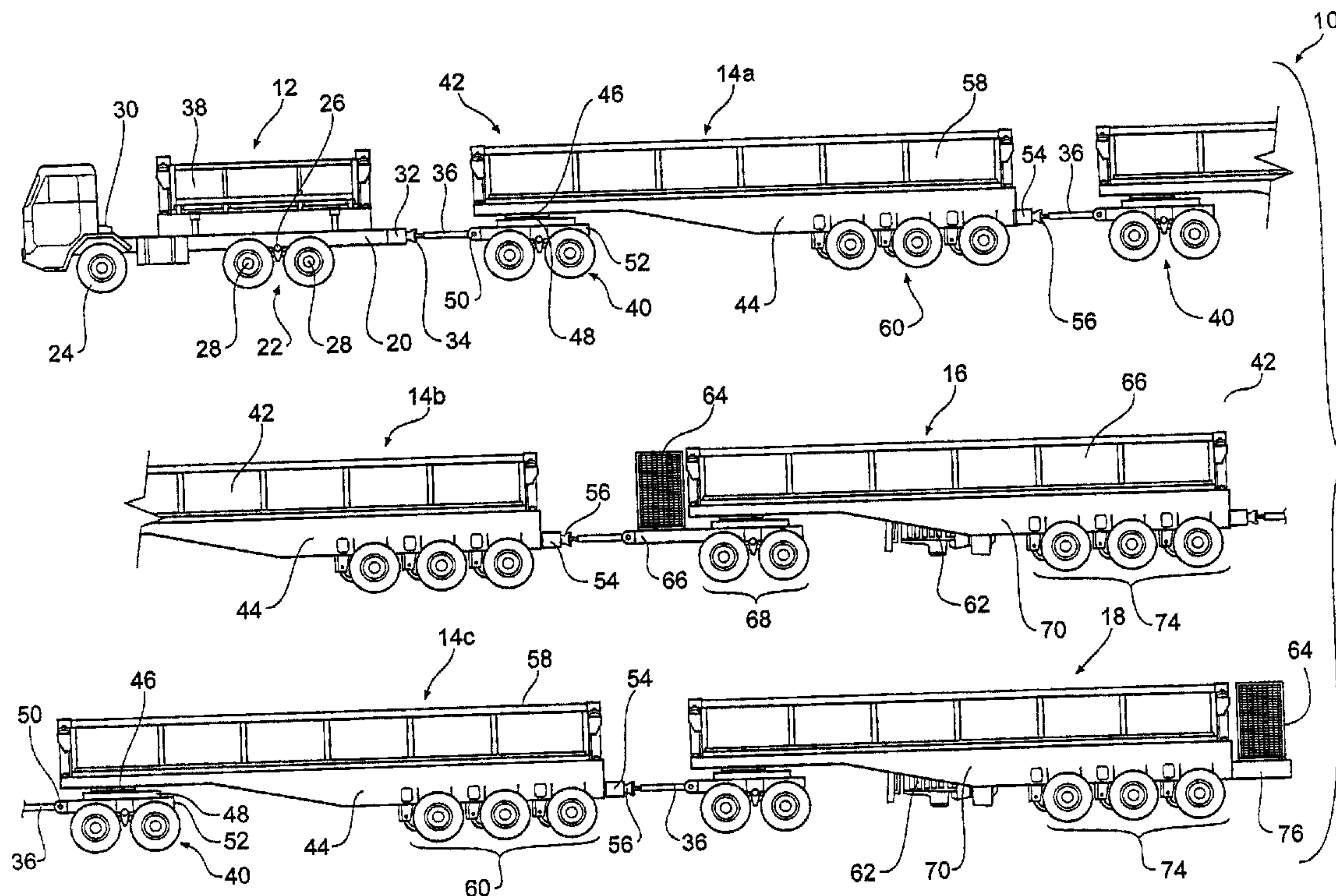




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(54) Titre : SYSTEME DE COMMANDE DE MOTEURS MULTIPLES DANS UN VEHICULE MULTICOMBINAISONS
(54) Title: SYSTEM FOR THE CONTROL OF MULTIPLE ENGINES IN A MULTI-COMBINATION VEHICLE



(57) Abrégé/Abstract:

A system is provided for the control of multiple engines in a multi-combination vehicle having at least two engines, each engine having its own power source and an electronic control module. The system includes an electronic throttle control having a power input and a variable output representative of a desired operation of each of the engines. The system further includes a throttle control module that is provided power from each of the electronic control modules and selectively provides power to the power input of the electronic throttle control from a selected one of the electronic control modules. The variable output of the electronic throttle control is in communication with at least the selected one of the electronic control modules. In other embodiments, the system of the present invention is effective for the control of multi-combination vehicles having at least three engines.

