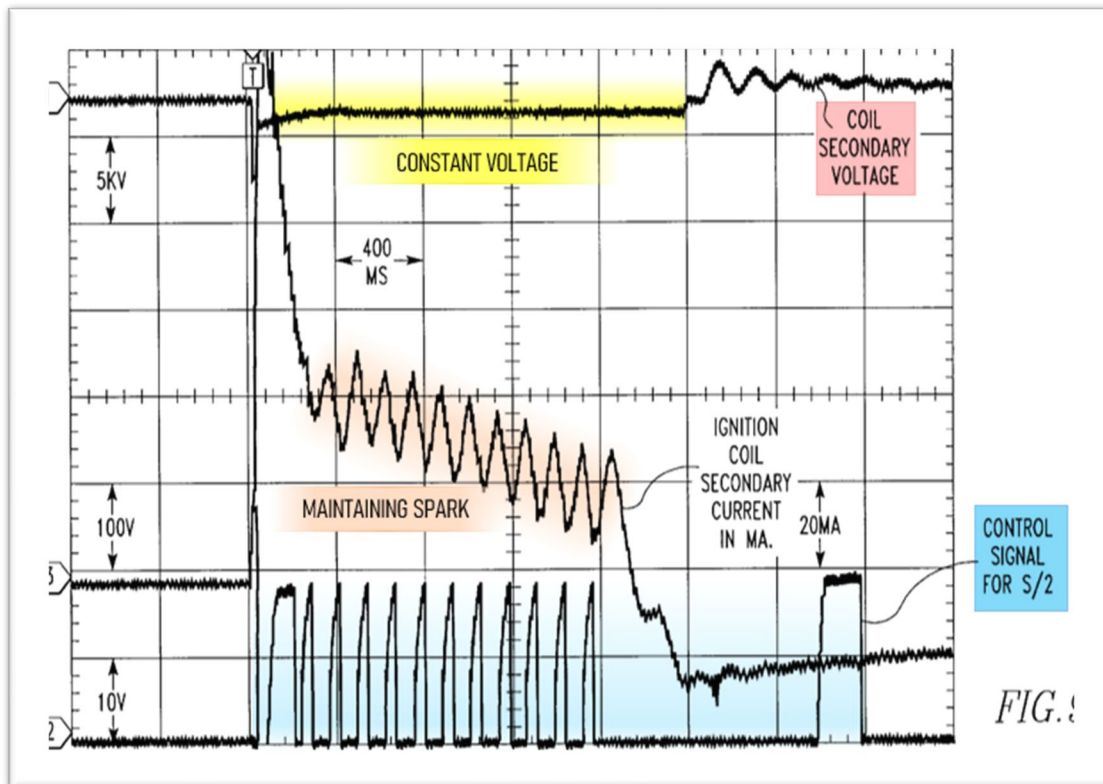
125. As such, it is my opinion that Lepley-I also discloses, or renders obvious, the capacitive discharge ignition circuit recited in limitation [8.pre].

[8.1] the improvement comprising an electronic control circuit for driving the controllable switch which is operating in synchronism with the engine such that the switch is initially closed for a period of time to transfer energy to the ignition coil primary, that after this time, the switch is then opened for a second period of time and then the switch is again closed creating a pulse train,

126. It is my opinion that both Lepley-I and Research Disclosure disclose or render obvious Element [8.1].

127. Lepley-I discloses or renders obvious Element [8.1]. EX1007, 1:42–56, 5:7–11. For example, Lepley-I teaches that its control circuit opens and closes controllable switches operating in synchronism with the engine to create a pulse train to be sent to the ignition transformer. EX1007, 1:47–58, 3:7–30, 3:54–4:38, 4:44–5:11, FIGS. 4–9. Lepley-I explains that “[a] circuit is provided to control the first and second triggerable switches [S1 and S2] in synchronism with the engine such that while the first switch is open, the second switch is closed for a period to store energy in the converter transformer and then opened to transfer energy to the storage capacitor followed by again closing of the second switch.” EX1007, 1:42–48. Lepley-I goes on to state that “[t]he first switch is closed to discharge the storage capacitor to the primary of the ignition coil. The second switch is reopened to

transfer energy stored in the converter transformer to the primary of the ignition transformer to prolong the current in the secondary of the ignition transformer.” EX1007, 1:48–53. Lepley-I then explains that this process is repeated a number of times to create a pulse train used to extend the duration of the spark: “The number of times N the second switch is reopened and closed and the time period T for which the second switch remains closed is controlled to control the duration and amplitude of the extended arc current.” EX1007, 1:53–56. Figures 4–9 provide examples of the pulse trains (labeled as “2”) used to extend spark duration, as demonstrated by the blue pulse train shown below in Figure 9.



