

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

TOYOTA MOTOR CORPORATION,

Petitioner,

v.

BUNKER HILL TECHNOLOGIES, LLC

Patent Owner

IPR2026-00250

U.S. Patent No. 10,549,648

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,549,648**

Table of Contents

I.	INTRODUCTION.....	1
II.	MANDATORY NOTICES.....	2
	A. Real Parties-in-Interest.....	2
	B. Related Matters	3
	C. Lead and Backup Counsel	3
	D. Service Information	3
III.	GROUND FOR STANDING	4
IV.	REQUESTED RELIEF.....	4
V.	REASONS FOR THE REQUESTED RELIEF.....	4
VI.	OVERVIEW OF THE CLAIMED TECHNOLOGY	5
	A. The '648 Patent Relates to Well-Known Propulsion Concepts.....	5
	B. The '648 Patent Claims.....	6
	C. The '648 Claims Were Allowed Without Rejection.....	8
	D. Priority Date.....	10
	E. Challenged Claims	10
VII.	STATUTORY GROUNDS FOR REVIEW	10
VIII.	LEVEL OF ORDINARY SKILL.....	11
IX.	CLAIM CONSTRUCTION.....	11
	A. “output of the second traction/electric motor” (claims 1, 9, 16).....	12
	B. “transmission device” (claims 1, 9, 16).....	12
X.	THE CLAIMS OF THE '648 PATENT ARE UNPATENTABLE	13
	A. Ground 1: Claims 1, 4, 5, 7, 8, 16, and 18-20 Are Anticipated by Conlon.....	13
	1. Independent Claim 1	13
	2. Dependent Claim 4.....	24
	3. Dependent Claim 5.....	24
	4. Dependent Claim 7.....	25
	5. Dependent Claim 8.....	26

6.	Independent Claim 16	26
7.	Dependent Claim 18.....	28
8.	Dependent Claim 19.....	29
9.	Dependent Claim 20.....	30
B.	Ground 2: Claims 1, 4, 5, 7, 8, 16, and 18-20 Are Obvious Over Conlon	30
C.	Ground 3: Claims 2, 3, 6, 9-15, and 17 Are Obvious Over Conlon in View of Reynolds.....	32
1.	Motivation to Combine Conlon and Reynolds	32
2.	Dependent Claim 2.....	32
3.	Dependent Claim 3.....	35
4.	Dependent Claim 6.....	37
5.	Independent Claim 9	39
6.	Dependent Claim 10.....	46
7.	Dependent Claim 11	48
8.	Dependent Claim 12.....	50
9.	Dependent Claim 13.....	50
10.	Dependent Claim 14.....	52
11.	Dependent Claim 15.....	53
12.	Dependent Claim 17.....	53
D.	Ground 4: Claims 1, 2, 4-10, and 12-20 Are Anticipated by Ortmann	56
1.	Independent Claim 1	56
2.	Dependent Claim 2.....	66
3.	Dependent Claim 4.....	66
4.	Dependent Claim 5.....	67
5.	Dependent Claim 6.....	67
6.	Dependent Claim 7.....	67
7.	Dependent Claim 8.....	68
8.	Independent Claim 9	68

9.	Dependent Claim 10.....	78
10.	Dependent Claim 12.....	78
11.	Dependent Claim 13.....	78
12.	Dependent Claim 14.....	79
13.	Dependent Claim 15.....	79
14.	Independent Claim 16	79
15.	Dependent Claim 17.....	81
16.	Dependent Claim 18.....	82
17.	Dependent Claim 19.....	82
18.	Dependent Claim 20.....	82
E.	Ground 5: Claims 3 and 11 Are Obvious Over Ortmann.....	83
1.	Dependent Claim 3.....	83
2.	Dependent Claim 11.....	83
XI.	CONCLUSION	84

Petitioner's Exhibit List

Toyota Exhibit No.	Description
1001	U.S. Patent No. 10,549,648
1002	Prosecution History of U.S. Patent No. 10,549,648
1003	Declaration of Dr. Mahdi Shahbakhti
1004	U.S. Patent Application Publication No. 2009/0176610 A1 ("Conlon")
1005	U.S. Patent Application Publication No. 2014/0100726 A1 ("Reynolds")
1006	Index of Claims 1-20 of U.S. Patent No. 10,549,648
1007	Prosecution History of U.S. Patent No. 10,442,296
1008	U.S. Patent Application Publication No. 2013/0012347 A1 ("Ortmann")
1009	Curriculum Vitae for Dr. Mahdi Shahbakhti

I. INTRODUCTION

U.S. Patent No. 10,549,648 (“the ’648 patent”) relates to a propulsion system for electric or hybrid electric vehicles. The ’648 patent describes a system that includes one or more energy storage devices coupled to multiple electric motors operating on independent channels to drive a vehicle and/or generate electrical power. The system splits power output between the electric motors and an internal combustion engine.

Hybrid electric vehicle (HEV) and plug-in hybrid electric vehicle (PHEV) propulsion systems with multiple electric motors operating on separate channels were well known before the ’648 patent’s January 2014 priority date. Thus, the claims of the ’648 patent recite nothing more than a previously known or obvious combination of propulsion system elements and functions that had been known in the art before 2014. The prior art in this petition—not of record during prosecution (which lasted less than two months and did not involve any Office Actions)—discloses or renders obvious all the limitations of the claims.

Conlon (U.S. Publication No. 2009/0176610 A1) discloses a powertrain that, like the system of the ’648 patent, includes separate electric motors coupled to an onboard energy storage device. It discloses all the structural elements of the ’648 claims, including a transmission device, gear assembly, internal combustion engine, and control system for operating the electric motors in different modes, such as

input-split mode (engine off), compound-split mode (engine on), and electric-only mode.

Reynolds (U.S. Publication No. 2014/0100726 A1) discloses a system for controlling an electric machine in an electric vehicle and includes a generator and a motor that are each electrically powered through separate inverters. Electrical power is stored in a battery and sent through a DC/DC converter to modify the vehicle voltage level according to the devices being powered.

Ortmann (U.S. Publication No. 2013/0012347 A1) discloses a multi-mode powersplit powertrain for an electric vehicle similar to the system of the '648 patent. The powertrain includes a battery, multiple motor-generators, an engine, a planetary gearset, and layshaft gearing. The various operating modes of the powertrain include one motor electric drive, two motor electric drive, series, powersplit, and direct drive.

II. MANDATORY NOTICES

A. Real Parties-in-Interest

The Petitioner is Toyota Motor Corporation (“Toyota” or “Petitioner”). Toyota, Toyota Motor North America, Inc., and Toyota Motor Sales, U.S.A., Inc. are the real parties-in-interest.

B. Related Matters

Patent Owner has asserted the '648 patent in *Bunker Hill Technologies, LLC v. Toyota Motor Corporation et al.*, Case No. 2:25-cv-01133, currently pending in the Eastern District of Texas. Petitioner is not aware of any other related matters.

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D. Service Information

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III. GROUNDS FOR STANDING

Petitioner certifies that the '648 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting *inter partes* review challenging the patent claims on the grounds identified in this Petition.

IV. REQUESTED RELIEF

Petitioner requests that the Board review the accompanying prior art and analysis, institute a trial for an *inter partes* review of claims 1-20 of the '648 patent, and cancel those claims as unpatentable.

V. REASONS FOR THE REQUESTED RELIEF

The claims of the '648 patent are anticipated and/or would have been obvious to a person of ordinary skill in the art ("POSITA") as of their priority date and are therefore unpatentable. The claims recite nothing more than previously known or obvious combinations of propulsion system elements and functions that had been known and used in the art before January 2014.

This Petition's showing that the cited art renders the '648 patent claims unpatentable is fully supported by the Declaration of Dr. Mahdi Shahbakhti (EX1003), a Professor of Mechanical Engineering at the University of Alberta. EX1003, ¶ 5. Dr. Shahbakhti is familiar with the state of the art before the 2014 priority date of the '648 patent and fully agrees with and supports the showing herein

that the claims are anticipated by, and/or obvious over, the cited art. EX1003, ¶¶ 24, 52.

Accordingly, the Board should institute trial and cancel claims 1-20 of the '648 patent.

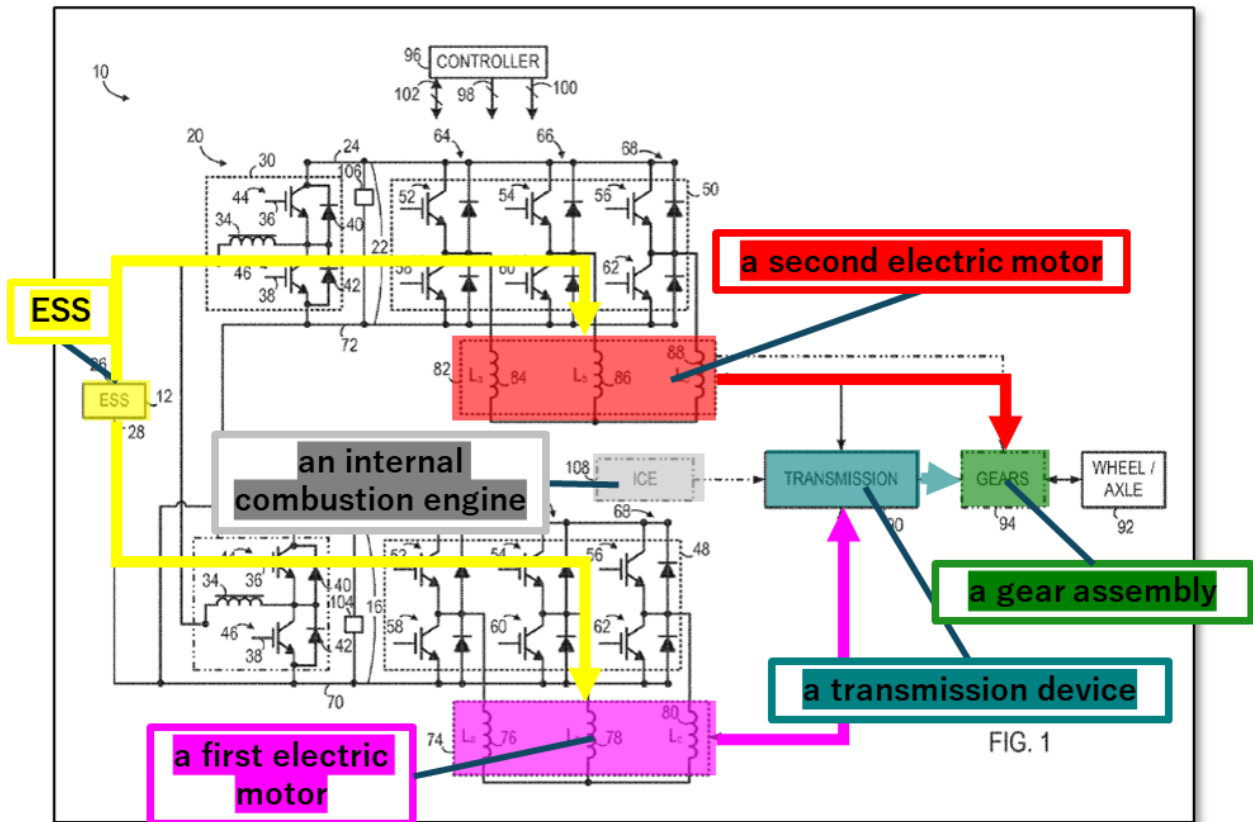
VI. OVERVIEW OF THE CLAIMED TECHNOLOGY

A. The '648 Patent Relates to Well-Known Propulsion Concepts

The '648 patent is directed to a propulsion system for electric or hybrid electric vehicles. The system includes one or more energy storage devices (batteries) coupled to multiple electric motors that can be operated on independent channels to drive a vehicle and/or generate electrical power and is described as providing improved overall system efficiency. EX1001, Cols. 1-2. The system may be configured in a pure electric (EV) arrangement that splits power output between two or more electric motors, or as a hybrid (HEV) propulsion system that includes an internal combustion engine. *Id.* at 3:17-23.

Figure 1, annotated below, shows standard components like energy storage system 12 (ESS) [shown in yellow], a first electromechanical device (motor) 74 [shown in purple], a second electromechanical device (motor) 82 [shown in red], a transmission 90 [shown in blue] coupled to the outputs of electric motors 74 and 82, a gear assembly 94 [shown in green] coupled to the output of transmission 90, and an internal combustion engine 108 [shown in gray] coupled to the output of

transmission 90. *Id.*, Cols. 3-5. Controller 96 monitors the operating conditions of the system, including the charging voltage of the ESS and bus voltage of each channel, and transmits control commands to other components, such as the internal combustion engine. *Id.* at 5:26-6:4.



B. The '648 Patent Claims

The '648 patent claims recite propulsion and electric drive systems for “transferring energy between one or more energy storage devices and multiple electromechanical devices of the vehicle.” EX1001 at 1:9-11. The claimed components were commonly used before the '648 patent’s filing.

Claim 1, for example, recites conventional components—an energy storage system, first and second traction motors, a transmission device, a gear assembly, an internal combustion engine, and a control system. *Id.* at 13:21-47. The control system is configured to selectively operate the first and second traction motors to drive the vehicle, to operate the first traction motor as a generator while operating the second traction motor to drive the vehicle, and to operate the second traction motor as a generator. *Id.*

Exemplary claim 1 recites:

1. A system for a hybrid electric vehicle, comprising:

an energy storage system;

a first traction motor coupled to the energy storage system;

a second traction motor coupled to the energy storage system;

a transmission device coupled to the first traction motor, the transmission device comprising an arrangement of planetary gears;

a gear assembly coupled between the second traction motor and the transmission device such that the output of the second traction motor bypasses the transmission device;

an internal combustion engine coupled to the transmission device via a path that does not include the first traction motor and second traction motor; and

a control system configured to selectively:

operate the first traction motor and second traction motor to drive the vehicle through the transmission device and gear assembly, respectively;

operate the first traction motor as a generator to generate electrical power while operating the second traction motor to drive the vehicle through the gear assembly; and

operate the second traction motor as a generator to generate electrical power.

C. The '648 Claims Were Allowed Without Rejection

The '648 patent issued on February 4, 2020, from U.S. Patent Application No. 16/555,487 (“the '487 application”) filed on August 29, 2019. EX1001, cover page. The '648 patent ultimately claims priority to U.S. Patent Application No. 14/168,224 filed on January 30, 2014. *Id.*

On October 3, 2019, less than two months after the '487 application was filed, the Examiner issued a Notice of Allowance without a single Office Action. EX1002, 152-176. Neither the Conlon, Reynolds, nor Ortmann references cited in this Petition were of record before the Examiner. *Id.* at 145, 152-176.

1. Prosecution of Parent Application

The '648 patent is a continuation of U.S. Patent Application No. 15/799,045 (“the '045 application”), now U.S. Patent No. 10,442,296, filed on October 31, 2017. EX1001, cover page. During prosecution of the '045 application, after a restriction requirement, then-pending claims 1, 2, 6-15, and 17-22 received a first Office Action rejection under § 102(a)(1) based on U.S. Patent Pub. No. 2006/0250902 to Bender (“Bender”). EX1007 at 658-63. Then-pending dependent claim 5 was objected to as

being dependent on a rejected base claim but would be allowable if rewritten in independent form. *Id.* at 663.

In response to the Office Action, applicants amended then-independent claims 1, 14, 21, and 22 to recite *inter alia* that the transmission device is “configured as an electrically variable transmission (EVT) that comprises an arrangement of planetary gears,” and amended claims 1, 14, and 21 to import from claim 22 the limitation “a gear assembly coupled to the second traction motor[/drive system] and the transmission device.” *Id.* at 525-30. Applicants argued that Bender did not teach these limitations. *Id.* at 532-33.

In a second Office Action, then-pending claims 1, 2, 7-15, and 18-22 were rejected under § 103 over Bender in view of U.S. Patent Pub. No. 2007/0007939 to Miller, which the Examiner found teaches a transmission configured as an EVT that comprises an arrangement of planetary gears. *Id.* at 497-504. Applicants responded by amending then-pending independent claims 1, 14, 21, and 22 to recite that the gear assembly is coupled “between” the second traction[/AC] motor[/drive system] and the transmission device “such that the output of the second traction[/AC] motor[/drive system] bypasses the transmission device.” *Id.* at 375-81. As a result of such amendment, the Examiner allowed the claims. *Id.* at 210-215.

Neither Conlon, Reynolds, nor Ortmann were of record before the Examiner during prosecution of the '045 application. *Id.* at 145, 153-54, 191-92, 221-22, 226-27, 231-32.

D. Priority Date

All the references cited in this Petition qualify as prior art based on the assumed priority date of January 30, 2014, the filing date of the U.S. patent application to which the '648 patent ultimately claims priority.

E. Challenged Claims

Claims 1-20 of the '648 patent are challenged in this Petition. An index showing claims 1-20 are attached as EX1006 for convenience.

VII. STATUTORY GROUNDS FOR REVIEW

This Petition presents five grounds for *inter partes* review:

Ground 1	Anticipation of claims 1, 4, 5, 7, 8, 16, and 18-20 by Conlon
Ground 2	Obviousness of claims 1, 4, 5, 7, 8, 16, and 18-20 over Conlon in view of the knowledge of a POSITA
Ground 3	Obviousness of claims 2, 3, 6, 9-15, and 17 over Conlon in view of Reynolds
Ground 4	Anticipation of claims 1, 2, 4-10, and 12-20 by Ortmann
Ground 5	Obviousness of claims 3 and 11 over Ortmann

Each of these references qualifies as prior art to the '648 patent under at least 35 U.S.C. § 102(a):

Conlon is a published United States patent application dated July 9, 2009, and therefore prior art under § 102(a)(1);

Reynolds is a published United States patent application that was filed on October 5, 2012, and therefore prior art under § 102(a)(2); and

Ortmann is a published United States patent application dated January 10, 2013, and therefore prior art under § 102(a)(1).

VIII. LEVEL OF ORDINARY SKILL

As of January 30, 2014, a POSITA would have had a bachelor's degree in mechanical engineering, electrical engineering, or a related scientific or engineering field, and at least three years of work or research experience relating to automotive powertrains, electric drive systems or a related field. EX1003, ¶ 43. A POSITA “would have had knowledge of and experience with propulsion systems in hybrid and electric vehicles.” *Id.*, ¶ 44. This experience would enable the POSITA to understand the “vehicle propulsion systems, electric drive systems, and energy transmission between and among energy storage devices and electromechanical components of such vehicles.” *Id.*

IX. CLAIM CONSTRUCTION

Terms not addressed below should be given their plain and ordinary meaning consistent with the claim construction standard of *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). EX1003, ¶¶ 46-51. Petitioner may, however, respond to any constructions offered by Patent Owner or the Board.

A. “output of the second traction/electric motor” (claims 1, 9, 16)

This term should be construed to mean “mechanical output of the second traction/electric motor.” The claims require that the output of the second traction/electric motor bypasses the transmission device. EX1001, 13:32-34, 14:15-17, 14:55-57. This output is mechanical power for driving the vehicle. EX1001, 5:3-25; EX1003, ¶ 49.

B. “transmission device” (claims 1, 9, 16)

In the '648 patent, “[t]ransmission 90 is constructed as a gear assembly, belt assembly, or combination thereof according to various embodiments. According to one embodiment, transmission 90 is configured as an electrically variable transmission (EVT) that couples the outputs of electromechanical devices 74, 82 through an arrangement of planetary gears *and clutches (not shown)*.” EX1001, 5:5-11 (emphasis added). “Depending on how the *clutches of transmission 90* are configured, electromechanical device 82 may be coupled to gear assembly 94 through transmission 90 or may be directly coupled to gear

assembly 94 such that the output of electromechanical device 82 bypasses transmission 90.” *Id.*, 5:21-25 (emphasis added). Clutches connect and disconnect the flow of power from a motor or engine. Accordingly, a POSITA would understand the plain and ordinary meaning of “transmission device” in the context of the ’648 patent to include clutches. EX1003, ¶ 50.

X. THE CLAIMS OF THE ’648 PATENT ARE UNPATENTABLE

As set forth below, the prior art cited in this Petition discloses or suggests all the elements of the challenged claims. There is no evidence of commercial success or other secondary considerations tied to the claimed combinations of features.