ABSTRACT OF THE DISCLOSURE

A system is provided for the control of multiple engines in a multi-combination vehicle having at least two engines, each engine having its own power source and an electronic control module. The system includes an electronic throttle control having a power input and a variable output representative of a desired operation of each of the engines. The system further includes a throttle control module that is provided power from each of the electronic control modules and selectively provides power to the power input of the electronic throttle control from a selected one of the electronic control modules. The variable output of the electronic throttle control is in communication with at least the selected one of the electronic control modules. In other embodiments, the system of the present invention is effective for the control of multi-combination vehicles having at least three engines.

SYSTEM FOR THE CONTROL OF MULTIPLE ENGINES IN A MULTI - COMBINATION VEHICLE

BACKGROUND

1.0 Field of the Invention

5 The present invention is directed to engine control systems and, more particularly, to a system for the control of multiple engines in a multi-combination vehicle, such a multi-combination vehicle being particularly useful in hauling mined payload from mines.

2.0 Related Art

10 Operators of mines are constantly searching for ways to reduce the costs associated with mined products. One of the most significant costs in operating a mine is transporting the mined material from the ore face to a processing plant. This is exacerbated when the mined payload is of low grade, that is, the desired mineral or metal is only a small percentage by weight and/or volume of the mined ore so that
15 substantial amounts of ore have to be handled to extract a small percentage of desired material. A further problem that occurs is where the ore has to be handled several times.

 There are several ways that ore can be transported from the ore face to the processing plant, depending on the type and configuration of the mine.

 Underground mines typically have a central lifting or winding shaft to bring the
20 mined ore to the surface. These shafts require a dedicated receival point. To get the ore to that point mines typically have a dedicated rail system that is level and route specific. Underground mine haulage or dump trucks are used to transport the ore from various mining levels both above and below the rail haulage level to the dedicated rial system that then transports the ore to the lifting shaft receival point. The trucks are always a
25 single unit that is either rigid or pivot steer. This type of arrangement has a number of distinct disadvantages.

 The dump trucks cause a significant amount of hot air per ton of ore hauled to be exhausted into the mine. Cold ventilation air has to be continually pumped into the mine via ventilation shafts, and one of the major costs in establishing underground mines is
30 the construction and drilling of ventilation shafts. Because of the limitation of currently known dump trucks, the time that they can operate underground is limited, particularly

due to excess heat they produce. To reduce the heat, the dump trucks have to move relatively slowly.

A railway system, especially one underground, is relatively expensive to install and operate due to the cost of acquiring the locomotive and installing the fixed railway system and the associated maintenance costs. Furthermore the underground railway system being route-specific is not flexible to changes in route without incurring the expense of installing additional railway tracks. As each new mining area opens, it is necessary to incur the cost of installing new track for the railway system, or use the dump trucks as described above whose efficiency decreases with increasing distances they have to travel.

The central lifting or winding shaft is quite expensive, the cost running into tens of millions of dollars and is of a fixed location. As the mine expands the distance from the ore face to the central shaft becomes important in the cost of operating the mine.

In some instances mines have utilised conveyor belts instead of the railway system and/or the lifting shaft. The difficulty with conveyor belts is that once again they are route specific, are quite expensive to install and maintain. Miners are also concerned that the belts may catch fire that would starve the area of oxygen.

In some instances the dump trucks may be used to transport the ore directly above ground. Because of the limitations described above, especially low speed and the heat they produce and with the inclination within underground mines generally being constant, the depth of a mine that can be realistically accessed by these dump trucks is therefore limited, typically to a depth of hundreds of metres.

When the ore has been transported to the surface, or in the case of an above ground mine, it is then necessary to transport the ore to a central processing plant.