EX1007, Figure 9 (Annotated)

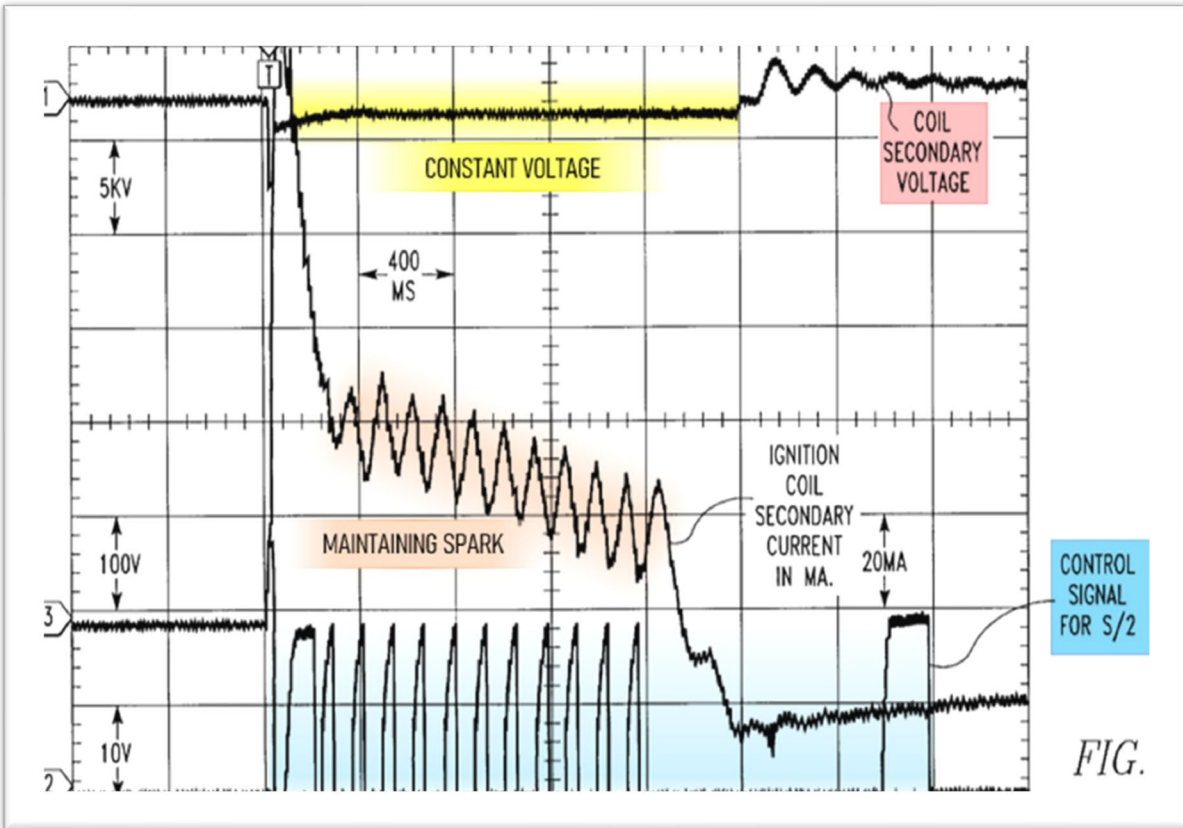
128. Further, as described in connection with Ground 1, Element [1.1], Research Disclosure also explains, “[t]he switch 14 is connected to a pulse control 24 which controls the switching of switch 14. EX1005, 2:12–14. Such pulse control mechanisms can control the switch to generate multiple sequentially generated pulse signals or “pulse trains.” EX1005, 2:12–18. Moreover, a POSA would have understood that the pulse train created by the control circuit disclosed in Research Disclosure results from closing the switch for a period of time to transfer energy to the ignition coil primary, opening the switch for a second period of time, and then closing the switch again.