A. Ground 1: Claims 1, 4, 5, 7, 8, 16, and 18-20 Are Anticipated by Conlon

Conlon anticipates claims 1, 4, 5, 7, 8, 16, and 18-20. This reference—not of record during prosecution—discloses the physical components of the claimed system.

1. Independent Claim 1

**1[p]: A system for a hybrid electric vehicle,
comprising:**

Conlon discloses a system for a hybrid electric vehicle. EX1004, ¶ 0006.

Figure 2 illustrates the powertrain system. EX1003, ¶¶ 75-76.

1[a]: an energy storage system;

Conlon discloses an energy storage system. EX1004, ¶ 0036. Figure 2 shows that the system includes energy storage device (ESD) 86 [shown in yellow]. *Id.*; EX1003, ¶¶ 77-78.

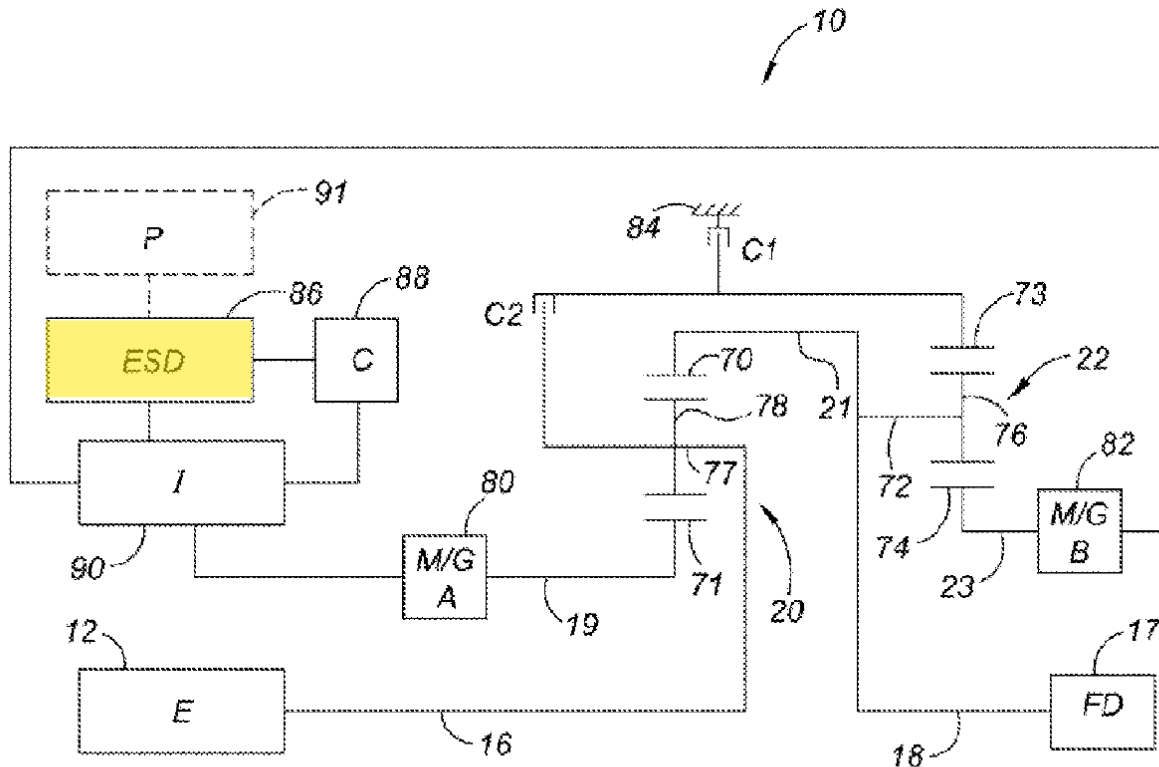


FIG. 2

1[b]: a first traction motor coupled to the energy storage system;

Conlon discloses a first traction motor coupled to the energy storage system. EX1004, ¶ 0036. Figure 2 shows that first motor/generator 80 (M/G A) [shown in purple] is operatively connected to ESD 86. *Id.* M/G A is a traction motor. EX1003, ¶¶ 79-80.

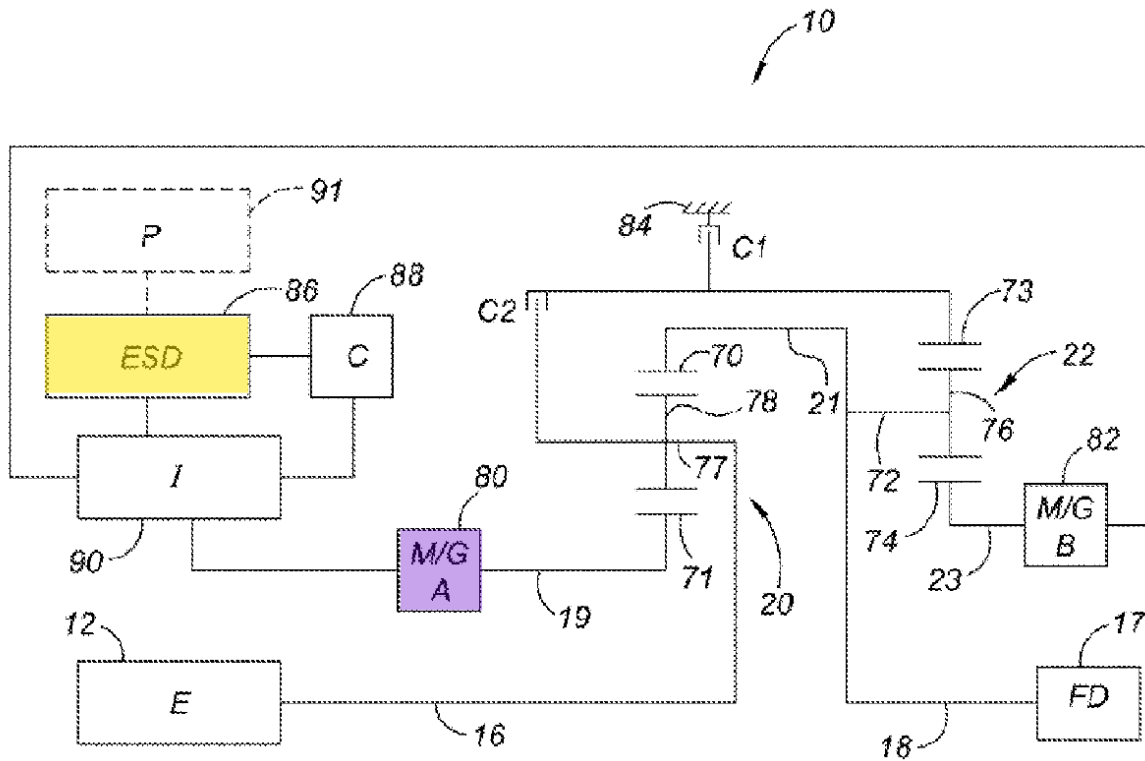
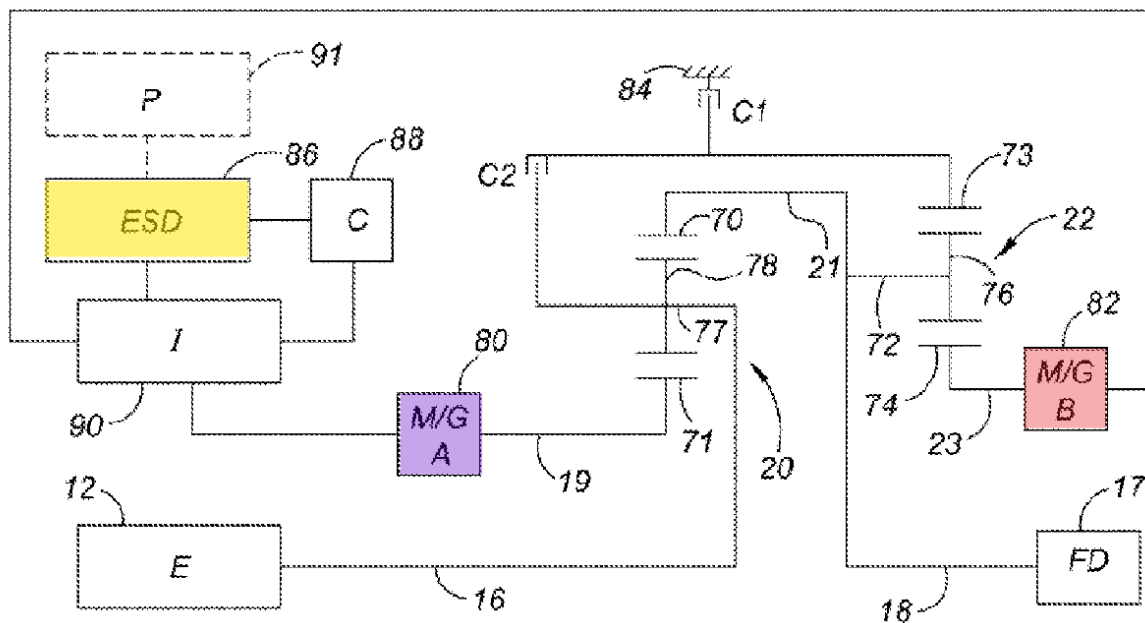


FIG. 2

1[c]: a second traction motor coupled to the energy storage system;

Conlon discloses a second traction motor coupled to the energy storage system.

EX1004, ¶ 0036. Figure 2 shows that second motor/generator 82 (M/G B) [shown in red] is operatively connected to ESD 86. *Id.* M/G B is a traction motor. EX1003, ¶¶ 81-82.



1[d]: a transmission device coupled to the first traction motor, the transmission device comprising an arrangement of planetary gears;

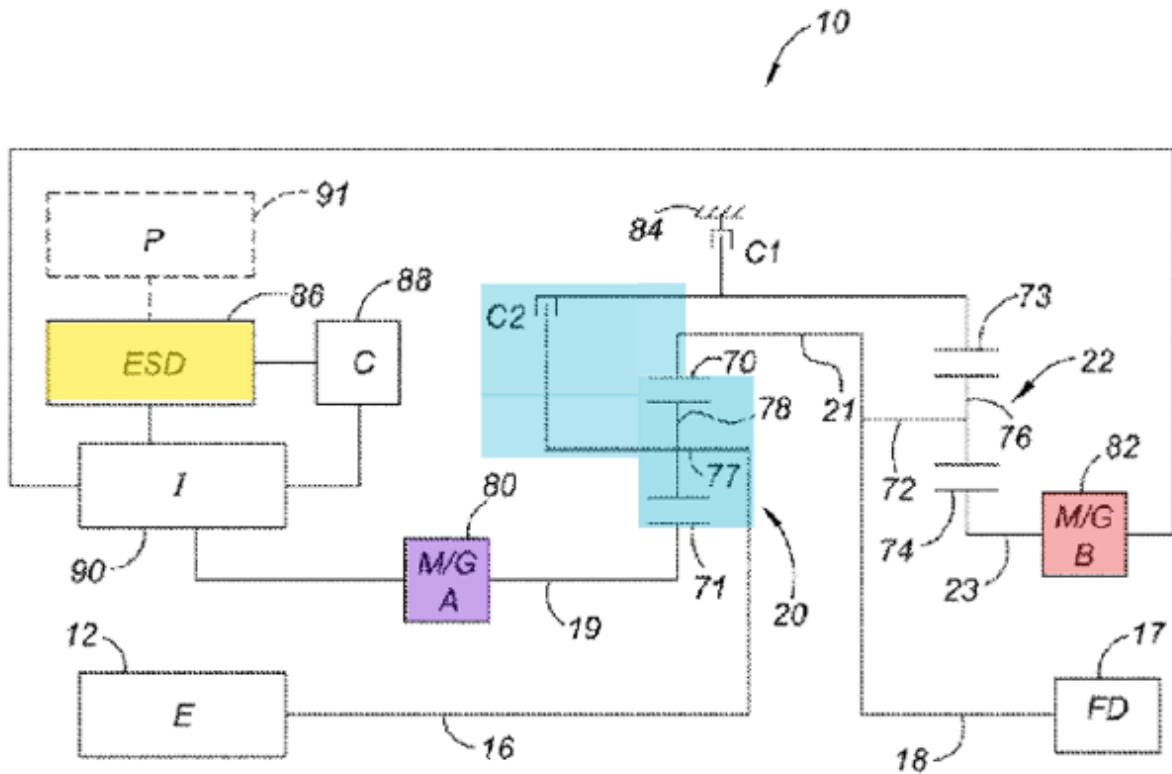


FIG. 2

1[e]: a gear assembly coupled between the second traction motor and the transmission device such that the output of the second traction motor bypasses the transmission device;

The claimed gear assembly is a separate and distinct element from the transmission device recited in limitation 1[d]. First, the claim lists the transmission device and gear assembly as separate elements. Second, the claim recites that the gear assembly is positioned “between” the second motor and the transmission device, indicating three distinct components arranged in sequence. Third, the claim requires that the second motor’s output “bypasses the transmission device,” further indicating the transmission and gear assembly are separate because the output of the second

motor cannot bypass the transmission device if the gear assembly to which the motor is coupled is part of the transmission device. EX1003, ¶ 85.

Conlon discloses a gear assembly coupled between the second traction motor and the transmission device such that the output of the second traction motor bypasses the transmission device. EX1004, ¶ 0035. Conlon's "second planetary gear set 22 has a sun gear 74, a ring gear 73, and a carrier member 72 having a plurality of pinion gears 76." *Id.*, ¶ 0034. In Figure 2, "[t]he second motor/generator 82 (M/G B) is continuously connected to the sun gear member 74 of the second planetary gear set 22, and is operable for transmitting torque to the output member 18." *Id.*, ¶ 0035. The second planetary gear set 22 [shown in green] is located between M/G B [shown in red] and the first planetary gear set 20 (transmission device) [shown in blue]. In Mode 1, for example, the mechanical power of M/G B is transmitted to output member 18 [shown in brown] without passing through (*i.e.*, bypassing) first planetary gear set 20 (transmission device), as shown by the red arrow. In this mode, clutch C1 is engaged and clutch C2 is disengaged; thus, no power is transmitted from M/G A to the output member 18. Power from M/G B is transmitted to planetary carrier member 72 which then transfers the power to the final drive via output member 18. EX1003, ¶¶ 86-87.

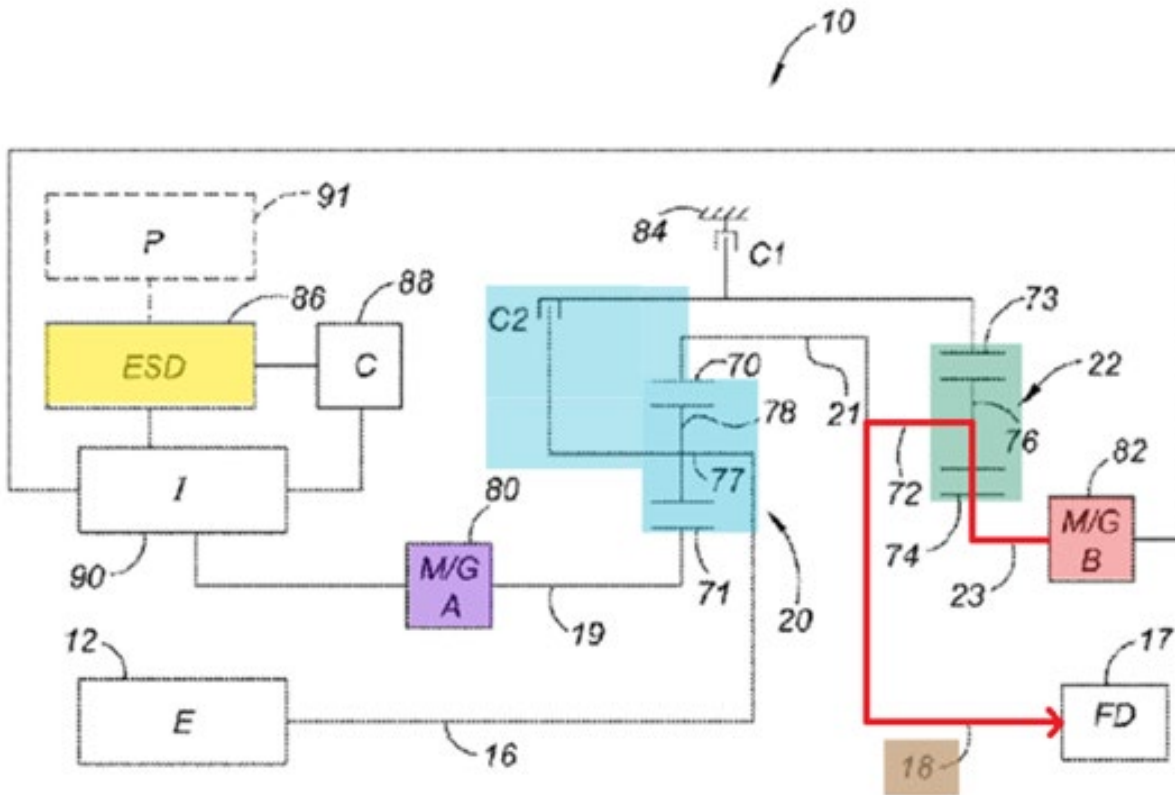
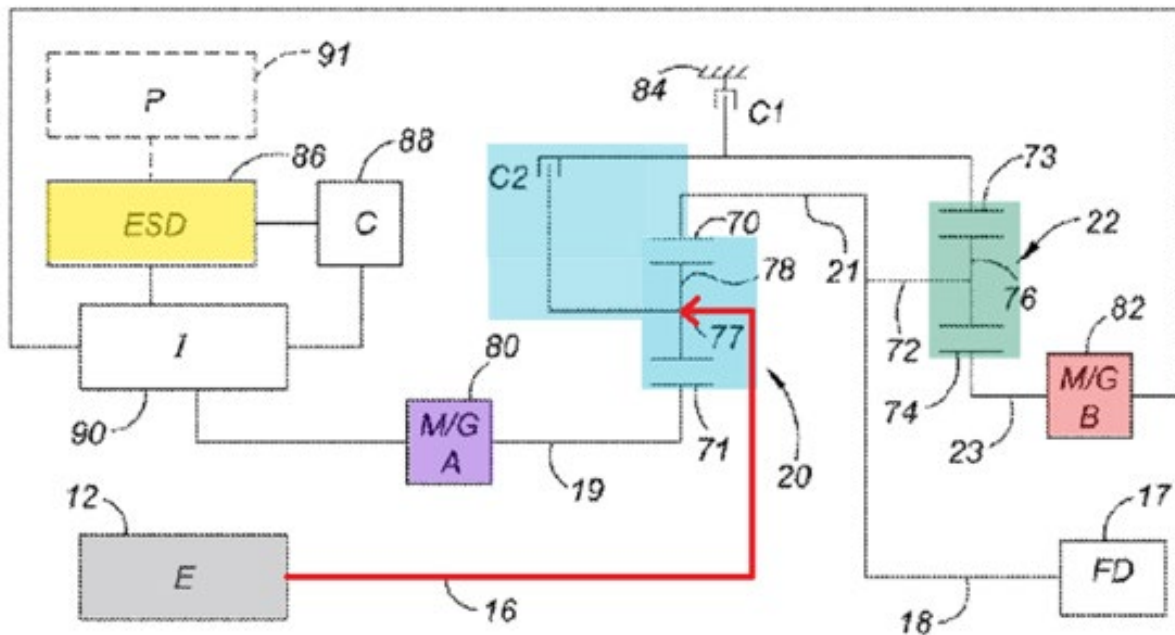


FIG. 2

1[f]: an internal combustion engine coupled to the transmission device via a path that does not include the first traction motor and second traction motor;

Conlon discloses an internal combustion engine coupled to the transmission device via a path that does not include the first traction motor and second traction motor. EX1004, ¶ 0035. In Figure 2, “engine 12, [shown in gray] is continuously connected to the carrier member 77 of the first planetary gear set 20” (transmission device) via a path that does not include M/G A and M/G B, as shown by the red arrow. *Id.*; EX1003, ¶¶ 88-89.



1[g]: a control system configured to selectively:

otherwise prevents or minimizes the amount of torque the second motor/generator transmits to output member 18). EX1004, ¶ 0042; Figs. 1-3.