One of the ways that this may be accomplished is by using conventional off-highway dump trucks that can either be a single rigid, pivot steer unit or an articulated vehicle consisting of a very short wheelbase earthmoving type or tractor unit coupled to a single hauled or carrying unit and virtually job specific. These units are designed to be a link in the chain of the actual mining, digging or producing the/any product. Their main function is to move product literally from the ore face to a receival point through the shortest possible distance are not route-specific. The shorter the route the more

economical they are, conversely, their tonne of ore transported per distance costs increase dramatically over longer routes. They are therefore not suitable for hauling ore great distances, thereby limiting the distance that ore can be transported at a reasonable cost. As such, these trucks are not suitable when there may be satellite mines, that is,
5 mines that are some distance away from the processing plant. In particular, these trucks have never been designed to be a transportation system for various reasons including the following:

- (a) Their axle loadings are extreme and require appropriate roading and bridging. Wheeled or articulated dump trucks with large tires carry a significant
10 loading per axle, up to 33 tons per axle.
- (b) These types of trucks being designed for hauling loads over relatively short distances and rough terrain are therefore designed with relatively large tires for relatively slow speed operation and are relatively expensive to operate and maintain due to fuel and tire costs.
- 15 (c) They produce too much heat in both their drive trains and tires. Furthermore they have poor power-to-weight ratios and low operating efficiencies.
- (d) Their mass requires a large cross-section both in height and width.
- (e) Their discharge methods are either: direct end tip (non captive) where the
20 centre of gravity is always raised, or bottom dump in the single articulated hauling vehicle that keeps the center of gravity down but is discharge captive.

An alternate way of transporting the ore to a central processing plant includes conventional type transportation system such as conveyor belts and rail systems, both routes being captive. Problems with these have been discussed above.

Another way of transporting the ore is using highway type road vehicle
25 combinations or multi-combination vehicles. These vehicles are limited by their horsepower, tractive or braking efforts or capacities, manufacturers ratings of various componentry, directional stability behaviour, swept path characteristics, gradability and startability.

As a result, currently known systems for the extraction of ore from mines set
30 limits on the commercial usefulness of mines simply due to the cost of transporting the ore.

As discussed above multi-combination vehicles, such as over-the-road vehicles are known and include a truck coupled to a plurality of trailers and converter dollies. Until recently these vehicles have included a single power source, generally a diesel engine, with the vehicles being limited to a payload of some 170 tonnes, and a gradient not exceeding 5%. These multicomcombination vehicles, commonly referred to as "road-trains" have been in use for some time, particularly in Australia, for the purpose of hauling mined products, or the commodities of other industries, over aboveground roadways. Conventional aboveground road-trains are typically designed for use at relatively high speed and on relatively flat ground. They are limited by their horse power, tractive or braking efforts and their capacities that are defined by manufacturers ratings, directional stability behaviour, swept path characteristics, gradability and startability. Accordingly they have limited uses for operation in mines.

The location of the mechanical couplings between each adjacent pair of vehicles in a multi-combination vehicle as described above is positioned to maintain the side-to-side sway, or yaw, of the last vehicle within acceptable limits for aboveground, over-the-road applications, but is not compatible for operation within an underground mine due to the relatively low operating speeds as well as the relatively narrow tunnels and small radius bends experienced in underground mines.

Specially configured multi-combination vehicles have been developed recently which have a significantly reduced swept path width as compared to conventional aboveground road-trains. This enables these vehicles to be used to transport various payloads such as mined ores, over the roadways existing in an underground mine. United States Patent No. 6,062,801 issued on May 16, 2000 and United States Patent No. 6,361,269 issued on March 26, 2002 describe these specially configured multi-combination vehicles which may be used in underground mines. The vehicles can operate in a tunnel system with restricted height, width, swept paths and directional path complying with a predetermined behaviour pattern obviating the need for the rail or conveyor system.