[8.2] such that the switch is controlled by a successive string of control pulses to the switch, each of the individual pulse times having a duration and spacing as determined by the control circuit,

129. It is my opinion that Element [8.2] is rendered obvious by Lepley-I, which discloses switches controlled by the control pulses to send a number of reenergizing pulses, each of the individual pulses having a duration and spacing as determined by the control circuit. For example, the control circuit in Lepley-I first sends control pulses that operate to ignite the spark and then sends a successive string of reenergizing control pulses to open and close switches S1 and S2 in order to provide additional energy to the primary coil of the ignition transformer to extend spark duration. EX1007, 2:47–61, 3:29–30, 3:33–37, 3:54–62, 4:4–8, 4:16–31, FIGS. 4–9. For example, Figure 4 demonstrates a situation in which “[a]fter the

initial closing of switch S1 and following the breakdown in the spark gap,” the control circuit sends a successive string of control pulses to switch S2 such that the switch is “opened and closed twelve (12) times over a period of 1,520 microseconds. This causes the primary of the ignition coil to be reenergized as many times and the duration of the spark to be extended by 1,920 microseconds.” EX1007, 3:54–62, FIG. 4.

130. Further, Figures 4–9 of Lepley-I demonstrate that the individual pulse times of the reenergizing pulses have a duration and spacing determined by the control circuit. Each of those figures show a control signal (labeled as “2”) having pulses of a certain duration and spacing. For example, Figure 9 (reproduced below) depicts a situation in which “twelve equally spaced reenergizing pulses are used to extend the spark duration.” EX1007, 4:24–26, FIG. 9. Figure 9, as compared to Figure 8, demonstrates that “the current during the extended spark duration can be controlled by controlling the width [i.e. duration] of the reenergizing pulses.” EX1007, 4:36–38, FIG. 9. Thus, it is my opinion that the spacing and width (or duration) of the reenergizing pulses is controlled by the control circuit in Lepley-I.



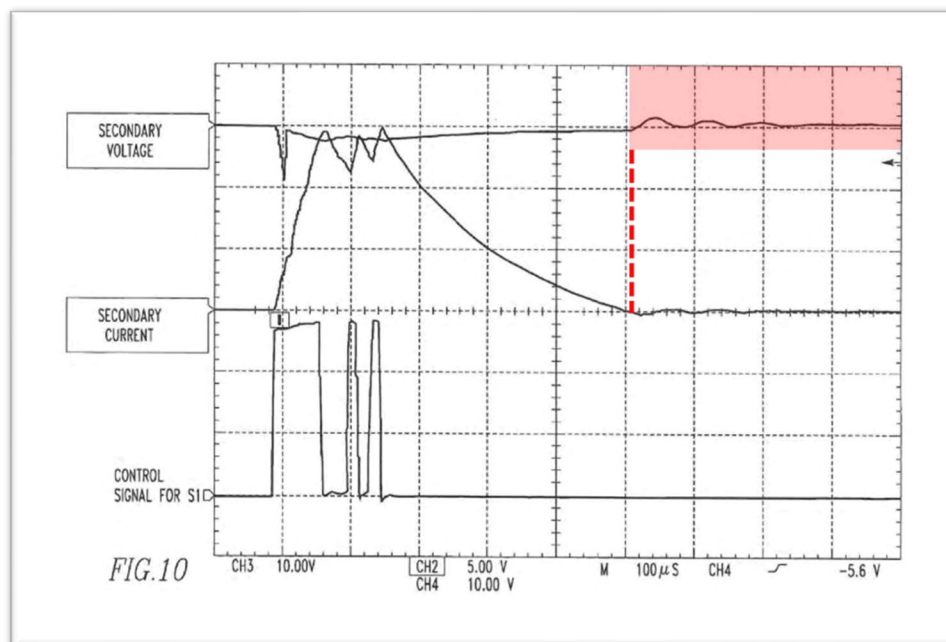
EX1007, Figure 9 (Annotated)

[8.3] these pulses being arranged in time to occur when it is possible to reinforce the ringing action of the ignition transformer secondary voltage resulting from the previous primary pulses, such that the secondary circuit current capability of the ignition transformer is increased.