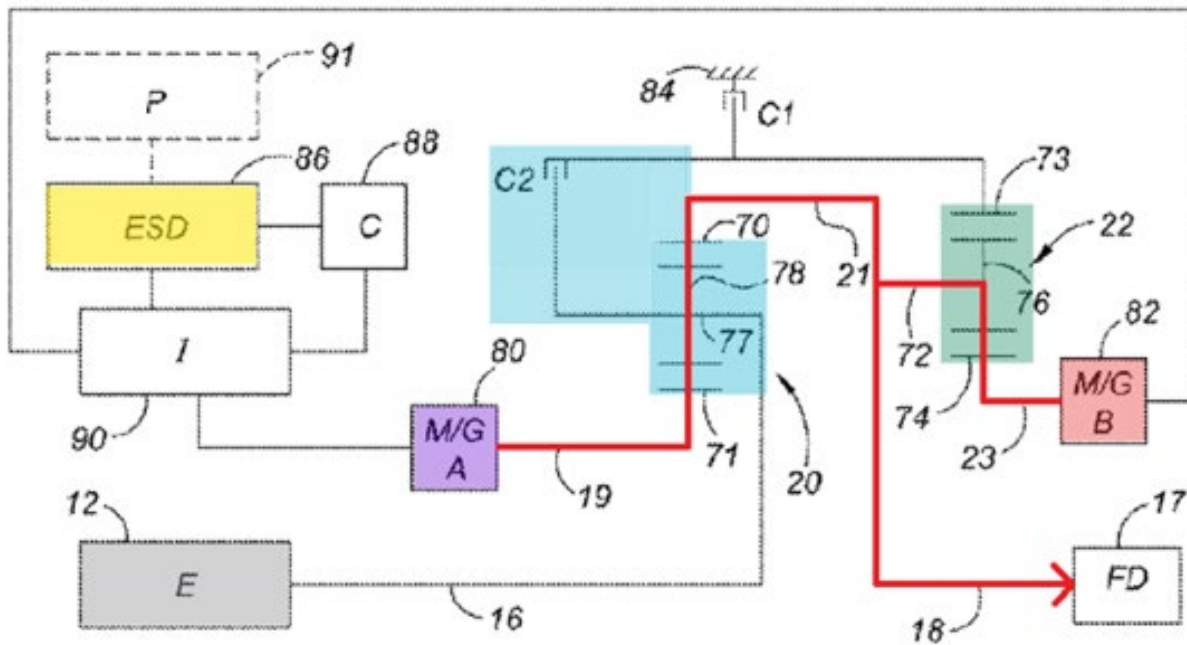
At rest, the system is in Mode 3, and then “transitions to Mode 1” once the engine reaches operating speed. *Id.*, ¶ 0044. At high rates of speed, the system may shift from Mode 1 to Mode 2 by releasing brake C1 and applying clutch C2, or alternately, the power of the first motor/generator may be supplied by the ESD, allowing the system to shift between Modes 1 and 2 without any torque being transmitted across slipping clutches. *Id.*, ¶ 0045; Figs. 2-3. The system can easily transition from either Mode 1 or Mode 2 to Mode 3 by a synchronous shift to the appropriate speed ratio, and then by engaging the appropriate brake C1 and/or clutch C2. *Id.*, ¶ 0047; Figs. 2-3. The shift between Mode 1 or Mode 2 to Mode 3 may also be achieved as an energy shift by engaging the appropriate brake C1 or clutch C2 to shift directly to Mode 3. *Id.*

Conlon necessarily teaches a control system for switching between these modes. A POSITA would have understood that a control system is required to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the ESD. EX1003, ¶¶ 90-93. A POSITA also would have understood that a control system is required to engage and disengage clutches C1/D1 and C2/D2 as needed to shift between respective modes. EX1004, ¶¶ 0006, 0017,

0033, 0043-0048, 0054-0058, Fig. 3; EX1003, ¶¶ 90-93. Accordingly, Conlon inherently discloses the claimed control system.

1[g][i]: operate the first traction motor and second traction motor to drive the vehicle through the transmission device and gear assembly, respectively;

Conlon has Mode 3, where both motors drive output member 18 (which is operatively connected to final drive assembly 17) at a fixed ratio for electric-only propulsion when the engine is off. EX1004, ¶¶ 0028, 0035, 0042, Figs. 1-3. As shown in Figure 2, the first motor 80 (M/G A) drives output member 18 and final drive assembly 17 through the first planetary gear set 20 (transmission device), and the second motor 82 (M/G B) drives output member 18 and final drive assembly 17 through the second planetary gear set 22 (gear assembly), as shown by the red arrows. EX1003, ¶¶ 94-95.



1[g][ii]: operate the first traction motor as a generator to generate electrical power while operating the second traction motor to drive the vehicle through the gear assembly; and

1[g][iii]: operate the second traction motor as a generator to generate electrical power.

In Mode 2, motor/generator 82 (M/G B) acts as a generator. EX1004, ¶¶ 0042, 0046, 0051-0052; EX1003, ¶¶ 98-99.

2. Dependent Claim 4

4. The system of claim 1, wherein the energy storage system comprises a battery.

As explained above, Conlon discloses all the limitations of claim 1.

Conlon discloses that “ESD 86 may be, for example, one or more batteries or battery packs.” EX1004, ¶ 0036; *see also* EX1003, ¶¶ 100-102.

3. Dependent Claim 5

5. The system of claim 1, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Conlon discloses all the limitations of claim 1.

Conlon discloses a wheel/axle assembly coupled to the gear assembly. EX1004, ¶ 0035. The second planetary gear set 22 is connected to and “operable for transmitting torque to the output member 18” (*id.*), which in turn is connected to final drive assembly 17 “for propelling the vehicle.” *Id.*, ¶ 0028. Figure 1, annotated below, shows the output of final drive assembly 17 “to wheels.” The second planetary gear set 22 is thus coupled to a wheel/axle assembly, as shown by the red line. EX1003, ¶¶ 103-105.

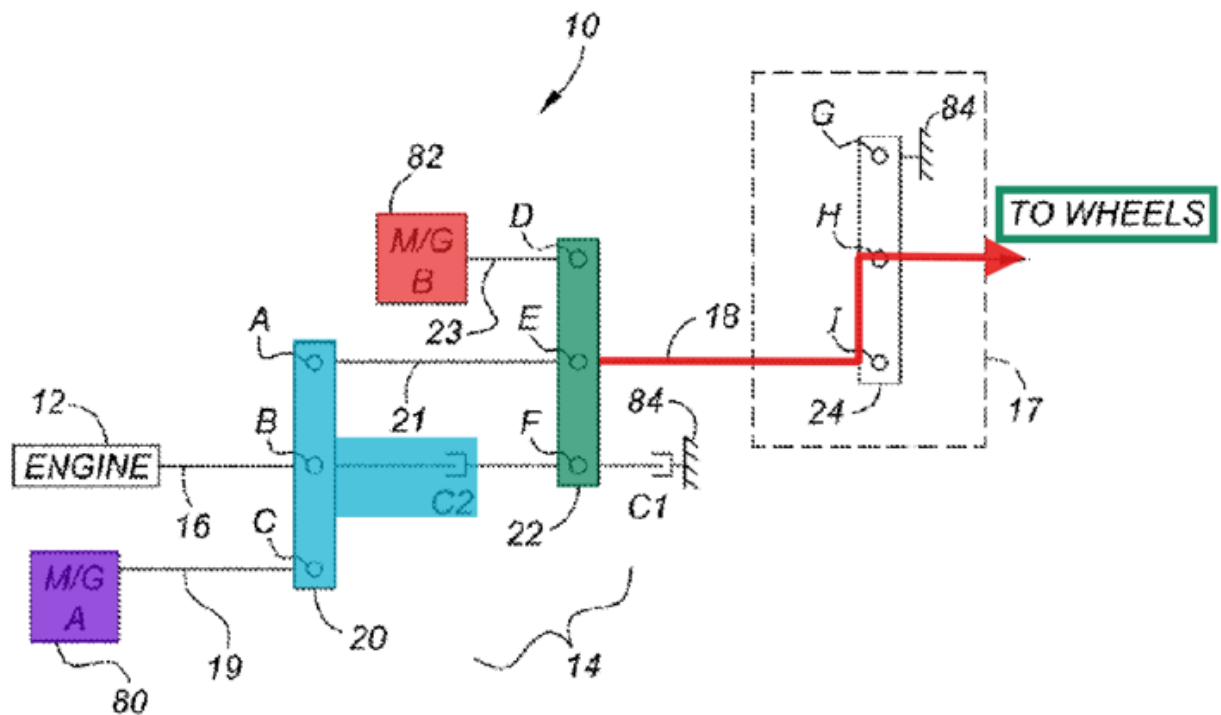


FIG. 1

4. **Dependent Claim 7**

7. The system of claim 1, wherein the electrical power generated by the first traction motor is provided to the second traction motor.

As explained above, Conlon discloses all the limitations of claim 1.

Conlon discloses that electrical power generated by the first traction motor is provided to the second traction motor. EX1004, ¶ 0044. In Mode 1, “the motor/generator 80 (M/G A) acts as a generator, and the motor/generator 82 (M/G B) acts as a motor.” *Id.* “ESD 86 . . . is operatively connected to each of the respective motor/generators 80, 82 such that motor/generators 80, 82 may

selectively transfer power to or receive power from the ESD 86.” *Id.*, ¶ 0036. Further, as shown in Figure 2, motor/generators 80, 82 are operatively connected to each other through inverter 90. *Id.*, ¶ 0038. Thus, electrical power generated by M/G A can be supplied to M/G B through ESD 86 via inverter 90. EX1003, ¶¶ 106-108.

5. Dependent Claim 8

8. The system of claim 1, wherein the electrical power generated by the second traction motor is provided to the energy storage system.

As explained above, Conlon discloses all the limitations of claim 1.

Conlon discloses that electrical power generated by the second traction motor is provided to the energy storage system. EX1004, ¶ 0013 (“the EVT includes an energy storage device (ESD) that is connected to the first and second motor/generators for providing power thereto and *receiving power therefrom*”) (emphasis added); ¶ 0036 (“The powertrain 10 may be further configured with an onboard energy storage device or ESD 86 that is operatively connected to each of the respective motor/generators 80, 82 such that motor/generators 80, 82 may selectively *transfer power to* or receive power from the ESD 86.”) (emphasis added). EX1003, ¶¶ 109-111.

6. Independent Claim 16

16[p]: A hybrid electric vehicle propulsion system, comprising:

See limitation 1[p]. EX1003, ¶¶ 112-113.

16[a]: an energy storage system;

See limitation 1[a]. EX1003, ¶¶ 114-115.

16[b]: a first electric motor coupled to the energy storage system;

See limitation 1[b]. EX1003, ¶¶ 116-117.

16[c]: a second electric motor coupled to the energy storage system;

See limitation 1[c]. EX1003, ¶¶ 118-119.

16[d]: a transmission device coupled to the first electric motor, the transmission device comprising an arrangement of planetary gears;

See limitation 1[d]. EX1003, ¶¶ 120-121.

16[e]: a gear assembly coupled between the second electric motor and the transmission device such that the output of the second electric motor bypasses the transmission device;

See limitation 1[e]. EX1003, ¶¶ 122-124.

16[f]: an internal combustion engine coupled to the transmission device;

See limitation 1[f]. EX1003, ¶¶ 125-126.

16[g]: a control system configured to selectively:

See limitation 1[g]. EX1003, ¶¶ 127-130.

16[g][i]: operate the first electric motor and second electric motor to drive the vehicle through the transmission device and gear assembly, respectively;

See limitation 1[g][i]. EX1003, ¶¶ 131-132.

16[g][ii]: operate the first electric motor as a generator to generate electrical power while operating the second electric motor to drive the vehicle through the gear assembly; and

See limitation 1[g][ii]. EX1003, ¶¶ 133-134.

16[g][iii]: operate the second electric motor as a generator to generate electrical power.

See limitation 1[g][iii]. EX1003, ¶¶ 135-136.

7. Dependent Claim 18

18. The system of claim 16, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Conlon discloses all the limitations of claim 16.

Conlon discloses a wheel/axle assembly coupled to the gear assembly. EX1004, ¶ 0035. The second planetary gear set 22 is connected to and “operable for transmitting torque to the output member 18” (*id.*), which in turn is connected to final drive assembly 17 “for propelling the vehicle.” *Id.*, ¶ 0028. Figure 1 shows the output of final drive assembly 17 “to wheels.” The second planetary gear set 22 is thus coupled to a wheel/axle assembly, as shown by the red line. EX1003, ¶¶ 137-139.

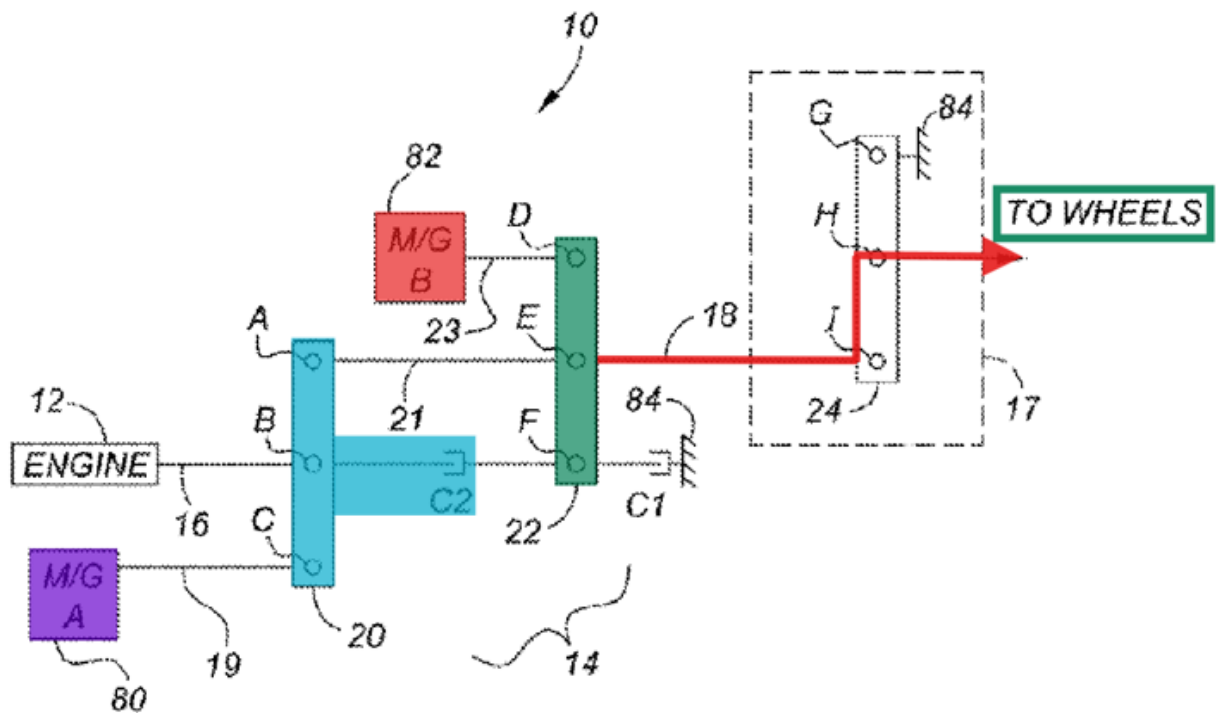


FIG. 1

8. Dependent Claim 19

19. The system of claim 16, wherein the electrical power generated by the first electric motor is provided to the second electric motor.

As explained above, Conlon discloses all the limitations of claim 16.

Conlon discloses that electrical power generated by the first electric motor is provided to the second electric motor. EX1004, ¶ 0044. In Mode 1 (input-split), “the motor/generator 80 (M/G A) acts as a generator, and the motor/generator 82 (M/G B) acts as a motor.” *Id.* “ESD 86 . . . is operatively connected to each of the respective motor/generators 80, 82 such that motor/generators 80, 82 may

selectively transfer power to or receive power from the ESD 86.” *Id.*, ¶ 0036. Further, as shown in Figure 2, motor/generators 80, 82 are operatively connected to each other through inverter 90. *Id.*, ¶ 0038. Thus, electrical power generated by M/G A can be supplied to M/G B through ESD 86 via inverter 90. EX1003, ¶¶ 140-142.

9. Dependent Claim 20

20. The system of claim 16, wherein the electrical power generated by the second electric motor is provided to the energy storage system.

As explained above, Conlon discloses all the limitations of claim 16.

Conlon discloses that electrical power generated by the second electric motor is provided to the energy storage system. EX1004, ¶ 0013 (“the EVT includes an energy storage device (ESD) that is connected to the first and second motor/generators for providing power thereto and *receiving power therefrom*”) (emphasis added); ¶ 0036 (“The powertrain 10 may be further configured with an onboard energy storage device or ESD 86 that is operatively connected to each of the respective motor/generators 80, 82 such that motor/generators 80, 82 may selectively *transfer power to* or receive power from the ESD 86.”) (emphasis added). EX1003, ¶¶ 143-145.

B. Ground 2: Claims 1, 4, 5, 7, 8, 16, and 18-20 Are Obvious Over Conlon

Ground 1 above is incorporated herein by reference. Further, to the extent that Conlon is found not to disclose the claimed control system in 1[g] and 16[g], the

subject matter of claims 1, 4, 5, 7, 8, 16, and 18-20 still would have been obvious to a POSITA based on the teachings of Conlon.

Conlon's powertrain operates in at least four modes: Mode 1 (input-split), Mode 2 (compound-split), Mode 3 (two-motor electric-only), and Mode 4 (neutral). EX1004, ¶ 0042, Figs. 1-3. At rest, the system is in Mode 3, and then transitions to Mode 1 once the engine reaches operating speed. *Id.*, ¶ 0044. At high rates of speed, the system may shift from Mode 1 to Mode 2. *Id.*, ¶ 0045, Figs. 2-3; EX1003, ¶ 163. The system can also transition from either Mode 1 or Mode 2 to Mode 3. EX1004, ¶ 0047, Figs. 2-3; EX1003, ¶ 163. To the extent this disclosure is not found to inherently teach the claimed "control system," a POSITA would have found it obvious to employ a control system for switching between modes. A POSITA certainly would have understood that a control system would be beneficial to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the ESD, and to shift between respective modes. Control systems for EV and HEV powertrains were well known in the industry before the January 2014 priority date of the '648 patent. A POSITA would have been motivated to incorporate a control system to selectively operate M/G A and M/G B according to the modes disclosed by Conlon for better efficiency and enhanced performance of the system. EX1003, ¶¶ 164.

Thus, independent claims 1 and 16, and dependent claims 4, 5, 7, 8, and 18-20, would have been obvious over Conlon in view of the knowledge of a POSITA. *Id.*, ¶¶ 146-217.

C. Ground 3: Claims 2, 3, 6, 9-15, and 17 Are Obvious Over Conlon in View of Reynolds

The subject matter of claims 2, 3, 6, 9-15, and 17 would have been obvious to a POSITA based on the teachings of Conlon in view of Reynolds. EX1003, ¶ 218.

1. Motivation to Combine Conlon and Reynolds

As set forth below in more detail with respect to specific limitations, a POSITA would have found it obvious to combine Conlon and Reynolds. In particular, both references are in the same technical field. Thus, Conlon and Reynolds are analogous references, and a POSITA would have found combining these references to be one of a finite number of identified means for transferring energy between multiple energy storage devices and electromechanical devices in EV and HEV vehicles, and further, would have had a reasonable expectation of success in combining their teachings. EX1003, ¶ 219.

2. Dependent Claim 2

2. The system of claim 1, further comprising a DC/DC converter coupled to the energy storage device.

As explained above in Grounds 1 and 2, Conlon discloses or renders obvious all the limitations of claim 1.

Reynolds discloses a DC/DC converter coupled to an energy storage device. “Electrical power stored in battery 46 is sent through a DC-DC voltage converter to modify the vehicle voltage level according to the devices being powered. The variable voltage control (VVC) 48 converts the DC voltage level of battery 46 to the DC desired voltage level of high-voltage electrical bus 50.” EX1005, ¶ 0013; *see also* Fig. 1.

It would have been obvious to a POSITA to incorporate Reynolds’ DC/DC converter into Conlon. A DC-DC converter is a standard device for converting direct current from one voltage to another. EX1003, ¶ 222. For hybrid and electric vehicles, it was well known in January 2014 that a DC-DC converter could be used to manage power flow between a battery and other systems. *Id.* For example, a DC-DC converter can step-down (buck) high voltage (*e.g.*, 250 V) from a battery to a lower voltage (*e.g.*, 12 V) for powering onboard devices such as lights, infotainment systems, or other accessories. *Id.* A DC-DC converter can also step-up (boost) voltage (*e.g.*, from 250 V to 650 V) to supply high power to electric motors via an inverter when it is necessary (*e.g.*, during heavy accelerations). *Id.* This will allow an automotive manufacturer to use a smaller, lighter physical battery pack while still achieving high-performance motor output. *Id.* A POSITA would have at least been motivated by Reynolds to include a DC-DC converter and variable voltage control (VVC) with the powertrain of Conlon to buck or boost voltage to/from the vehicle

battery as needed, as shown by Reynolds’ teaching that “battery 46 further includes a two-way electrical connection, such that it can also receive and store energy provided through regenerative braking, for example, and then supply the energy to an electric machine.” EX1005, ¶ 0017; *see also* EX1003, ¶ 222. Accordingly, it would have been obvious to a POSITA to include the DC-DC converter taught by Reynolds in the powertrain disclosed in Conlon to power onboard devices as well as turn braking energy back into electricity for charging the battery. EX1003, ¶ 222.

In addition, a POSITA would have recognized the drawback of Conlon’s single inverter 90 powering motors and generators simultaneously (*i.e.*, simultaneous “push and pull”). *Id.*, ¶ 223. Motors and generators have different electrical and control requirements. *Id.* For example, motors are optimized for torque production and a wide range of speeds, while generators are optimized for voltage regulation and efficiently exporting electrical power. *Id.* A single inverter cannot simultaneously support a motor and a generator as required in Mode 1 of operation in Conlon’s powertrain due to such different electrical and control requirements. *Id.* A POSITA incorporating Reynolds’ DC-DC converter into Conlon’s powertrain would have been motivated to replace inverter 90 with Reynolds’ DC-DC converter 48 and two-inverter system 42 and 44. *Id.* Separate inverters will be essential and would provide a stable and reliable system by allowing M/G A and M/G B to run

under their own optimal voltage and current conditions, and by allowing independent regulation of power flow to/from each motor/generator. *Id.*

For at least these reasons, claim 2 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 220-224.

3. Dependent Claim 3

3. The system of claim 2, further comprising a second energy storage system coupled to the DC/DC converter.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 2.

Conlon discloses that “ESD 86 may be, for example, one or more batteries or battery packs.” EX1004, ¶ 0036. Thus, a POSITA would have understood that Conlon teaches a second energy storage system, and further, that the second energy storage system could be coupled to Reynolds’ DC-DC converter for the same reasons discussed above for claim 2. EX1003, ¶ 226. However, even if Conlon is found to disclose only a single ESD with multiple batteries, it would have been obvious to a POSITA to further modify Conlon by including a second ESD coupled to the DC-DC converter taught by Reynolds. *Id.* Use of two energy storage systems—*i.e.*, a high-voltage (HV) battery (200 V to 700 V) and a low-voltage (LV) battery (12 V to 14 V)—was common in HEVs before 2014. *Id.* Some examples include model year (MY) 1997 Toyota Prius (Gen 1), MY 1999 Honda Insight (Gen 1), MY 2003 Honda Civic Hybrid (Gen 1), MY 2004 Toyota Prius (Gen 2), MY

2004 Ford Escape Hybrid, MY 2006 Saturn Vue Green Line, MY 2007 Nissan Altima Hybrid, and MY 2011 Chevrolet Volt (Gen 1). *Id.* These vehicles include a high-voltage (HV) battery (*e.g.*, 200 V to 700 V), and a low-voltage (LV) battery (*e.g.*, 12 V to 14 V). *Id.* The HV battery is used for vehicle propulsion, while the LV battery is used to power the accessories in the vehicle. *Id.* This dual-battery system is advantageous over a single-battery system, due to i) improved safety and isolation of functions, ii) component compatibility since many parts (headlights, wipers, airbag, power windows, door locks, etc.) are standardized to run on 12 V, and expecting them to run on high voltage (*e.g.*, 400 V) would require expensive and custom step-down converters for every single component, and iii) higher reliability to support “fail-safe” for critical non-propulsion systems. *Id.* A DC-DC converter is also commonly used between these two batteries (*e.g.*, the HV battery charges the LV battery). *Id.* A POSITA would have been motivated to include a second energy storage system coupled to the DC-DC converter to provide power for auxiliary applications such as heating, cooling, and cabin accessories that run on lower voltage and which were common in EV and HEV vehicles in 2014. *Id.* Incorporating a second energy storage system in Conlon—and coupling the second energy storage system to the DC-DC converter taught by Reynolds—would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in doing so. *Id.*

For at least these reasons, claim 3 is obvious over Conlon in view of Reynolds.

Id., ¶¶ 225-228.

4. Dependent Claim 6

6. The system of claim 1, further comprising: a first inverter coupled between the energy storage device and first traction motor; and a second inverter coupled between the energy storage device and second traction motor.

As explained above in Grounds 1 and 2, Conlon discloses or renders obvious all the limitations of claim 1.

Conlon also discloses inverter 90 coupled between ESD 86 and M/G A and M/G B. EX1004, ¶ 0038, Fig. 2.

A POSITA would have recognized the drawback of Conlon's single inverter 90 powering motors and generators simultaneously (*i.e.*, simultaneous "push and pull"). EX1003, ¶ 231. Motors and generators have different electrical and control requirements. *Id.* For example, motors are optimized for torque production and a wide range of speeds, while generators are optimized for voltage regulation and efficiently exporting electrical power. *Id.* A single inverter cannot simultaneously support a motor and a generator as required in Mode 1 of operation in Conlon's powertrain due to such different electrical and control requirements. *Id.*

Reynolds discloses two inverters 42 and 44 coupled between battery 46 and generator 32 and motor 34, respectively. EX1005, ¶¶ 0013, 0014, Fig. 1. A POSITA would have been motivated to replace inverter 90 with Reynolds' DC-DC converter

48 and two-inverter system 42 and 44. EX1003, ¶ 232. Separate inverters would be essential and would provide a stable and reliable system by allowing M/G A and M/G B to run under their own optimal voltage and current conditions, and by allowing independent regulation of power flow to/from each motor/generator. *Id.*

It also would have been obvious to a POSITA to incorporate a two-inverter system as taught by Reynolds into Conlon's system. *Id.*, ¶ 233. An inverter is a standard component that converts direct current (DC) from the energy storage system (*e.g.*, battery) into the alternating current (AC) needed to power the electric motor, and performs the reverse (AC to DC) during regenerative braking and battery recharging. *Id.* Using separate inverters as taught by Reynolds to manage power flow to and from each motor in Conlon would have been well within the knowledge of a POSITA as a way to support the operating modes in Conlon's powertrain—for example, by splitting the load so that a single inverter does not handle the load of both motors, which may be operating in different modes as discussed above (*e.g.*, motoring operation in M/G B vs regen operation in M/G A). *Id.* Replacing inverter 90 in Conlon with a two-inverter system would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in doing so. *Id.*

For at least these reasons, claim 6 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 229-234.

5. Independent Claim 9

9[p]: A vehicle propulsion system, comprising:

See limitation 1[p]. EX1003, ¶¶ 235-236.

9[a]: an energy storage system;

See limitation 1[a]. EX1003, ¶¶ 237-238.

9[b]: a first traction drive system coupled to the energy storage system, the first traction drive system comprising a first inverter coupled to a first AC motor;

Conlon discloses a first traction drive system coupled to the energy storage system where the first traction drive system comprises a first inverter coupled to a first AC motor. EX1004, ¶ 0036. Figure 2 shows that first motor/generator 80 (M/G A) [shown in purple] is operatively connected to ESD 86. *Id.* Conlon also discloses DC-AC inverter 90 [also shown in purple] coupled between ESD 86 and M/G A and M/G B. *Id.*, ¶ 0038, Fig. 2. Conlon's description of inverter 90 as "DC-to-AC" indicates that the motors are AC motors. EX1003, ¶¶ 239-240.

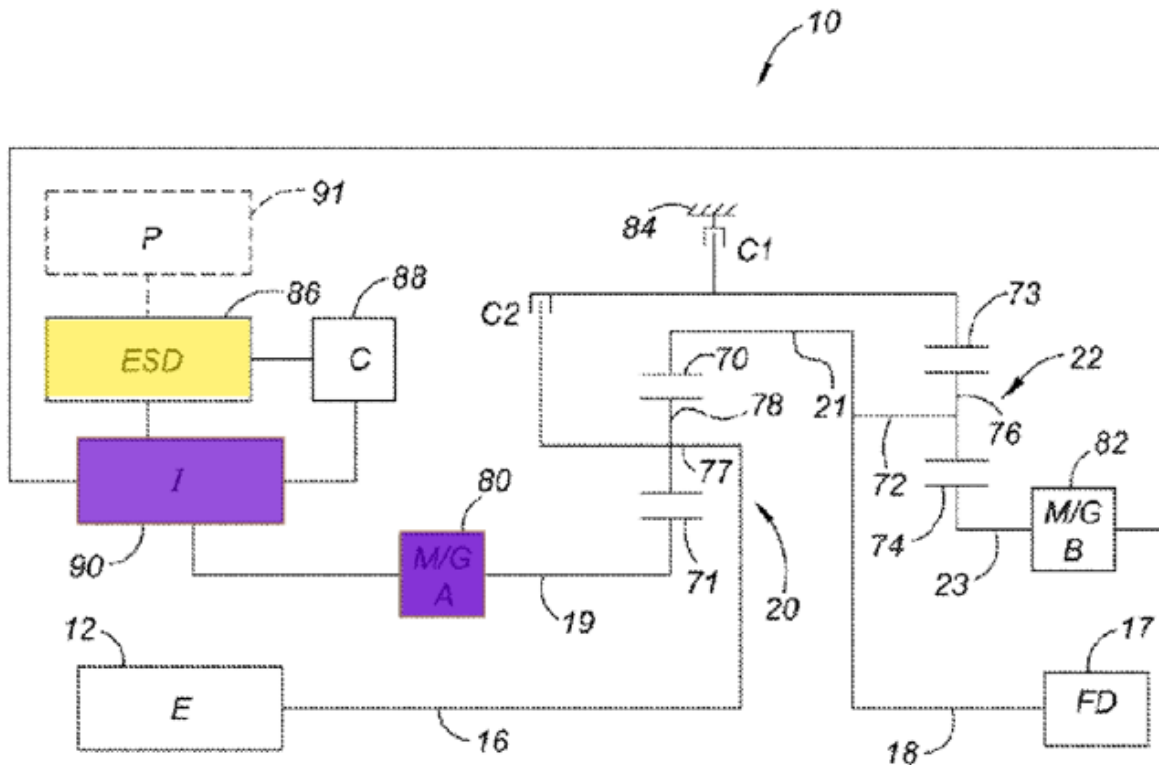
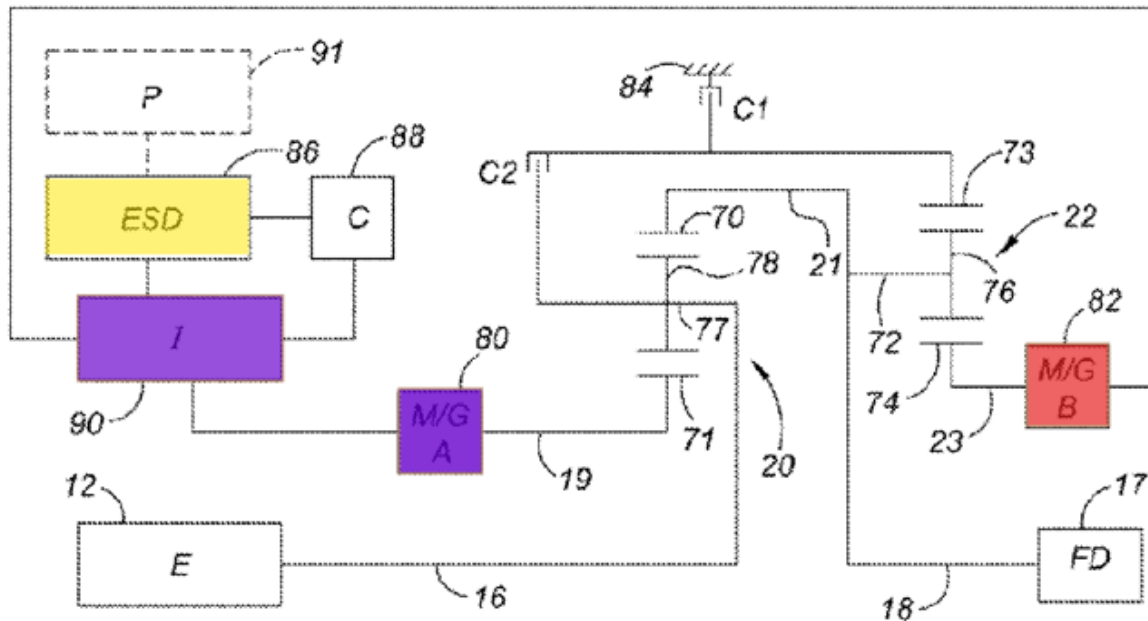


FIG. 2

9[c]: a second traction drive system coupled to the energy storage system, the second traction drive system comprising a second inverter coupled to a second AC motor;

Conlon discloses a second AC motor coupled to the energy storage system.

EX1004, ¶ 0036. In Figure 2, the second AC motor 82 (M/G B) [shown in red] is operatively connected to ESD 86. *Id.*



Conlon does not disclose a second inverter. However, Reynolds discloses two inverters 42 and 44 coupled between battery 46 and generator 32 and motor 34, respectively. EX1005, ¶¶ 0013, 0014, Fig. 1. It would have been obvious to a POSITA to incorporate a second inverter as taught by Reynolds into Conlon's system between ESD 86 and the second AC motor. EX1003, ¶ 242. An inverter is a standard component that converts direct current (DC) from the energy storage system (*e.g.*, battery) into the alternating current (AC) needed to power the electric motor, and performs the reverse (AC to DC) during regenerative braking and battery recharging. *Id.* Using separate inverters to manage power flow to and from each

motor in Conlon would have been well within the knowledge of a POSITA as a way to support the operating modes in Conlon’s powertrain—for example, by splitting the load so that a single inverter does not handle the load of both motors, which may be operating in different modes as discussed above (*e.g.*, motoring operation in M/G B vs regen operation in M/G A). *Id.* Incorporating a second inverter in Conlon would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in doing so. *Id.*

In addition, a POSITA would have recognized the drawback of Conlon’s single inverter 90 powering motors and generators simultaneously (*i.e.*, simultaneous “push and pull”). *Id.*, ¶ 243. Motors and generators have different electrical and control requirements. *Id.* For example, motors are optimized for torque production and a wide range of speeds, while generators are optimized for voltage regulation and efficiently exporting electrical power. *Id.* A single inverter cannot simultaneously support a motor and a generator as required in Mode 1 of operation in Conlon’s powertrain due to such different electrical and control requirements. *Id.* A POSITA would have been motivated to replace inverter 90 with Reynolds’ DC-DC converter 48 and two-inverter system 42 and 44. *Id.* Separate inverters would be essential and would provide a stable and reliable system by allowing M/G A and M/G B to run under their own optimal voltage and current conditions, and by allowing independent regulation of power flow to/from each motor/generator. *Id.*

For at least these reasons, limitation 9[c] is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 241-244.

9[d]: a transmission device coupled to the first traction drive system, the transmission device comprising an arrangement of planetary gears;

See limitation 1[d]. EX1003, ¶¶ 245-246.

9[e]: a gear assembly coupled between the second traction drive system and the transmission device such that the output of the second traction motor bypasses the transmission device;

See limitation 1[e]. EX1003, ¶¶ 247-250.

9[f]: an internal combustion engine coupled to the transmission device via a path that does not include the first AC motor and second AC motor;

See limitation 1[f]. EX1003, ¶¶ 251-252.

9[g]: a control system configured to selectively:

The powertrain and EVT of Conlon are capable of operating in several modes: Mode 1 (input-split mode, which is an electrically variable mode normally used with the engine turned off, such as during low vehicle speeds), Mode 2 (compound-split mode, which is normally used when the engine is turned on, such as during high vehicle speeds), Mode 3 (two-motor electric-only mode, which is used with both of the motor/generators driving the output member 18 at a fixed ratio for electric-only propulsion when the engine is turned off), and Mode 4 (neutral mode, which effectively disconnects the second motor/generator from output member 18, or

otherwise prevents or minimizes the amount of torque the second motor/generator is able to transmit to output member 18). EX1004, ¶ 0042; Figs. 1-3.

At rest, the EVT is in Mode 3, and then “transitions to Mode 1” once the engine reaches operating speed. *Id.*, ¶ 0044. At relatively high rates of speed, the EVT may shift from Mode 1 to Mode 2 by releasing the brake C1 and applying the clutch C2, or alternately, the power of the first motor/generator may be supplied by the ESD, allowing the EVT to shift between Modes 1 and 2 without any torque being transmitted across slipping clutches. *Id.*, ¶ 0045; Figs. 2-3. The EVT can easily transition from either Mode 1 or Mode 2 to Mode 3 by a synchronous shift to the appropriate speed ratio, and then by engaging the appropriate brake C1 and/or clutch C2. *Id.*, ¶ 0047; Figs. 2-3. The shift between Mode 1 or Mode 2 to Mode 3 may also be achieved as an energy shift by engaging the appropriate brake C1 or clutch C2 to shift directly to Mode 3. *Id.*

Conlon necessarily teaches a control system for switching the EVT between these modes. A POSITA would have understood that a control system is required to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the ESD. EX1003, ¶ 255. In addition, a POSITA would have understood that a control system is required to engage and disengage clutches C1/D1 and C2/D2 as needed to shift the EVT between respective modes. EX1004, ¶¶ 0006,

0017, 0033, 0043-0048, 0054-0058, Fig. 3; EX1003, ¶ 255. Accordingly, Conlon inherently discloses the claimed control system. *Id.*, ¶¶ 253-256

To the extent this disclosure is not found to inherently teach the claimed “control system,” a POSITA would have found it obvious to employ a control system for switching the powertrain between modes. A POSITA certainly would have understood that a control system would have been beneficial to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the ESD. In addition, a POSITA would have understood that a control system is required to engage and disengage clutches C1/D1 and C2/D2 as needed to shift the EVT between respective modes. EX1004, ¶¶ 0006, 0017, 0033, 0043-0048, 0054-0058, Fig. 3; EX1003, ¶ 257. Control systems for EV and HEV powertrains were well known in the industry before the January 2014 priority date of the ’648 patent. A POSITA would have been motivated to incorporate a control system to selectively operate M/G A and M/G B according to the modes disclosed by Conlon for better efficiency and enhanced performance of the powertrain. EX1003, ¶¶ 257-258.

9[g][i]: operate the first traction drive system and second traction drive system to drive the vehicle through the transmission device and gear assembly, respectively;

See limitation 1[g][i]. EX1003, ¶¶ 259-260.

9[g][ii]: operate the first traction drive system to generate electrical power while operating the second traction drive system to drive the vehicle through the gear assembly;

See limitation 1[g][ii]. EX1003, ¶¶ 261-262.

9[g][iii]: operate the second traction drive system to generate electrical power.

See limitation 1[g][iii]. EX1003, ¶¶ 263-264.

6. Dependent Claim 10

10. The system of claim 9, further comprising a DC/DC converter coupled to the energy storage device.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 9.

Reynolds discloses a DC/DC converter coupled to an energy storage device. “Electrical power stored in battery 46 is sent through a DC-DC voltage converter to modify the vehicle voltage level according to the devices being powered. The variable voltage control (VVC) 48 converts the DC voltage level of battery 46 to the DC desired voltage level of high-voltage electrical bus 50.” EX1005, ¶ 0013; *see also* Fig. 1.