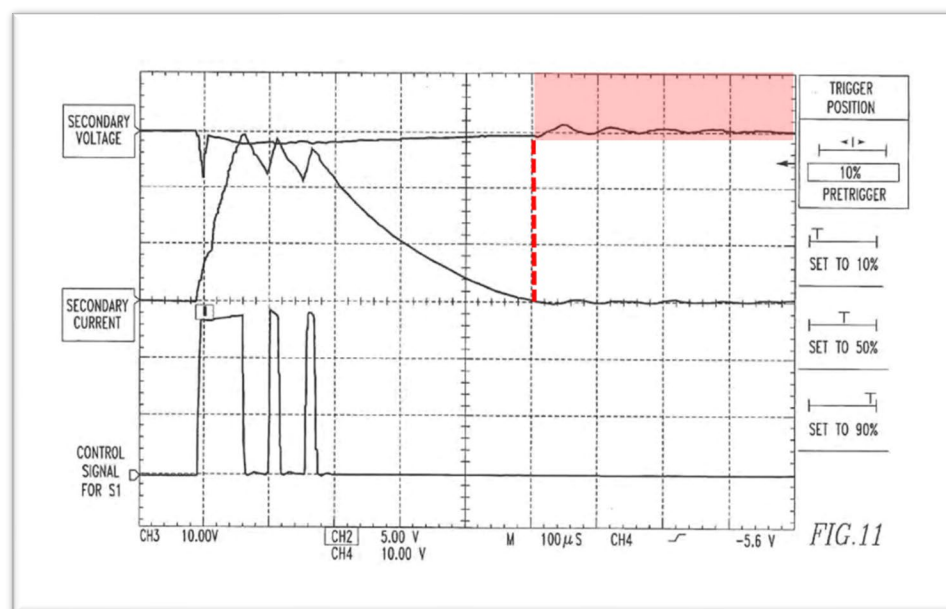
131. I first note that this claim limitation recites “reinforc[ing] the ringing action of the ignition transformer secondary voltage . . . such that the secondary circuit current capability of the ignition transformer is increased.” It is my opinion that this step would not be accomplished in actuality because there is no ringing action of the ignition transformer secondary voltage when (1) a spark is present and (2) a secondary circuit current is flowing across the spark gap. Under these

conditions, there is no oscillation of voltage, much less a “ringing action” being reinforced by pulses, and no such oscillation is shown in the ’603 Patent.

132. To explain further, when energy is flowing through a transformer, as is the case when a spark is present, the leakage inductances on the primary and secondary sides are not trapping energy. Trapped energy (meaning energy that cannot continuously flow out to the arc) between the inductor and the capacitor is needed for oscillations to occur and, when energy is flowing through the transformer, no oscillations occur, and no ringing action is possible or occurs. Figures 10 and 11 of the ’603 Patent show ringing in the secondary voltage trace due to the trapped energy only *after* the spark current interruption, or arch quenching. EX1001, FIGS. 10–11. When a spark is present, the ignition transformer secondary voltage is that of the arc and is nearly constant, which generates a highly conductive path of energy flowing. Because of this energy flow, energy is not trapped in any component of the transformer or the circuit and there cannot be any kind of oscillation or reinforced ringing action. This is supported by Altronic’s U.S. Patent No. 9,429,132 (“’132 Patent”), which explains that the ringing action is not occurring when the spark is present, and only “after the spark event” does an AC current arise that “causes the ringing of the secondary voltage.” EX1008, 2:18–32.



EX1001, Figure 10 (Annotated)

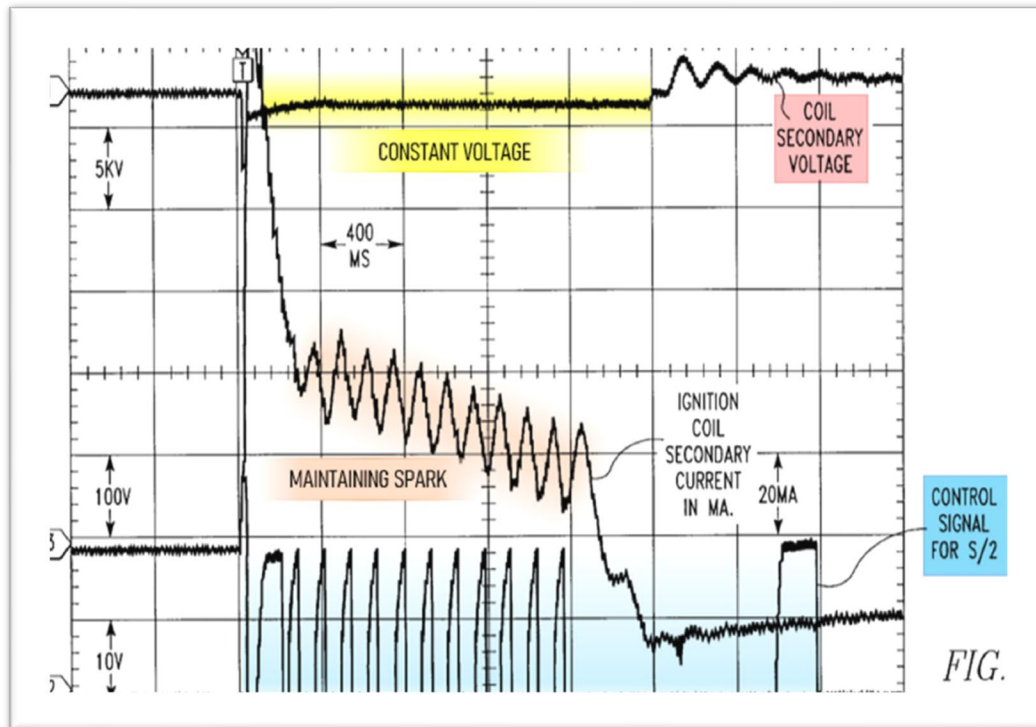


EX1001, Figure 11 (Annotated)

133. In the ITC Proceeding, the Patent Owner failed to introduce any oscillogram in the '603 Patent that showed evidence of reinforcing the ringing action

of the secondary voltage, which also supports my opinion that such ringing action cannot occur when a spark is present. Nonetheless, Joseph Lepley, the named inventor of the '603 Patent, took the position in the ITC Proceeding that ringing action does occur within the ignition transformer when the spark is present. EX1012, 88:9, 94:2–98:9. He argues that this ringing action cannot be seen in an oscillogram measuring the ignition transformer secondary voltage at the spark gap. EX1012, 69:8–17. This is contrary to the laws of physics and basic understanding of transformer operation.

134. To the extent Patent Owner adopts Mr. Lepley's position and reads this claim such that it is possible to reinforce ringing action of the ignition transformer secondary voltage waveform when the spark is present, then this limitation is taught by Lepley-I. Specifically, Patent Owner argued in the ITC Proceeding that the ringing action which cannot be observed when a spark is present is instead evidenced circumstantially by the increased spark duration when additional pulses are sent to the ignition transformer. EX1013, 70:19–71:14, 509:20–510:19, 682:11–683:4. Lepley-I demonstrates the exact same phenomenon. For example, Figures 4–9 of Lepley-I demonstrate that the spark duration is extended by sending additional pulses to the ignition transformer, as evidenced in Figure 9 below. EX1007, FIGS. 4–9.



EX1007, Figure 9 (Annotated)

135. Lepley-I also discloses “that the secondary circuit current capability of the ignition transformer is increased.” For example, the system of Lepley-I generates “an arc discharge three to six times longer than typical for the type of ignition coil in use.” EX1007, 1:12–16. Further, Lepley-I explains that the spark duration can be increased by controlling either the number or width of reenergizing pulses sent to the ignition transformer. EX1007, 1:53–56, 3:54–4:38. This is demonstrated by, for example, Figure 9, which shows “twelve equally spaced reenergizing pulses [that] are used to extend the spark duration.” EX1007, 4:24–26, FIG. 9.

136. As such, under Patent Owner's theory that there could be ringing action of the ignition transformer secondary voltage when a spark is present, the extension of the spark duration of Lepley-I shown above in Figure 9 would be due, at least in part, to the reinforcement of the ringing action of the secondary voltage of the ignition transformer. EX1007, 4:24–26, FIG. 9.

137. With respect to motivation to combine, Lepley-I and Research Disclosure are analogous art to the '603 Patent and to one another. Each of Lepley-I, Research Disclosure, and the '603 Patent belong to the field of spark generation in an internal combustion engine. EX1001, 1:31–36; EX1005, 2:1–39; EX1007, Abstract. Moreover, each of Lepley-I, Research Disclosure, and the '603 patent address a common problem—namely, increasing the energy provided to a spark plug to ensure combustion at the spark plug gap even when spark plug conditions may vary. EX1001, 1:42–47; EX1005, 2:23–3:7; EX1007, 1:17–25, 3:63–4:3.

138. The interrelated teachings of Lepley-I and Research Disclosure demonstrate that a POSA would have had a motivation to combine the teachings of Lepley-I and Research Disclosure. Both Lepley-I and Research Disclosure disclose using a switch to generate pulses that provide energy to an ignition transformer. EX1005, 2:12–18; EX1007, 3:54–62, FIG. 4. Both Lepley-I and Research Disclosure disclose a secondary winding of the ignition transformer connected in series with the spark plug. EX1005, 2:6–7, Figure at 3; EX1007, FIG. 1. Both

Lepley-I and Research Disclosure teach that the timing of pulses can be controlled. EX1005, 2:13–18, 2:23–27; EX1007, 4:16–31. Both Lepley-I and Research Disclosure disclose that the pulses provided to the ignition transformer increase the energy provided to the spark plug. EX1005, 2:29–32; EX1007, 3:54–62.

b. **Claim 9**

[9.0] A device according to claim 8, wherein the control circuit drives the switch to establish the time period for which the switch remains closed such that the amplitude of the extended arc current of the spark is controlled.