It would have been obvious to a POSITA to incorporate Reynolds’ DC/DC converter into Conlon. A DC-DC converter is a standard device for converting direct current from one voltage to another. EX1003, ¶ 267. For hybrid and electric vehicles, it was well known in January 2014 that a DC-DC converter could be used to manage power flow between a battery and other systems. *Id.* For example, a DC-DC

converter can step-down (buck) high voltage (*e.g.*, 250 V) from a battery to a lower voltage (*e.g.*, 12 V) for powering onboard devices such as lights, infotainment systems, or other accessories. *Id.* A DC-DC converter can also step-up (boost) voltage (*e.g.*, from 250 V to 650 V) to supply high power to electric motors via an inverter when it is necessary (*e.g.*, during heavy accelerations). *Id.* This will allow an automotive manufacturer to use a smaller, lighter physical battery pack while still achieving high-performance motor output. *Id.* A POSITA would have at least been motivated by Reynolds to include a DC-DC converter and variable voltage control (VVC) with the powertrain of Conlon to buck or boost voltage to/from the vehicle battery as needed, as shown by Reynolds' teaching that "battery 46 further includes a two-way electrical connection, such that it can also receive and store energy provided through regenerative braking, for example, and then supply the energy to an electric machine." EX1005, ¶ 0017; *see also* EX1003, ¶ 267.

In addition, a POSITA would have recognized the drawback of Conlon's single inverter 90 powering motors and generators simultaneously. *Id.*, ¶ 268. Motors and generators have different electrical and control requirements. *Id.* For example, motors are optimized for torque production and a wide range of speeds, while generators are optimized for voltage regulation and efficiently exporting electrical power. *Id.* A single inverter cannot simultaneously support a motor and a generator as required in Mode 1 of operation in Conlon's powertrain due to such

different electrical and control requirements. *Id.* A POSITA incorporating Reynolds' DC-DC converter into Conlon's powertrain would have been motivated to replace inverter 90 with Reynolds' DC-DC converter 48 and two-inverter system 42 and 44. *Id.* Separate inverters would have been essential and would have provided a stable and reliable system by allowing M/G A and M/G B to run under their own optimal voltage and current conditions, and by allowing independent regulation of power flow to/from each motor/generator. EX1003, ¶ 268.

For at least these reasons, claim 10 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 265-269.

7. Dependent Claim 11

11. The system of claim 10, further comprising a second energy storage system coupled to the DC/DC converter.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 10.

Conlon discloses that “ESD 86 may be, for example, one or more batteries or battery packs.” EX1004, ¶ 0036. Thus, a POSITA would have understood that Conlon teaches a second energy storage system, and further, that the second energy storage system could be coupled to Reynolds' DC-DC converter for the same reasons discussed above for claim 2. EX1003, ¶ 271. However, even if Conlon is found to disclose only a single ESD with multiple batteries, it would have been obvious to a POSITA to further modify Conlon by including a second ESD coupled

to the DC-DC converter taught by Reynolds. *Id.*, ¶ 272. Use of two energy storage systems—*i.e.*, a high-voltage (HV) battery (200 V to 700 V) and a low-voltage (LV) battery (12 V to 14 V)—was common in HEVs before 2014. *Id.* Some examples include model year (MY) 1997 Toyota Prius (Gen 1), MY 1999 Honda Insight (Gen 1), MY 2003 Honda Civic Hybrid (Gen 1), MY 2004 Toyota Prius (Gen 2), MY 2004 Ford Escape Hybrid, MY 2006 Saturn Vue Green Line, MY 2007 Nissan Altima Hybrid, and MY 2011 Chevrolet Volt (Gen 1). *Id.* These vehicles include a high-voltage (HV) battery (*e.g.*, 200 V to 700 V), and a low-voltage (LV) battery (*e.g.*, 12 V to 14 V). *Id.* The HV battery is used for vehicle propulsion, while the LV battery is used to power the accessories in the vehicle. *Id.* This dual-battery system is advantageous over a single-battery system, due to i) improved safety and isolation of functions, ii) component compatibility since many parts (headlights, wipers, airbag, power windows, door locks, etc.) are standardized to run on 12 V, and expecting them to run on high voltage (*e.g.*, 400 V) would require expensive and custom step-down converters for every single component, and iii) higher reliability to support “fail-safe” for critical non-propulsion systems. *Id.* A DC-DC converter is also commonly used between these two batteries (*e.g.*, the HV battery charges the LV battery). *Id.* A POSITA would have been motivated to include a second energy storage system coupled to the DC-DC converter to provide power for auxiliary applications such as heating, cooling, and cabin accessories that run on lower voltage

and which were common in EV and HEV vehicles in 2014. *Id.* Incorporating a second energy storage system in Conlon—and coupling the second energy storage system to the DC-DC converter taught by Reynolds—would have yielded predictable results, and a POSITA would have had a reasonable expectation of success in doing so. *Id.*

For at least these reasons, claim 11 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 270-273.

8. Dependent Claim 12

12. The system of claim 9, wherein the energy storage system comprises a battery.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 9.

Conlon discloses that “ESD 86 may be, for example, one or more batteries or battery packs.” EX1004, ¶ 0036.

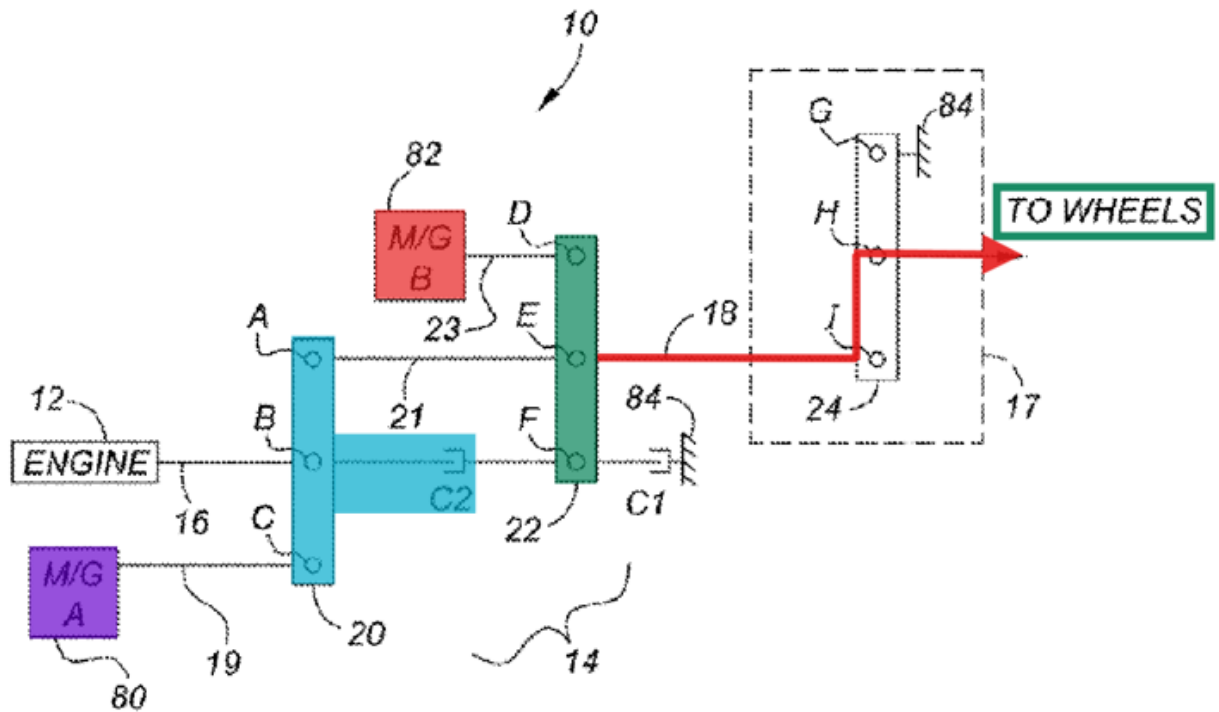
For at least these reasons, claim 12 is obvious over Conlon in view of Reynolds. EX1003, ¶¶ 274-276.

9. Dependent Claim 13

13. The system of claim 9, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 9.

Conlon discloses a wheel/axle assembly coupled to the gear assembly. EX1004, ¶ 0035. The second planetary gear set 22 is connected to and “operable for transmitting torque to the output member 18” (*id.*), which in turn is connected to final drive assembly 17 “for propelling the vehicle.” *Id.*, ¶ 0028. Figure 1 shows the output of final drive assembly 17 “to wheels.” The second planetary gear set 22 is thus coupled to a wheel/axle assembly, as shown by the red line. EX1003, ¶ 278.



For at least these reasons, claim 13 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 277-279.

10. Dependent Claim 14

14. The system of claim 9, wherein the electrical power generated by the first traction drive system is provided to the second traction drive system.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 9.

Conlon discloses that electrical power generated by the first traction drive system is provided to the second traction drive system. EX1004, ¶ 0044. In Mode 1 (input-split), “the motor/generator 80 (M/G A) acts as a generator, and the motor/generator 82 (M/G B) acts as a motor.” *Id.* “ESD 86 . . . is operatively connected to each of the respective motor/ generators 80, 82 such that motor/generators 80, 82 may selectively transfer power to or receive power from the ESD 86.” *Id.*, ¶ 0036. Further, as shown in Figure 2, motor/generators 80, 82 are operatively connected to each other through inverter 90. *Id.*, ¶ 0038. Thus, electrical power generated by M/G A can be supplied to M/G B through ESD 86 via inverter 90. EX1003, ¶ 281.

For at least these reasons, claim 14 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 280-282.

11. Dependent Claim 15

15. The system of claim 9, wherein the electrical power generated by the second traction drive system is provided to the energy storage system.

As explained above, Conlon in view of Reynolds discloses all the limitations of claim 9.

Conlon discloses that electrical power generated by the second traction drive system is provided to the energy storage system. EX1004, ¶ 0013 (“the EVT includes an energy storage device (ESD) that is connected to the first and second motor/generators for providing power thereto and *receiving power therefrom*”) (emphasis added); ¶ 0036 (“The powertrain 10 may be further configured with an onboard energy storage device or ESD 86 that is operatively connected to each of the respective motor/generators 80, 82 such that motor/generators 80, 82 may selectively *transfer power to* or receive power from the ESD 86.”) (emphasis added).

For at least these reasons, claim 15 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 283-285.

12. Dependent Claim 17

17. The system of claim 16, further comprising a DC/DC converter coupled to the energy storage device.

As explained above, Conlon discloses or renders obvious all the limitations of claim 16.

Reynolds discloses a DC/DC converter coupled to an energy storage device. “Electrical power stored in battery 46 is sent through a DC-DC voltage converter to modify the vehicle voltage level according to the devices being powered. The variable voltage control (VVC) 48 converts the DC voltage level of battery 46 to the DC desired voltage level of high-voltage electrical bus 50.” EX1005, ¶ 0013; *see also* Fig. 1.

It would have been obvious to a POSITA to incorporate Reynolds’ DC/DC converter into Conlon. A DC-DC converter is a standard device for converting direct current from one voltage to another. EX1003, ¶ 288. For hybrid and electric vehicles, it was well known in January 2014 that a DC-DC converter could be used to manage power flow between a battery and other systems. *Id.* For example, a DC-DC converter can step-down (buck) high voltage (*e.g.*, 250 V) from a battery to a lower voltage (*e.g.*, 12 V) for powering onboard devices such as lights, infotainment systems, or other accessories. *Id.* A DC-DC converter can also step-up (boost) voltage (*e.g.*, from 250 V to 650 V) to supply high power to electric motors via an inverter when it is necessary (*e.g.*, during heavy accelerations). *Id.* This will allow an automotive manufacturer to use a smaller, lighter physical battery pack while still achieving high-performance motor output. *Id.* A POSITA would have at least been motivated by Reynolds to include a DC-DC converter and variable voltage control (VVC) with the powertrain of Conlon to buck or boost voltage to/from the vehicle

battery as needed, as shown by Reynolds' teaching that "battery 46 further includes a two-way electrical connection, such that it can also receive and store energy provided through regenerative braking, for example, and then supply the energy to an electric machine." EX1005, ¶ 0017; *see also* EX1003, ¶ 288.

In addition, a POSITA would have recognized the drawback of Conlon's single inverter 90 powering motors and generators simultaneously. EX1003, ¶ 289. Motors and generators have different electrical and control requirements. *Id.* For example, motors are optimized for torque production and a wide range of speeds, while generators are optimized for voltage regulation and efficiently exporting electrical power. *Id.* A single inverter cannot simultaneously support a motor and a generator as required in Mode 1 of operation in Conlon's powertrain due to such different electrical and control requirements. *Id.* A POSITA incorporating Reynolds' DC-DC converter into Conlon's powertrain would have been motivated to replace inverter 90 with Reynolds' DC-DC converter 48 and two-inverter system 42 and 44. *Id.* Separate inverters would have been essential and would have provided a stable and reliable system by allowing M/G A and M/G B to run under their own optimal voltage and current conditions, and by allowing independent regulation of power flow to/from each motor/generator. *Id.*

For at least these reasons, claim 17 is obvious over Conlon in view of Reynolds. *Id.*, ¶¶ 286-290.

**D. Ground 4: Claims 1, 2, 4-10, and 12-20 Are Anticipated by
Ortmann**

Ortmann anticipates claims 1, 2, 4-10, and 12-20. This reference—not of record during prosecution—discloses the physical components of the claimed system.

1. Independent Claim 1

1[p]: A system for a hybrid electric vehicle, comprising:

Ortmann discloses a system for a hybrid electric vehicle. EX1008, ¶¶ 0002-0012. Figures 1 and 4 of Ortmann illustrate HEV and PHEV powertrains, respectively. EX1003, ¶¶ 292-293.

1[a]: an energy storage system;

Ortmann discloses an energy storage system. EX1008, ¶ 0021. In Figure 4, the powertrain includes traction battery 40 [shown in yellow]. *Id.*; EX1003, ¶¶ 294-295.

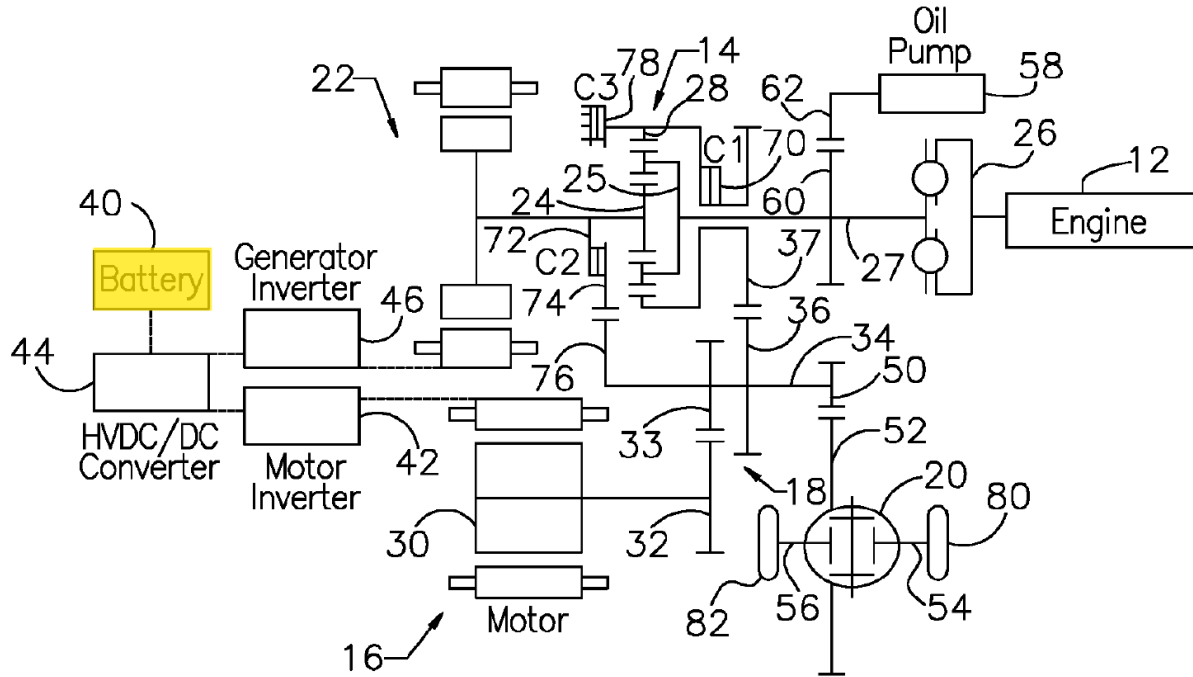


Fig. 4

1[b]: a first traction motor coupled to the energy storage system;

Ortmann discloses a first traction motor coupled to the energy storage system.

EX1008, ¶¶ 0019, 0021, 0030. In Figure 4, the first traction motor-generator 22 [shown in purple] “is electrically connected to battery 40 through an inverter 46 and converter 44.” *Id.*, ¶ 0021; EX1003, ¶¶ 296-298.

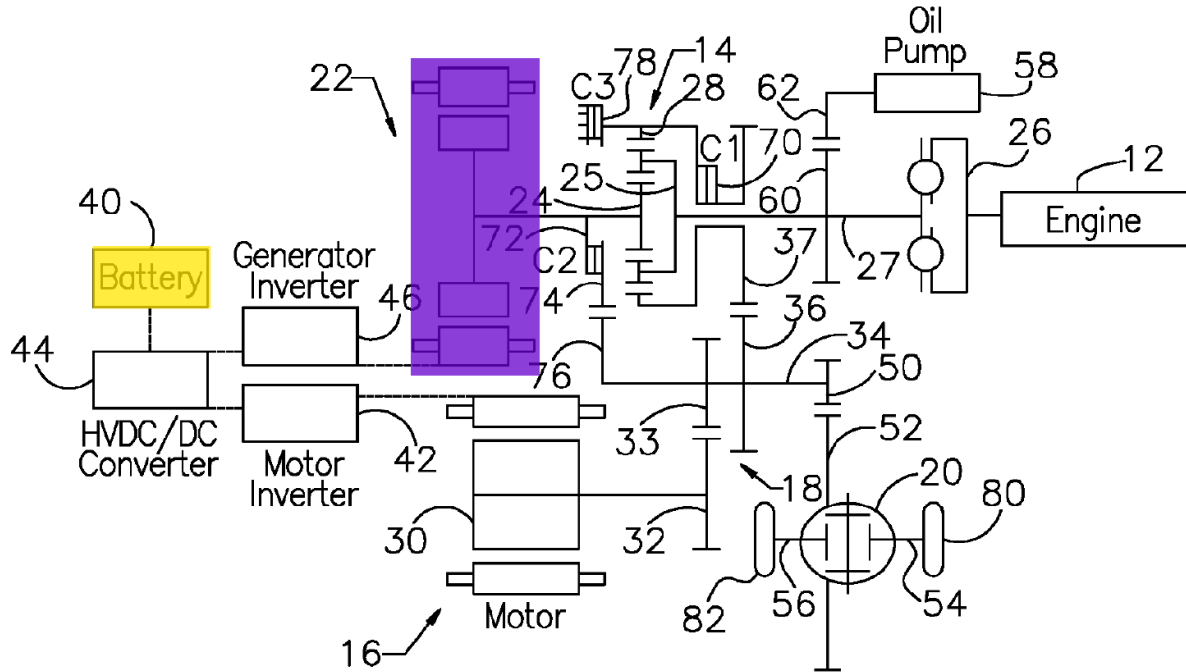


Fig. 4

1[c]: a second traction motor coupled to the energy storage system;

Ortmann discloses a second traction motor coupled to the energy storage system. EX1008, ¶¶ 0019, 0021. In Figure 4, the second traction motor-generator 16 [shown in red] “is electrically connected to battery 40 through an inverter 42 and a high voltage DC/DC converter 44.” *Id.*, ¶ 0021; EX1003, ¶¶ 299-300.