139. It is my opinion that Claim 9 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to implement the control circuit to drive the switch by establishing the time period for the switch to remain closed such that the amplitude of the extended arc current is controlled by increasing it to a desired value. *See, e.g.*, EX1007, 6:9–13, FIGS. 8–9. A POSA would have understood that the amount of time that the switch is closed will limit the voltage pulse that goes into the ignition transformer and thus the voltage that comes out of the ignition transformer. The result is that the amplitude of the extended arc current will be controlled.

c. **Claim 10**

[10.0] A device according to claim 8, wherein the control circuit for the controllable switch causes the pulse train to continue to send additional pulses to drive the secondary current higher until a desired secondary current level is reached.

140. It is my opinion that Claim 10 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to implement the control circuit to cause the pulse train to continue to send additional pulses to increase the secondary current to a desired level. *See, e.g.*, EX1007, 5:12–6:2, 6:9–13; EX1005, 2:13–32. A POSA would have known that sending properly-timed additional pulses would increase the amplitude of the secondary current, and the timing of the pulses could be used to drive the secondary current to a desired level.

d. **Claim 11**

[11.0] A device according to claim 8, wherein the control circuit for the controllable switch causes the pulse train for the control of the switch to continue to send additional pulses to drive the secondary current higher until a desired maximum secondary current level is reached and then suspend sending pulses until the current falls to a value below a desired minimum secondary current level when pulses are then sent again.

141. It is my opinion that Claim 11 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to implement the control circuit to cause the pulse train to continue to send additional pulses to increase the secondary circuit current to a desired maximum level and then stop sending pulses until the current falls below a certain level and then start sending pulses again. *See, e.g.*, EX1007, 5:7–11; EX1005, 2:23–32. A POSA would have understood that this would have prevented the current from exceeding levels which could be handled by the components of the circuit.

e. **Claim 12**

[12.0] A device according to claim 8, wherein the control circuit for the controllable switch causes the pulse train for the control of the switch to continue to send additional pulses to drive the secondary current higher until a desired maximum secondary current level is reached and then suspend sending pulses until the current falls to a value below a desired minimum secondary current level when pulses are then sent again, for a desired total time of the spark duration.

142. It is my opinion that Claim 12 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to implement the control circuit to cause the pulse train to continue to send additional pulses to increase the secondary circuit current to a desired maximum level and then stop sending pulses until the current falls below a certain level and then start sending pulses again. *See, e.g.*, EX1007, 1:52–56, 6:9–13; EX1005, 2:23–32. A POSA would have known that this would have allowed the circuit to achieve a desired total time for the duration of the spark by maintaining a high enough secondary current, while also preventing the current from exceeding levels which could be handled by the components of the circuit.

f. **Claim 13**

[13.0] A device according to claims 8, 9, 10, 11 or 12, wherein the control circuit for the controllable switch operates in a closed loop manner by measuring the behavior of the circuit parameters to determine the exact wave shape of the pulse train sent to the controllable switch.

143. It is my opinion that Claim 13 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these

references to operate the control circuit in a closed loop manner by measuring the behavior of the circuit parameters to determine the exact wave shape of the pulse train sent to the controllable switch. A POSA would have understood that it is efficient to measure the behavior of the circuit parameters and use those measurements to determine the wave shape of the pulse train to be sent to the controllable switch. Further, a POSA would have known that there are two methods of taking these measurements and using them to determine the wave shape of the pulse train. One of them is a closed loop feedback method that measures the parameters and provides the feedback to the control circuit to make decisions on the timing and shape of additional pulses.

g. Claim 14

[14.0] A device according to claims 8, 9, 10 or 11, wherein the control circuit (EC1) for the controllable switch operates in an open loop manner by using a stored memory map to determine the exact wave shape of the pulse train sent to controllable switch.

144. It is my opinion that Claim 14 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to operate the control circuit in an open loop manner by using a stored memory map to determine the exact wave shape of the pulse train sent to the controllable switch. As I discussed above for Claim 7, a POSA would have understood that it is efficient to measure the behavior of the circuit parameters and use those measurements to determine the wave shape of future pulse trains to be sent

to the controllable switch. Further, a POSA would have known that one way to implement this is known as open loop control, where the circuit measures system parameters and uses those measurements to create instructions for programming the control circuit to use in the future to make decisions on the timing and shape of additional pulses.

h. **Claim 15**

[15.0] A device according to claims 8, 9, 10 or 11, wherein the control circuit for the controllable switches enables the duration and amplitude of the extended arc current of the spark to be controlled independently of the initial breakdown voltage required to initiate the spark.

145. It is my opinion that Claim 15 is obvious in view of Lepley-I and Research Disclosure because the extended arc current is controlled independently of the initial breakdown voltage required to initiate the spark. *See, e.g.*, EX1007, 6:3–8. A POSA would have understood from these references that a control circuit would send the pulse train to generate the initial breakdown voltage that is required to generate the spark. After the spark is generated, the control circuit is no longer using the pulse train to generate the initial breakdown voltage to generate the spark. After the spark is generated, the control circuit uses the pulse train to control the duration and amplitude of the secondary circuit current. Thus, these two parameters are controlled independently.

i. **Claim 16**

[16.0] A device according to claim 12, wherein the control circuit for the controllable switch enables the secondary power versus time wave shape to be controlled to produce a spark having a desired energy envelope.

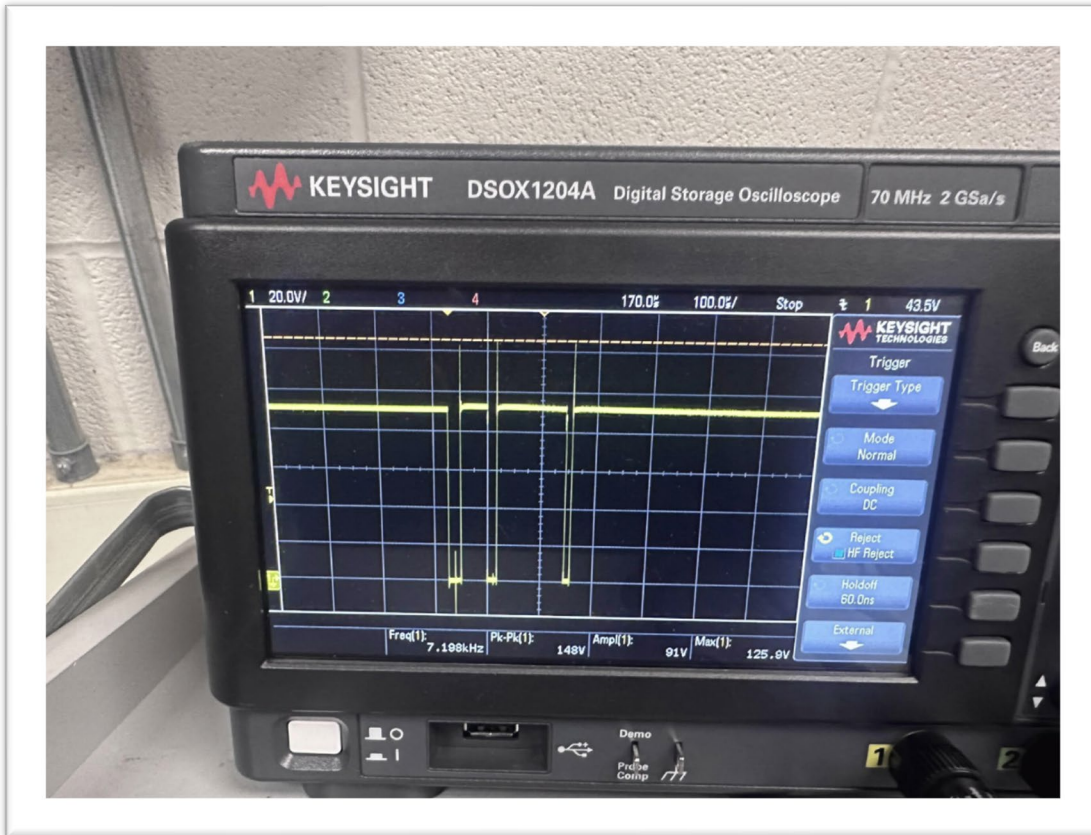
146. It is my opinion that Claim 16 is obvious in view of Lepley-I and Research Disclosure because it would have been obvious to a POSA from these references to implement the control circuit to cause the pulse train to the continue to send additional pulses to increase the secondary circuit current to a desired level, which would enable the secondary power versus time wave shape to be controlled to produce a spark having the desired energy envelope. *See, e.g.*, EX1007, 4:16–31; FIGS. 8–9; EX1005, 2:13–32.

IX. OBJECTIVE INDICIA OF NON-OBVIOUSNESS

147. I understand that in the ITC Proceeding, Patent Owner asserted certain objective indicia of non-obviousness. For example, the Patent Owner’s expert testified that the ’603 Patent brought an improvement over the prior art by providing “a description of a control circuit that launches pulses into the primary transformer so that they accumulate with a resonance in the transformer, and then can provide increased voltage sparking capability on the output of the transformer,” which provides “improved voltage capability to make a spark or to have improved spark duration or amplitude, or both.” EX1014, 1248:15–1249:9.