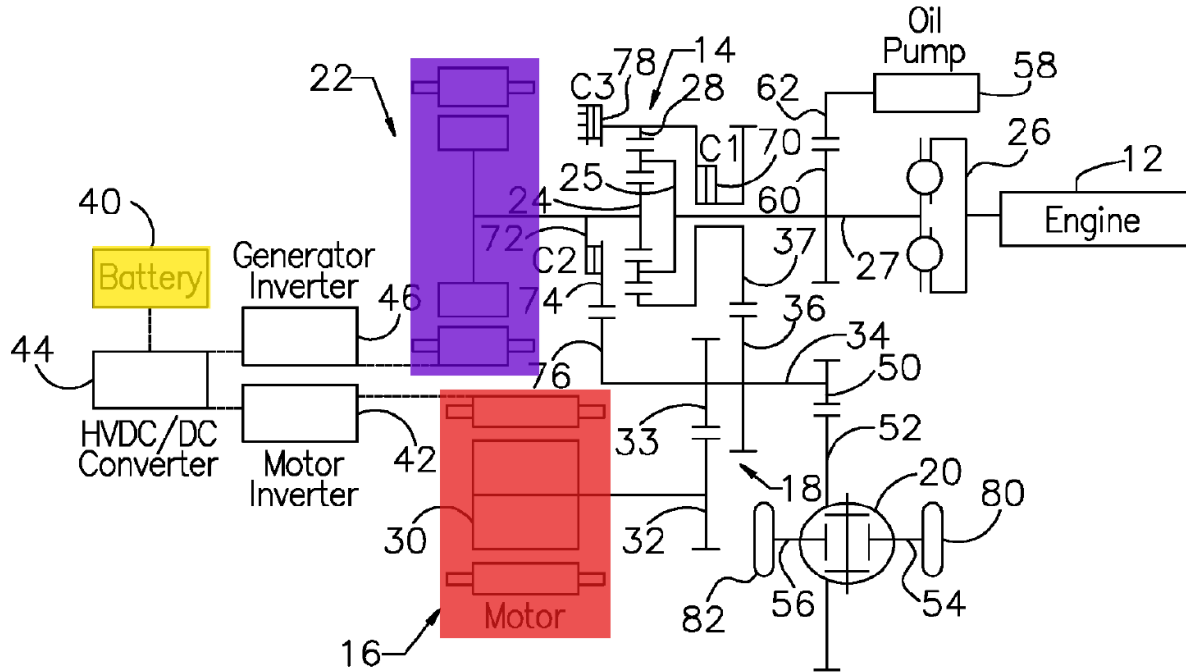


Fig. 4

1[d]: a transmission device coupled to the first traction motor, the transmission device comprising an arrangement of planetary gears;

Ortmann discloses a transmission device coupled to the first traction motor where the transmission device comprises an arrangement of planetary gears. EX1008, ¶¶ 0019, 0020. In Figure 4, “planetary gearset 14 is connected to the [motor-]generator 22.” *Id.*, ¶ 0020. Planetary gear set 14 [shown in blue] is a transmission device comprising at least sun gear 24, ring gear 28, and carrier 25. *Id.*; EX1003, ¶ 301. The transmission device may also include, for example, clutch 72 (C2). EX1003, ¶ 301.

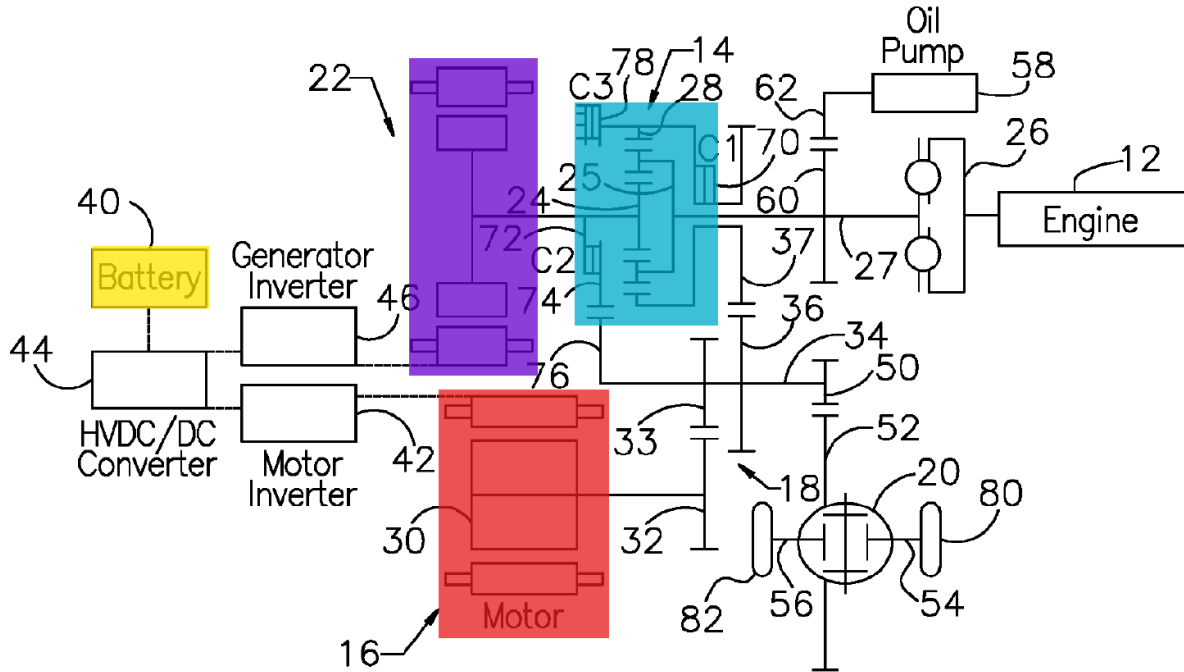


Fig. 4

1[e]: a gear assembly coupled between the second traction motor and the transmission device such that the output of the second traction motor bypasses the transmission device;

The claimed gear assembly is a separate and distinct element from the transmission device in limitation 1[d] for reasons explained in Section VII(A)(1). Ortmann discloses a gear assembly coupled between the second traction motor and the transmission device such that the output of the second traction motor bypasses the transmission device. EX1008, ¶¶ 0019, 0020. Ortmann's layshaft gearing 18 includes countershaft 34 and layshaft gear pairs 32-33, 36-37, and 50-52. *Id.*, ¶¶ 0019, 0020, 0029, 0030, 0032. In Figure 4, motor 16 is "driveably connected to the vehicle wheels through layshaft gearing 18." *Id.*, ¶ 0019. Ring gear 28 of the

transmission device “is connected to countershaft 34 and layshaft gear pair 36-37” and “rotor 30 of motor 16 is connected to countershaft 34 through the layshaft gear pair 32-33.” *Id.*, ¶ 0020. Layshaft gearing 18 [shown in green] is located between motor 16 [shown in red] and the planetary gear set 14 (transmission device) [shown in blue]. In Modes 1 and 3, the mechanical power of motor 16 is transmitted to differential mechanism 20 and axle shafts 54, 56 [shown in brown] without passing through (*i.e.*, bypassing) planetary gear set 14 (transmission device), as shown by the red arrow. EX1003, ¶¶ 303-305.

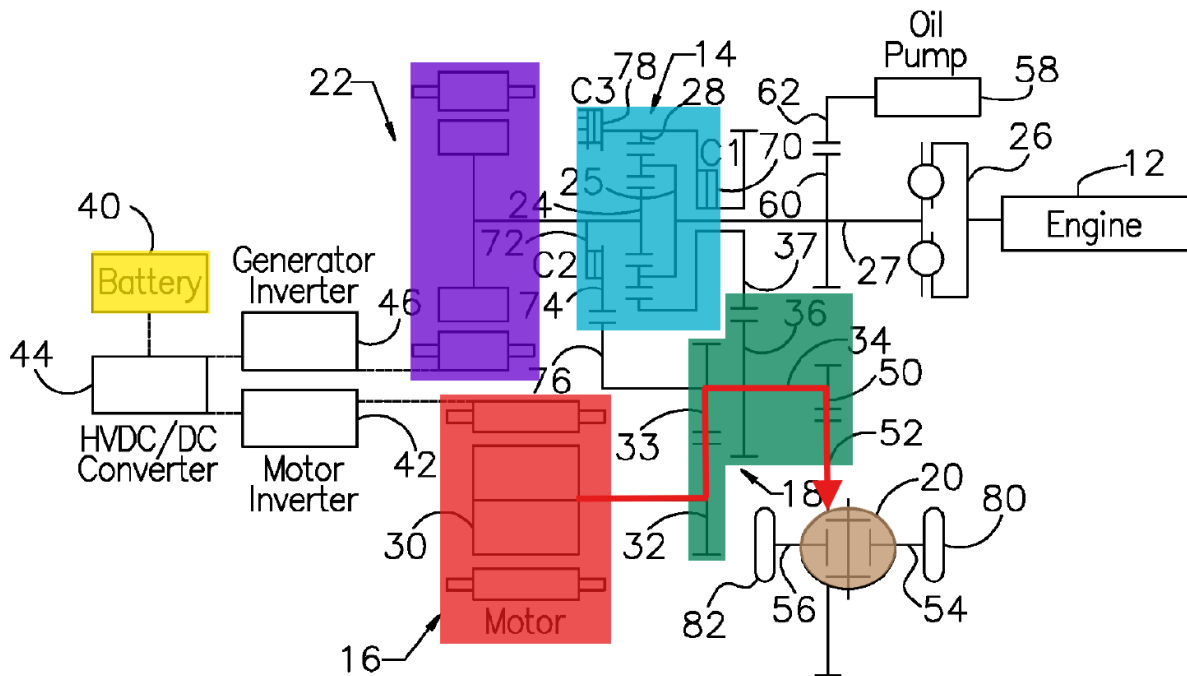


Fig. 4

1[f]: an internal combustion engine coupled to the transmission device via a path that does not include the first traction motor and second traction motor;

Ortmann discloses an internal combustion engine coupled to the transmission device via a path that does not include the first traction motor and second traction motor. EX1008, ¶¶ 0019, 0020. In Figure 4, “[t]he carrier 25 of the planetary gearset 14 [transmission device] is connected to the engine 12 [shown in gray] through a torsion damper 26 and shaft 27” via a path that does not include motor 22 and motor 16, as shown by the red arrow. *Id.*, ¶ 0020; EX1003, ¶¶ 306-307.

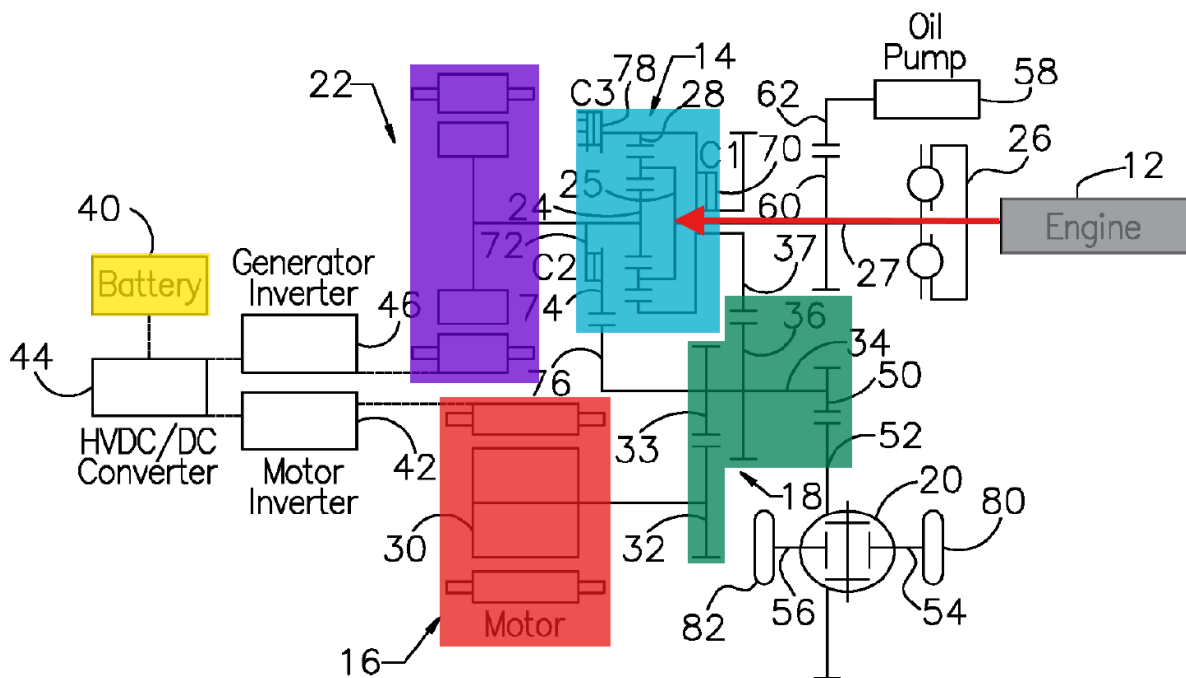


Fig. 4

1[g]: a control system configured to selectively:

Ortmann's powertrain is capable of operating in several modes: Mode 1 (one motor electric drive), Mode 2 (two motor electric drive), Mode 3 (series), Mode 4 (powersplit), and Modes 5 and 6 (direct drive). EX1008, ¶¶ 0029-0035. Ortmann necessarily teaches a control system for switching the powertrain among these modes. A POSITA would have understood that a control system is required to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the battery, and to engage and disengage clutches C1, C2, and C3 as needed to shift the powertrain between respective modes. *Id.*, Fig. 5; EX1003, ¶¶ 308-309.

1[g][i]: operate the first traction motor and second traction motor to drive the vehicle through the transmission device and gear assembly, respectively;

Mode 2 of Ortmann is two motor electric drive. EX1008, ¶ 0030. "When clutch 72 is engaged, and both clutch 72 and brake 78 are disengaged, generator 22 is connected to the countershaft 34 and drives the vehicle wheels 80, 82 through clutch 72, layshaft gears 74-76, countershaft 34, layshaft gears 50-52, and differential 20." *Id.* "Mode 2 is used during electric drive (sometimes called charge depletion) to provide extra power and torque under conditions of high torque demand." *Id.* Clutch 72 (C2) is part of the transmission device. EX1003, ¶ 310. Thus, in this mode, when the power from first motor-generator 22 is transmitted to clutch

72, it is transmitted through the transmission device. EX1008, ¶ 0026, Figs. 4-5; EX1003, ¶ 310. Therefore, motor-generator 22 drives the vehicle through (clutch 72 of) the transmission device, and motor-generator 16 drives the vehicle through layshaft gearing 18 (gear assembly), as shown by the red arrows in annotated Figure 4. EX1003, ¶ 310.

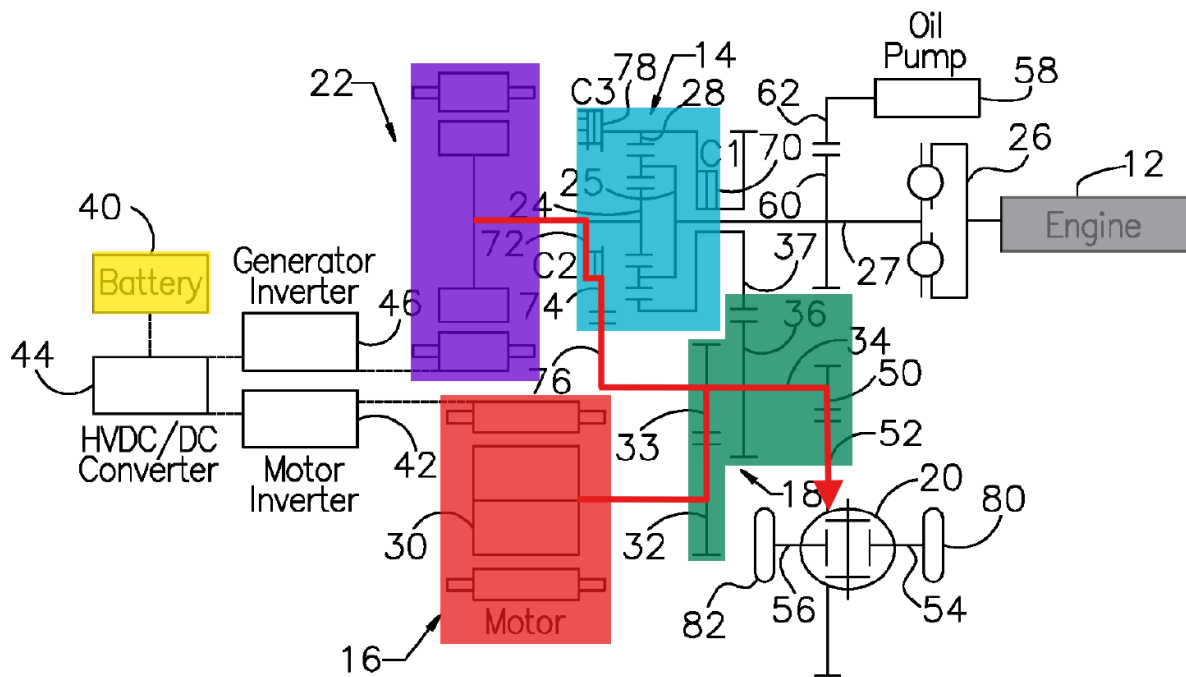


Fig. 4

Alternatively, Ortmann discloses that in Mode 5, the engine power can be transmitted to planet carrier 25 of the transmission device, power from motor/generator 22 can be transmitted to the sun gear 24 of the transmission device, and ring gear 28 of the transmission device would be free to rotate and will transmit the output. EX1008, ¶¶ 0034-0036, Figs. 4-5; EX1003, ¶¶ 311-313. The power flow

to support the high torque need during vehicle launch in Mode 5 is shown below with the two inputs to the transmission device (one input from motor/generator 22 and one input from the engine) shown with red arrows, and the output shown with a yellow arrow. The output from second motor/generator 16 driving the vehicle through the gear assembly is also shown with a red arrow. EX1003, ¶¶ 313-317.

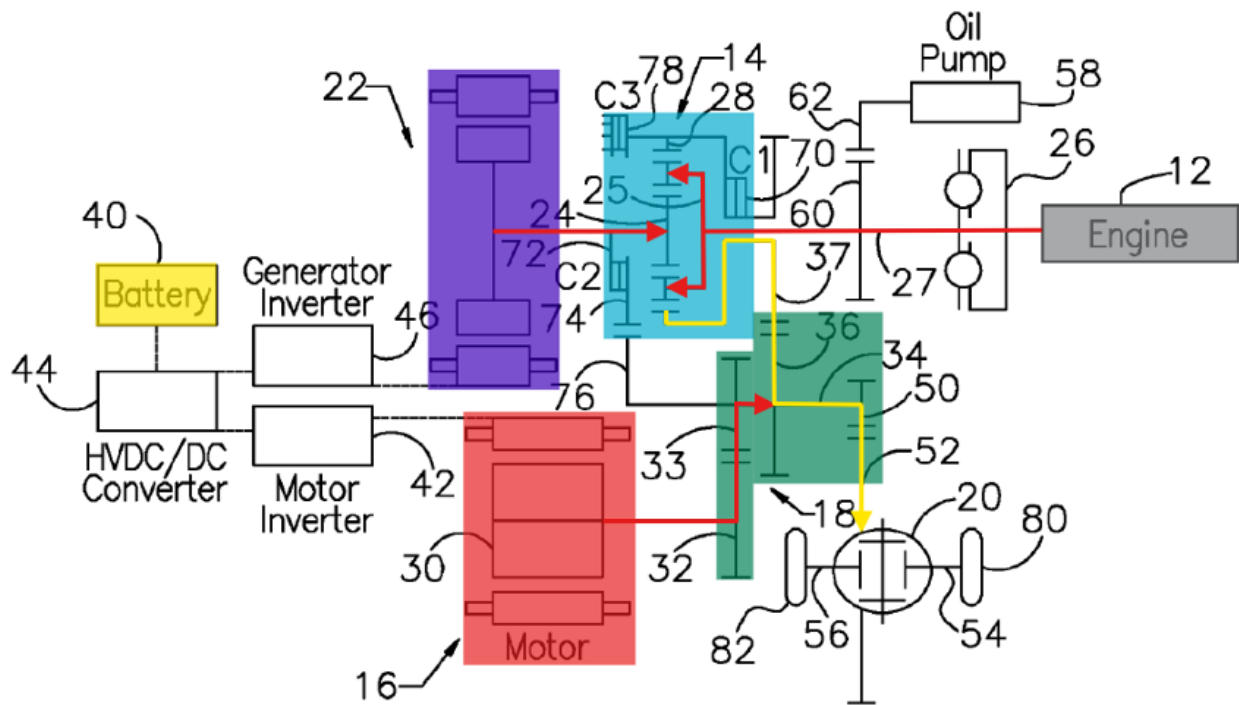


Fig. 4

1[g][ii]: operate the first traction motor as a generator to generate electrical power while operating the second traction motor to drive the vehicle through the gear assembly;

Ortmann is capable of operating in Mode 3 (series). EX1008, ¶ 0031.

“When brake 78 is engaged and clutches 70, 72 are disengaged; generator 22 is driven through the planetary gearset 14 at about two to three times engine speed

with brake 78 due to brake 78 grounding the ring gear 28 and providing a torque reaction.” *Id.* “The traction motor 16 is connected directly to the wheels 80, 82 to provide propulsion.” *Id.* Thus, motor-generator 22 generates electrical power and motor-generator 16 drives the vehicle through layshaft gearing 18 (gear assembly). EX1003, ¶¶ 318-319.

1[g][iii]: operate the second traction motor as a generator to generate electrical power.

During braking, motor-generator 16 acts as a generator. EX1003, ¶¶ 320-321.

2. Dependent Claim 2

2. The system of claim 1, further comprising a DC/DC converter coupled to the energy storage device.

As explained above, Ortmann discloses all the limitations of claim 1. Ortmann also discloses DC/DC converter 44 coupled to battery 40. EX1008, ¶ 0021, Figs. 1, 4; EX1003, ¶¶ 322-324.

3. Dependent Claim 4

4. The system of claim 1, wherein the energy storage system comprises a battery.

As explained above, Ortmann discloses all the limitations of claim 1. In particular, Ortmann discloses traction battery 40. EX1008, ¶ 0021, Figs. 1, 4; *see also* EX1003, ¶¶ 325-327.

4. Dependent Claim 5

5. The system of claim 1, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Ortmann discloses all the limitations of claim 1. Ortmann also discloses wheels 80, 82 and axle shafts 54, 56 coupled to layshaft gearing 18 (gear assembly) through countershaft 34, pinion 50, ring gear 52, and differential mechanism 20. EX1008, ¶¶ 0019, 0022, 0029-0031, Fig. 4; *see also* EX1003, ¶¶ 328-330.

5. Dependent Claim 6

6. The system of claim 1, further comprising: a first inverter coupled between the energy storage device and first traction motor; and a second inverter coupled between the energy storage device and second traction motor.

As explained above, Ortmann discloses all the limitations of claim 1. Ortmann also discloses inverters 42 and 46 coupled between battery 40 and motor-generators 16 and 22, respectively. EX1008, ¶ 0021, Figs. 1, 4; *see also* EX1003, ¶¶ 331-333.

6. Dependent Claim 7

7. The system of claim 1, wherein the electrical power generated by the first traction motor is provided to the second traction motor.

As explained above, Ortmann discloses all the limitations of claim 1. Further, in Mode 3, the engine powers motor-generator 22, which charges battery 40, and then electric power from the battery is transmitted to traction motor 16 to propel the vehicle. EX1003, ¶¶ 334-336.

7. Dependent Claim 8

8. The system of claim 1, wherein the electrical power generated by the second traction motor is provided to the energy storage system.

As explained above, Ortmann discloses all the limitations of claim 1. During braking, motor-generator 16 produces AC electricity that is sent to the motor inverter 42, which converts it to DC and pushes it to battery 40. EX1003, ¶¶ 337-338.

8. Independent Claim 9

9[p]: A vehicle propulsion system, comprising:

Ortmann discloses a vehicle propulsion system. EX1008, ¶¶ 0002-0012. Figures 1 and 4 of Ortmann illustrate HEV and PHEV powertrains, respectively. EX1003, ¶¶ 339-340.

9[a]: an energy storage system;

Ortmann discloses an energy storage system. EX1008, ¶ 0021. Figure 4 shows the powertrain includes traction battery 40 [shown in yellow]. *Id.*; EX1003, ¶¶ 341-343.

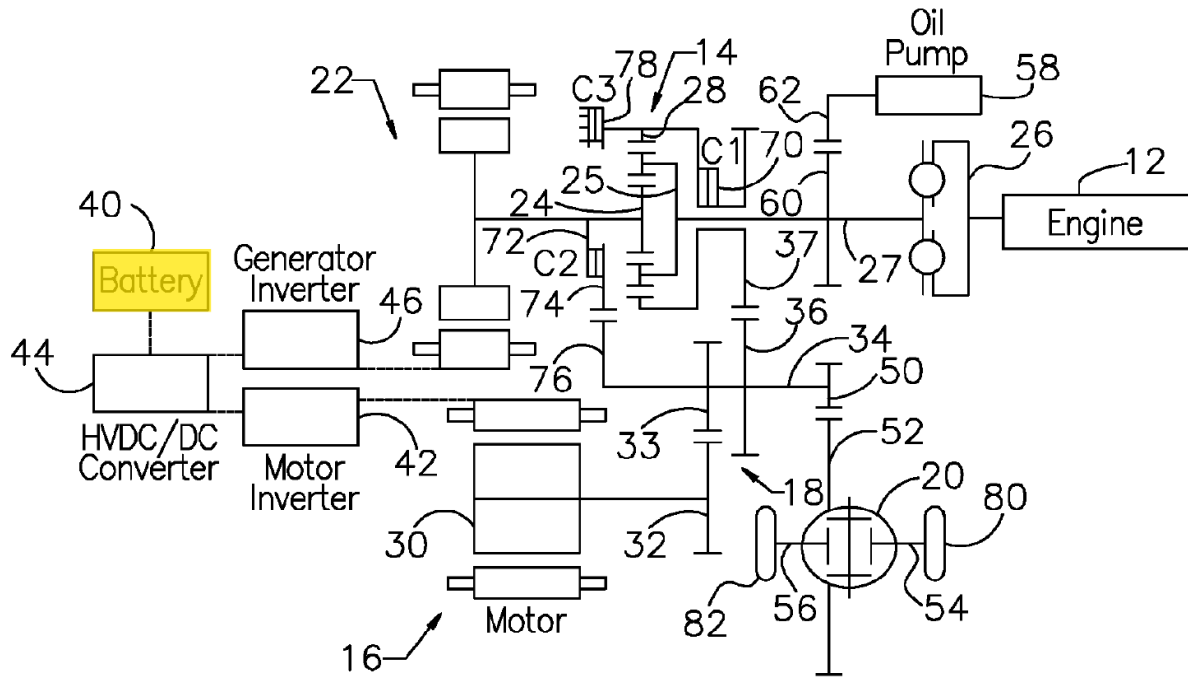


Fig. 4

9[b]: a first traction drive system coupled to the energy storage system, the first traction drive system comprising a first inverter coupled to a first AC motor;

Ortmann discloses a first traction drive system coupled to the energy storage system where the first traction drive system comprises a first inverter coupled to a first AC motor. EX1008, ¶¶ 0019, 0021, 0030. Figure 4 shows that first traction motor-generator 22 [shown in purple] “is electrically connected to battery 40 through an inverter 46 [also shown in purple] and converter 44.” *Id.*, ¶ 0021. EX1003, ¶ 344. Motor-generator 22 is an AC motor that drives the vehicle in Mode 2. EX1003, ¶¶ 344-346.

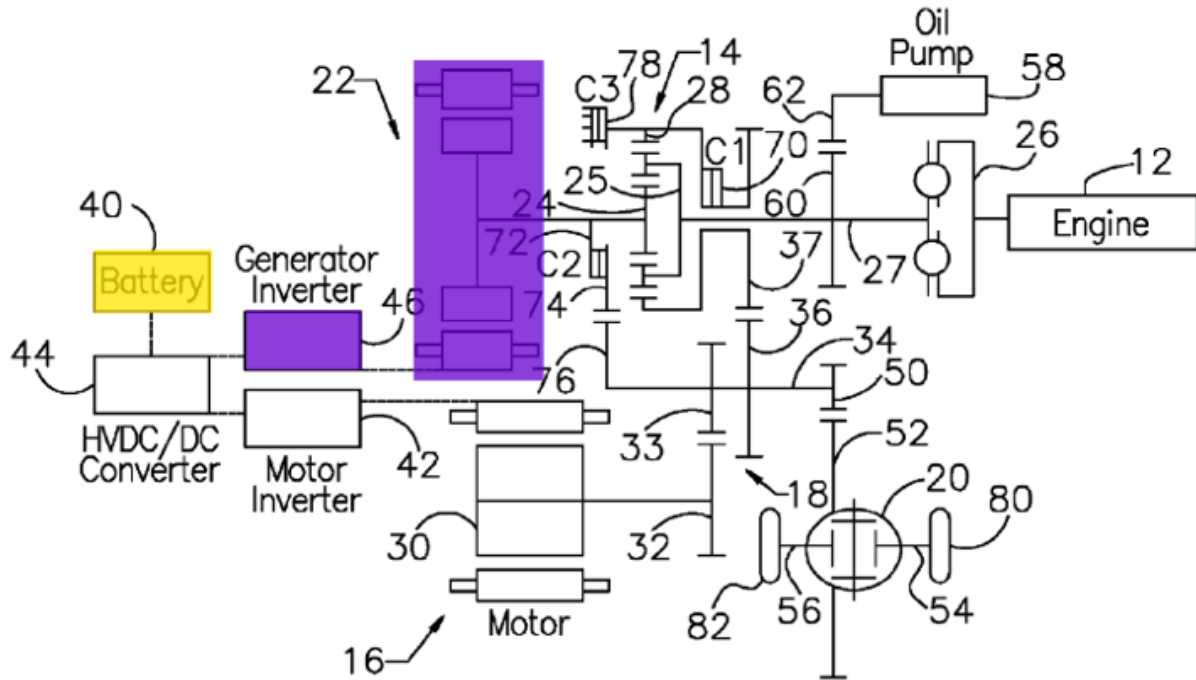


Fig. 4

9[c]: a second traction drive system coupled to the energy storage system, the second traction drive system comprising a second inverter coupled to a second AC motor;

Ortmann discloses a second traction drive system coupled to the energy storage system where the second traction drive system comprises a second inverter coupled to a second AC motor. EX1008, ¶¶ 0019, 0021. Figure 4 shows that second traction motor-generator 16 [shown in red] “is electrically connected to battery 40 through an inverter 42 [also shown in red] and a high voltage DC/DC converter 44.” *Id.*, ¶ 0021. EX1003, ¶ 347. Motor-generator 16 is an AC motor that drives the vehicle in Modes 1-3. EX1003, ¶¶ 347-348.

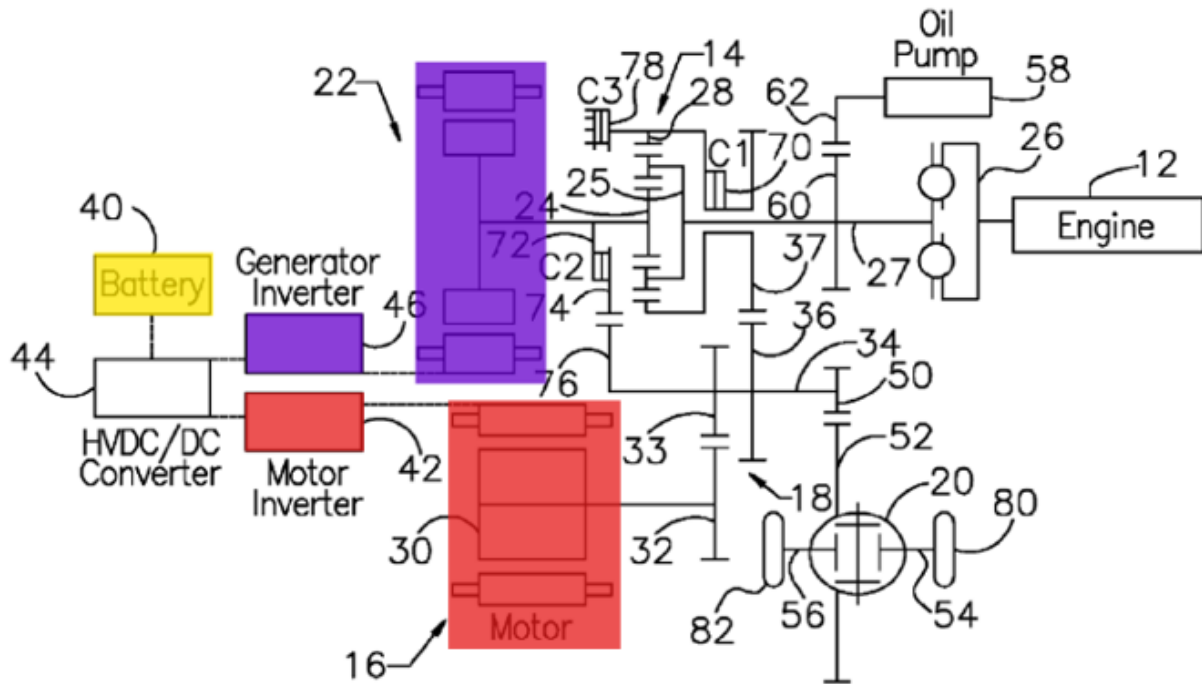


Fig. 4

9[d]: a transmission device coupled to the first traction drive system, the transmission device comprising an arrangement of planetary gears;

Ortmann discloses a transmission device coupled to the first traction drive system where the transmission device comprises an arrangement of planetary gears. EX1008, ¶¶ 0019, 0020. In Figure 4, “planetary gearset 14 is connected to the [motor-]generator 22.” *Id.*, ¶ 0020. Planetary gear set 14 [shown in blue] is a transmission device comprising sun gear 24, ring gear 28, and carrier 25. *Id.*; EX1003, ¶ 349. The transmission device may also include, for example, clutch 72 (C2). EX1003, ¶¶ 349-350.

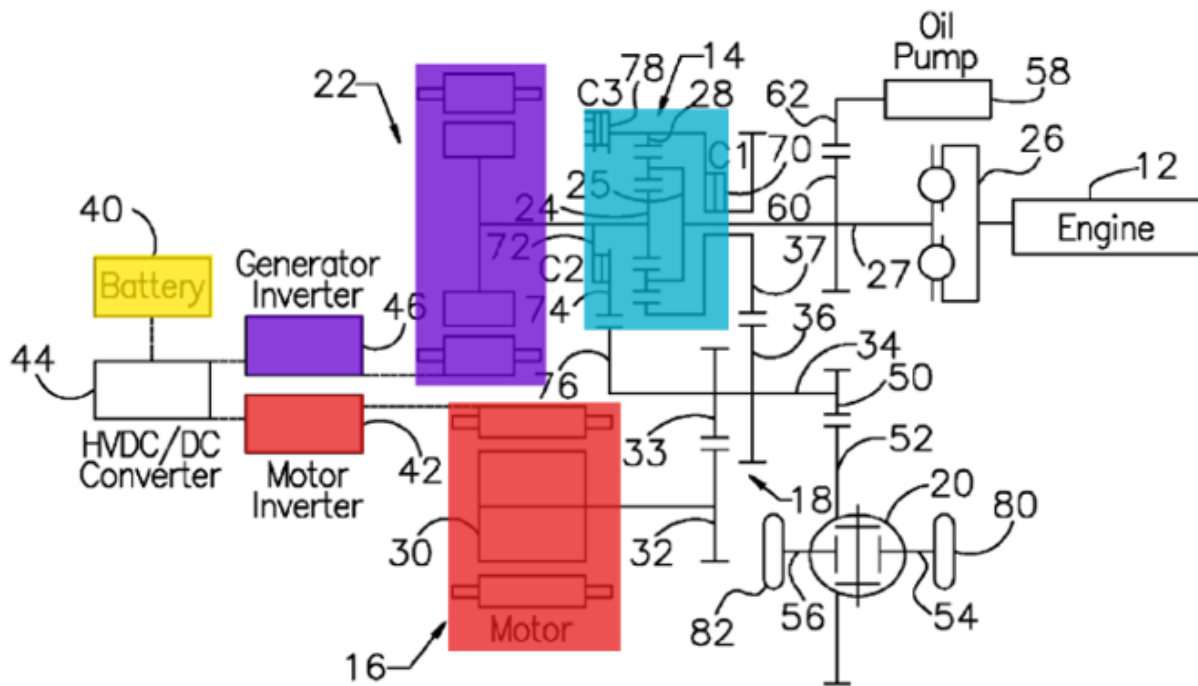


Fig. 4

9[e]: a gear assembly coupled between the second traction drive system and the transmission device such that the output of the second traction motor bypasses the transmission device;

Ortmann discloses a gear assembly coupled between the second traction drive system and the transmission device such that the output of the second traction drive system bypasses the transmission device. EX1008, ¶¶ 0019, 0020. The claimed gear assembly is a separate and distinct element from the transmission device recited in limitation 9[d]. Ortmann's layshaft gearing 18 includes countershaft 34 and layshaft gear pairs 32-33, 36-37, and 50-52. *Id.*, ¶¶ 0019, 0020, 0029, 0030, 0032. In Figure 1, motor 16 is "driveably connected to the vehicle wheels through layshaft gearing 18." *Id.*, ¶ 0019. Ring gear 28 of the transmission device "is connected to

countershaft 34 and layshaft gear pair 36-37” and “rotor 30 of motor 16 is connected to countershaft 34 through the layshaft gear pair 32-33.” *Id.*, ¶ 0020. Layshaft gearing 18 [shown in green] is located between motor 16 [shown in red] and the planetary gear set 14 (transmission device) [shown in blue]. In Modes 1 and 3, the mechanical power of motor 16 is transmitted to differential mechanism 20 and axle shafts 54, 56 [shown in brown] without passing through (*i.e.*, bypassing) planetary gear set 14 (transmission device), as shown by the red arrow. EX1003, ¶¶ 351-352.

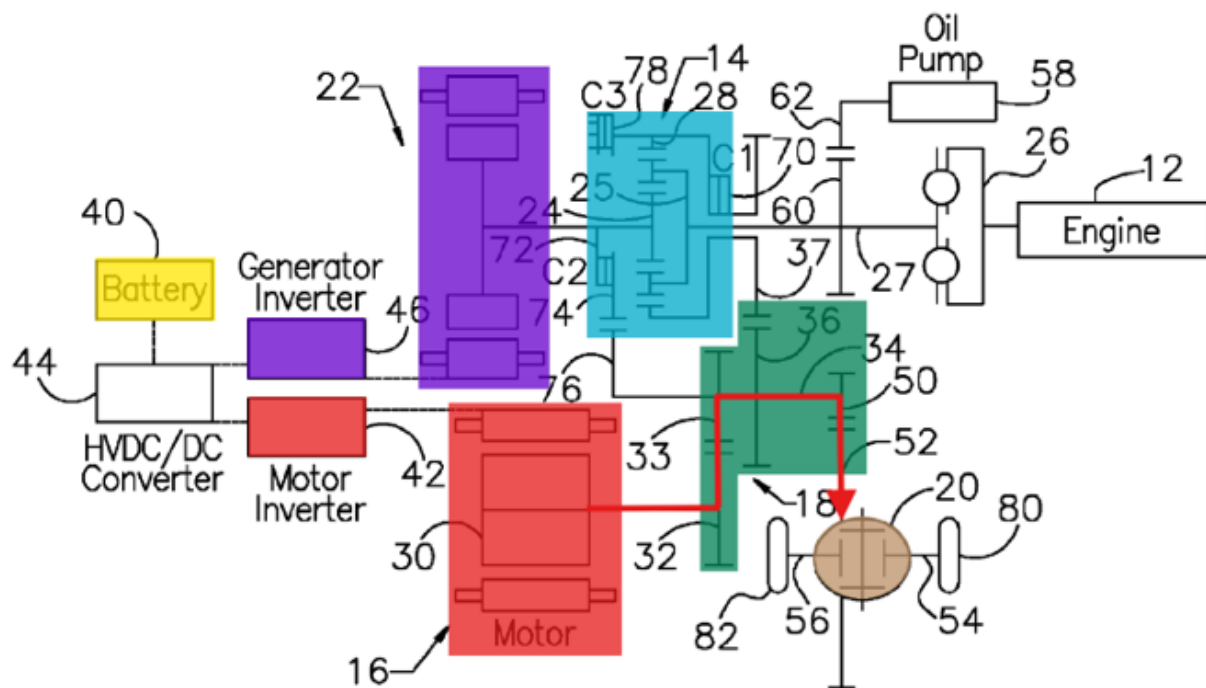


Fig. 4

9[f]: an internal combustion engine coupled to the transmission device via a path that does not include the first AC motor and second AC motor;

Ortmann discloses an internal combustion engine coupled to the transmission device via a path that does not include the first and second AC motors. EX1008, ¶¶ 0019, 0020. In Figure 4, “[t]he carrier 25 of the planetary gearset 14 [transmission device] is connected to the engine 12 [shown in gray] through a torsion damper 26 and shaft 27” via a path that does not include motor 22 and motor 16, as shown by the red arrow. *Id.*, ¶ 0020; EX1003, ¶¶ 353-354.