148. It is my opinion that the evidence offered by Altronic does not establish these alleged objective indicia. First, I understand Patent Owner has the burden to prove that its products practice the subject matter in Claims 1–16 if Patent Owner assert objective indicia of nonobviousness. It is my understanding that this is referred to as a nexus between Patent Owner’s products and the objective indicia. It is my opinion that the evidence provided by Patent Owner during the ITC Proceeding did not establish this nexus, and I am not aware of any other evidence that would establish the nexus.

149. For example, in the ITC Proceeding, Patent Owner pointed to its MORIS product, but provided no explanation of how the MORIS product meets the elements of any claim of the ’603 Patent. Patent Owner provided a single oscillogram depicting testing of MORIS, but it only shows three control pulses (shown below in yellow). It is my opinion that this oscillogram does not show the secondary voltage resulting from these control pulses, much less that the control pulses occur when it is possible to reinforce the ringing action of the secondary voltage by adding energy during the ignition transformer secondary voltage ringing down cycle, as required by Claim 1.



Oscillogram of Patent Owner's Product, MORIS (RX-0478)

150. Further, Patent Owner provided no evidence as to how MORIS meets the “arranged in time . . .” limitation of Claim 8. It introduced no oscillogram or other evidence showing the ignition transformer secondary voltage; thus, there is no evidence of reinforcing the ringing action of the secondary voltage (which, as previously discussed, cannot occur when a spark is present). Patent Owner also provided no evidence showing the secondary circuit current capability of MORIS or how it is increased by reinforcing the ringing action of the secondary voltage. It is thus my opinion that Patent Owner has not previously shown evidence of any nexus between MORIS and Claims 1 or 8.

151. Likewise, while Patent Owner identified other ignition controller products during the ITC Proceeding, such as its CPU-XL or CPU-95EVS, it is my opinion that the evidence I have seen to date does not show nexus. Nonetheless, I reserve the right to provide additional opinions on the nexus issue if Patent Owner asserts objective indicia based on MORIS, CPU-XL, CPU-95EVS or any other product.

152. Further, even if nexus could be established, it is my opinion that the evidence offered by Patent Owner did not demonstrate that there was a long-felt but unresolved need for ignition controllers that could meet these goals or that others had failed to design products that met these goals. It is my opinion that every industry, including the ignition controller industry, is always looking to develop products that are more reliable and operate in a more efficient manner. However, development of a product that is more reliable or more efficient does not necessarily indicate that there is a long-felt need that has been addressed or that prior technology represented a failure by others. Indeed, improving reliability, efficiency, and performance are not needs that can be “solved” by any technology, let alone needs that were, in fact, solved by the ’603 Patent. Instead, these are general industry goals that all engineers in the field of internal combustion engines seek to address. Though the ’603 Patent purports to address these industry goals, this is not evidence of a technological advancement or of a solution to a long-felt need.

153. Further, in the ITC Proceeding, Patent Owner raised an argument that Petitioner copied Patent Owner's products. However, it is my opinion that the evidence cited by Patent Owner did not establish copying. First, in the ITC Proceedings, I explained that Petitioners' accused ignition controller products did not infringe the claims of the '603 Patent and thus would not have copied Patent Owner's products in ways that are relevant to the patent. *See* EX1015, 1035:2–8, 1050:7–1056:6, 1076:19–1077:15. Moreover, Patent Owner previously discussed one of Petitioners' products, the MIC4, in internal presentations, and Patent Owner called the product technically inferior to Patent Owner's products and never identified the MIC4 as a "copy" of Patent Owner's products. EX1016, 288:12–292:18, 301:14–302:11. This evidence supports my opinion that I have not seen evidence that Petitioner copied Patent Owner's products.

154. Thus, in my opinion, any objective indicia of non-obviousness offered by Patent Owner would not overcome the prior art that clearly demonstrates that the subject matter of Claims 1–16 of the '603 Patent would have been obvious to a POSA as of February 2, 2007. Nonetheless, I reserve the right to supplement my opinion if Patent Owner presents objective indicia evidence as part of this proceeding.

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;

Declaration of Mark Ehsani, Ph.D.

U.S. Patent No. 7,401,603

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.

Executed this 6th day of January, 2025.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Mark Ehsani', written in a cursive style.

Mark Ehsani, Ph.D., P.E.