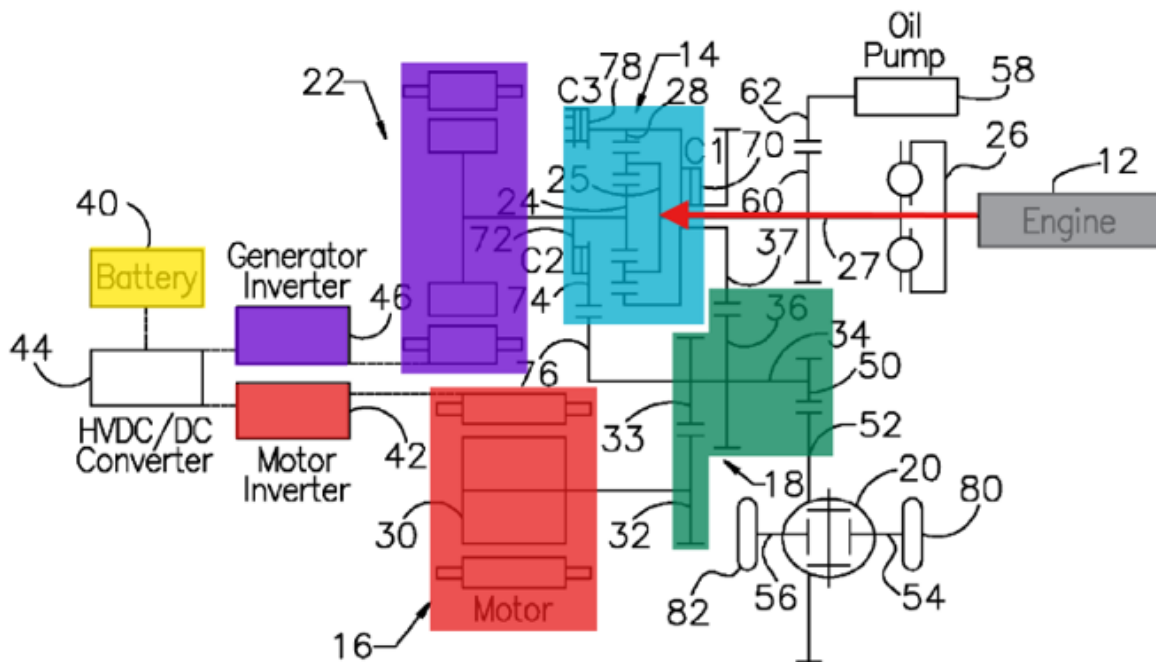


Fig. 4

9[g]: a control system configured to selectively:

Ortmann's powertrain is capable of operating in several modes: Mode 1 (one motor electric drive), Mode 2 (two motor electric drive), Mode 3 (series), Mode 4

(powersplit), and Modes 5 and 6 (direct drive). EX1008, ¶¶ 0029-0035. Ortmann necessarily teaches a control system for switching the powertrain among these modes. A POSITA would have understood that a control system is required to monitor operating conditions such as vehicle speed, motor speed, speed ratio, and power supplied from the battery, and to engage and disengage clutches C1, C2, and C3 as needed to shift the powertrain between respective modes. *Id.*, Fig. 5; EX1003, ¶¶ 355-356.

9[g][i]: operate the first traction drive system and second traction drive system to drive the vehicle through the transmission device and gear assembly, respectively;

Mode 2 of Ortmann is a two motor electric drive. EX1008, ¶ 0030. “When clutch 72 is engaged, and both clutch 72 and brake 78 are disengaged, generator 22 is connected to the countershaft 34 and drives the vehicle wheels 80, 82 through clutch 72, layshaft gears 74-76, countershaft 34, layshaft gears 50-52, and differential 20.” *Id.* “Mode 2 is used during electric drive (sometimes called charge depletion) to provide extra power and torque under conditions of high torque demand.” *Id.* Clutch 72 (C2) is part of the transmission device. EX1003, ¶ 357. Thus, in this mode, when the power from first motor-generator 22 is transmitted to clutch 72, it is transmitted through the transmission device. *Id.*, ¶ 0026, Figs. 4-5; EX1003, ¶ 357. Therefore, motor-generator 22 drives the vehicle through (clutch 72 of) the transmission device, and motor-generator 16 drives the vehicle through layshaft

gearing 18 (gear assembly), as shown by the red arrows in annotated Figure 4.

EX1003, ¶ 357.

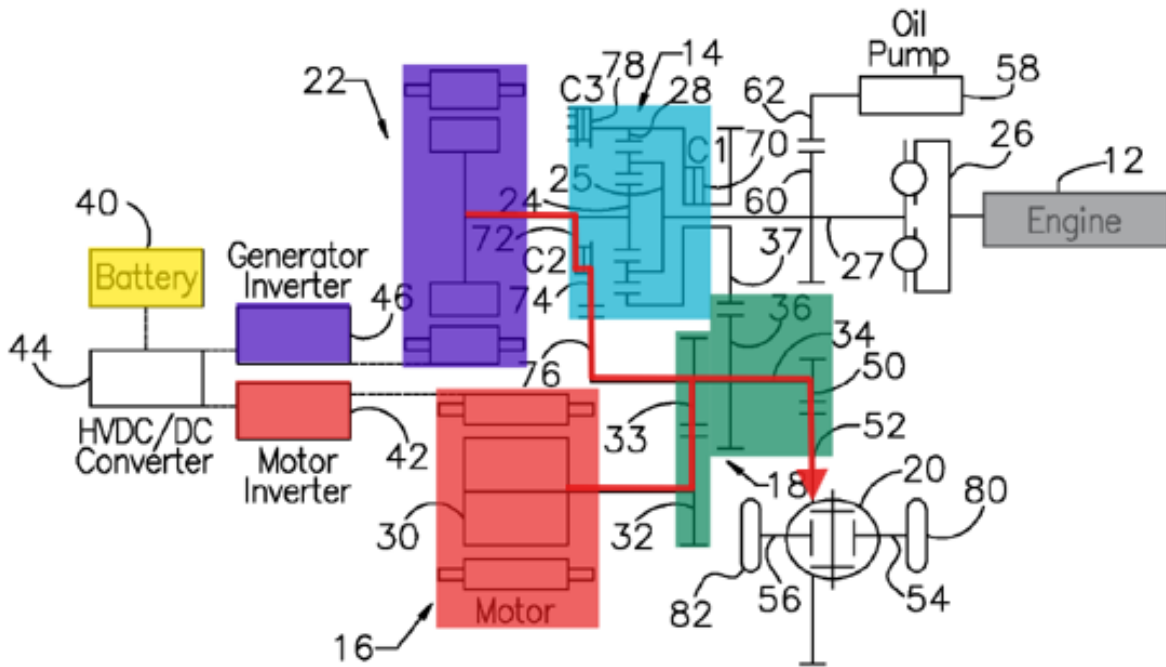


Fig. 4

Alternatively, Ortmann discloses that, in Mode 5, the engine power can be transmitted to planet carrier 25 of the transmission device, power from motor/generator 22 can be transmitted to the sun gear 24 of the transmission device, and ring gear 28 of the transmission device would be free to rotate and will transmit the output. EX1008, ¶¶ 0034-0036, Figs. 4-5; EX1003, ¶¶ 358-360. The power flow to support the high torque needed during vehicle launch in Mode 5 is shown below with the two inputs to the transmission device (one input from motor/generator 22 and one input from the engine) shown with red arrows, and the output shown with a

yellow arrow. The output from second motor/generator 16 driving the vehicle through the gear assembly is also shown with a red arrow. EX1003, ¶¶ 358-364.

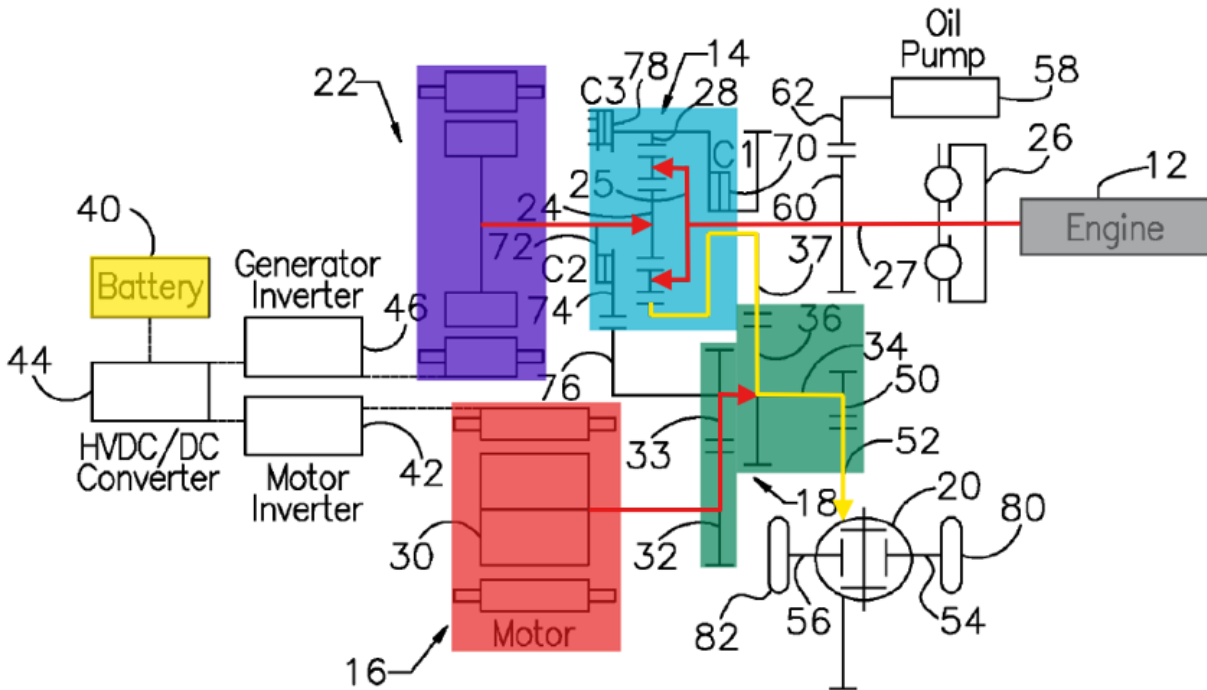


Fig. 4

9[g][iii]: operate the first traction drive system to generate electrical power while operating the second traction drive system to drive the vehicle through the gear assembly;

Ortmann is capable of operating in Mode 3 (series). EX1008, ¶ 0031. “When brake 78 is engaged and clutches 70, 72 are disengaged; generator 22 is driven through the planetary gearset 14 at about two to three times engine speed with brake 78 due to brake 78 grounding the ring gear 28 and providing a torque reaction.” *Id.* “The traction motor 16 is connected directly to the wheels 80, 82 to provide propulsion.” *Id.* Thus, motor-generator 22 generates electrical power and

motor-generator 16 drives the vehicle through layshaft gearing 18 (gear assembly).

EX1003, ¶¶ 365-366.

9[g][iii]: operate the second traction drive system to generate electrical power.

During braking, motor-generator 16 acts as a generator. EX1003, ¶¶ 367-368.

9. Dependent Claim 10

10. The system of claim 9, further comprising a DC/DC converter coupled to the energy storage device.

As explained above, Ortmann discloses all the limitations of claim 9. Ortmann also discloses DC/DC converter 44 coupled to battery 40. EX1008, ¶ 0021, Figs. 1, 4; EX1003, ¶¶ 369-371.

10. Dependent Claim 12

12. The system of claim 9, wherein the energy storage system comprises a battery.

As explained above, Ortmann discloses all the limitations of claim 9. In particular, Ortmann discloses traction battery 40. EX1008, ¶ 0021, Figs. 1, 4; *see also* EX1003, ¶¶ 372-374.

11. Dependent Claim 13

13. The system of claim 9, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Ortmann discloses all the limitations of claim 9. Ortmann also discloses wheels 80, 82 and axle shafts 54, 56 coupled to layshaft gearing 18 (gear assembly) through countershaft 34, pinion 50, ring gear 52, and differential

mechanism 20. EX1008, ¶¶ 0019, 0022, 0029-0031, Fig. 4; *see also* EX1003, ¶¶ 375-377.

12. Dependent Claim 14

14. The system of claim 9, wherein the electrical power generated by the first traction drive system is provided to the second traction drive system.

As explained above, Ortmann discloses all the limitations of claim 9. Further, in Mode 3, the engine powers motor-generator 22 of the first traction drive system, which charges battery 40, and then electric power from the battery is transmitted to traction motor 16 of the second traction drive system to propel the vehicle. EX1003, ¶¶ 378-380.

13. Dependent Claim 15

15. The system of claim 9, wherein the electrical power generated by the second traction drive system is provided to the energy storage system.

During braking, motor-generator 16 of the second traction drive system produces AC electricity that is sent to the motor inverter 42, which converts it to DC and pushes it to battery 40. EX1003, ¶¶ 381-382.

14. Independent Claim 16

16[p]: A hybrid electric vehicle propulsion system, comprising:

See limitation 1[p]. EX1003, ¶¶ 383-384.

16[a]: an energy storage system;

See limitation 1[a]. EX1003, ¶¶ 385-386.

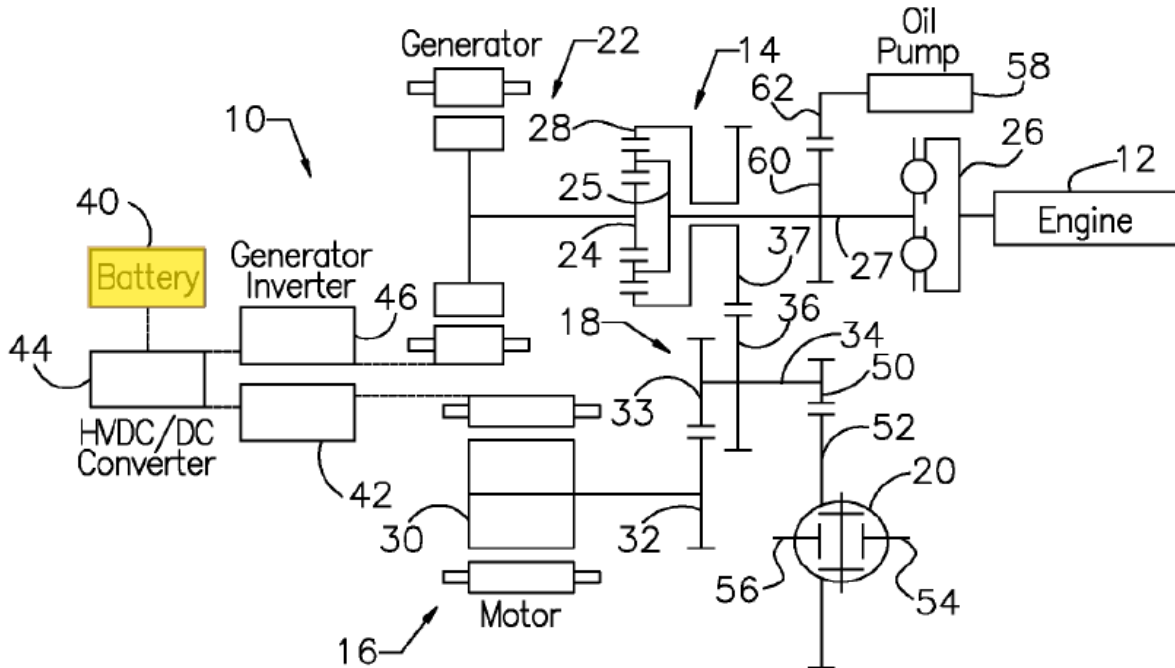


Fig. 1

16[b]: a first electric motor coupled to the energy storage system;

See limitation 1[b]. EX1003, ¶¶ 387-388.

16[c]: a second electric motor coupled to the energy storage system;

See limitation 1[c]. EX1003, ¶¶ 389-390.

16[d]: a transmission device coupled to the first electric motor, the transmission device comprising an arrangement of planetary gears;

See limitation 1[d]. EX1003, ¶¶ 391-393.

16[e]: a gear assembly coupled between the second electric motor and the transmission device such that the output of the second electric motor bypasses the transmission device;

See limitation 1[e]. EX1003, ¶¶ 394-395.

16[f]: an internal combustion engine coupled to the transmission device;

See limitation 1[f]. EX1003, ¶¶ 396-397.

16[g]: a control system configured to selectively:

See limitation 1[g]. EX1003, ¶¶ 398-399.

16[g][i]: operate the first electric motor and second electric motor to drive the vehicle through the transmission device and gear assembly, respectively;

See limitation 1[g][i]. EX1003, ¶¶ 400-407.

16[g][ii]: operate the first electric motor as a generator to generate electrical power while operating the second electric motor to drive the vehicle through the gear assembly;

See limitation 1[g][ii]. EX1003, ¶¶ 408-409.

16[g][iii]: operate the second electric motor as a generator to generate electrical power.

See limitation 1[g][iii]. EX1003, ¶¶ 410-411.

15. Dependent Claim 17

17. The system of claim 16, further comprising a DC/DC converter coupled to the energy storage device.

As explained above, Ortmann discloses all the limitations of claim 16. Ortmann also discloses DC/DC converter 44 coupled to battery 40. EX1008, ¶ 0021, Figs. 1, 4; EX1003, ¶¶ 412-414.

16. Dependent Claim 18

18. The system of claim 16, further comprising a wheel/axle assembly coupled to the gear assembly.

As explained above, Ortmann discloses all the limitations of claim 16. Ortmann also discloses wheels 80, 82 and axle shafts 54, 56 coupled to layshaft gearing 18 (gear assembly) through countershaft 34, pinion 50, ring gear 52, and differential mechanism 20. EX1008, ¶¶ 0019, 0022, 0029-0031, Fig. 4; *see also* EX1003, ¶¶ 415-417.

17. Dependent Claim 19

19. The system of claim 16, wherein the electrical power generated by the first electric motor is provided to the second electric motor.

As explained above, Ortmann discloses all the limitations of claim 16. Further, in Mode 3, the engine powers motor-generator 22, which charges battery 40, and then electric power from the battery is transmitted to electric motor 16 to propel the vehicle. EX1003, ¶¶ 418-420.

18. Dependent Claim 20

20. The system of claim 16, wherein the electrical power generated by the second electric motor is provided to the energy storage system.

As explained above, Ortmann discloses all the limitations of claim 16. During braking, motor-generator 16 produces AC electricity that is sent to the

motor inverter 42, which converts it to DC and pushes it to battery 40. EX1003, ¶¶ 421-422.

E. Ground 5: Claims 3 and 11 Are Obvious Over Ortmann

The subject matter of claims 3 and 11 would have been obvious to a POSITA based on the teachings of Ortmann. EX1003, ¶ 423.

1. Dependent Claim 3

3. The system of claim 2, further comprising a second energy storage system coupled to the DC/DC converter.

As explained above in Ground 4, Ortmann discloses all the limitations of claim 2.

It would have been obvious to a POSITA to modify Ortmann by including a second battery coupled to the DC-DC converter. EX1003, ¶ 425.

For at least these reasons, claim 3 is obvious over Ortmann. *Id.*, ¶¶ 424-426.

2. Dependent Claim 11

11. The system of claim 10, further comprising a second energy storage system coupled to the DC/DC converter.

As explained above in Ground 4, Ortmann discloses all the limitations of claim 10.

It would have been obvious to a POSITA to modify Ortmann by including a second battery coupled to the DC-DC converter. EX1003, ¶ 428.

For at least these reasons, claim 11 is obvious over Ortmann. *Id.*, ¶¶ 427-429.

XI. CONCLUSION

For the reasons set forth above, Petitioner asks that the Patent Office order an *inter partes* review and cancel the challenged claims as unpatentable.

Date: February 3, 2026

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned attorney for Petitioner declares that the argument section of this Petition has 13,998 words, according to the word count tool in Microsoft Word™.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF SERVICE

The undersigned certifies, in accordance with 37 C.F.R. §§ 42.105 and 42.6, that service was made on the Patent Owner as detailed below.

Date of service February 3, 2026

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