Even after the advent of the foregoing specially configured multi-combination vehicles, various operational problems remained to be solved with regard to the transport of mined ores, in both underground and aboveground applications. For instance, due to the heavy loads of the road-train combination, the traction provided by the powered

wheels of a road-train, usually provided to two rear axles, was insufficient to satisfactorily negotiate the gradients associated with the declines providing ingress and egress to and from some underground mines. Alternatively these declines into underground mines would have to be constructed at a much gentler slope leading to excessively long tunnels. In addition, the relatively low speed of the road trains underground due to the size of the tunnels and safety considerations result in road-trains travelling underground for a significant length of time, even up to an hour in some cases. This places strain on the road-train cooling system that is typically designed for aboveground road-trains travelling at significant speeds, generally around 80 km/h and the engines are prone to overheating.

Also, before the introduction of multi-combinational vehicles incorporating a power trailer (i.e., one having a source of motive power), which are subsequently discussed in detail, multi-combination vehicles for dedicated road haulage therefor such as mineral concentrate haulage operated at a 170 tonne payload, as noted previously. However, there is a practical limit to the payload of the multi-combination vehicle with a single truck. Since the cost of haulage is determined mainly on weight, if one can increase the total haulage that can be moved by a single vehicle that does not require additional operators, the cost benefit is substantial especially. This is especially so if ore can be hauled directly from within a mine to a processing plant without needing to be reloaded onto another transport system.

In order to further improve multi-combination vehicles and provide even greater advantages to the operators using these vehicles, multi-combination vehicles have been developed which utilise a truck and an additional motive power source advantageously located within the chassis of a trailer and including a unique cooling system that enables operation of the multi-combination vehicle at low speeds, on steeper gradients and with a greater payload than previously known. International Patent Application No. PCT/AU01/01154 discloses a multi-combinational vehicle including a power trailer having an engine that overcomes the foregoing problems of traction and cooling of such multi-combination vehicles. International Patent Application No. PCT/AU01/01568 discloses various features that may be incorporated in the drive trains of multi-combination vehicles of this type. These multi-combination

vehicles having the ability to transverse different mining levels have removed the need for conventional dump truck haulage from the ore face to the rail head, and have also enabled the vehicle to haul ore directly from the ore face from any level underground via an access tunnel directly to a processing plant eliminating the need for the lifting shaft.

5 Furthermore, these types of multi-combination vehicles coupled with specifically configured power trailers, typically B-double trailers, can be used above ground to transport ore directly to a processing plant eliminating the need for other dump trucks, increasing the total payload from some 170 tonnes to 270 tonnes whilst staying within the manufacturers rating and at the same time increasing the general behaviour pattern
10 creating a safer multi-combination vehicle.

Use of a multi-combination vehicle using a truck and a power trailer provides a further significant advantage over conventional single-engine dump trucks, as well as multi-combination vehicles having only a truck, in that even if one of the engines fail there is the potential to use the second engine to at least move the multi-combination
15 vehicle out of the way or even bring it to the surface for analysis and repair. As known in the art, in the event of engine failure it is more than a simple exercise to retrieve a single-engine dump truck from the depths of an underground mine that is then blocking the underground road for use by other trucks. A similar problem may exist with multi-combination vehicles powered only by a single truck, or in some instances a single
20 prime mover.

However, current engines used not only in dump trucks but also in multi-combination vehicles include complex Engine Control Modules that control the operation of the engine including the throttle control and that optimise the operation of such an engine taking into account various parameters such as fuel consumption,
25 emission standards and operating temperatures to mention but a few. These engines are also designed to shut down and be inoperable if any of a number of operating parameters is exceeded and can not be simply restarted without proper diagnostic analysis and subsequent repair of the engine or its Control Module.

In multi-combination vehicles one throttle control provides an output to two
30 engines, typically a truck engine, and a power trailer engine. Since a single throttle control unit provides the necessary output to each of the engines' Electronic Control Module, it is provided operating power by only one of the vehicles power supply

maintained by its engine. Whilst each engine has its own power supply, generally the truck engine provides the power to the throttle control found in the cab of the truck that operates both engines.

If the truck engine was for some reason inoperable an operator currently cannot
5 use the engine of the power trailer even if its engine is in perfect operating condition. Similarly, if the power for the throttle control was provided from the power trailer engine, in the event that it failed, the operator would not be able to control the truck engine even if it was operable.

The inventor is unaware of any known above-ground or under-ground,
10 multicomination vehicle of the type just described, which is capable of operating using a single throttle control even when one of the engines has failed, and which may be road-legal.

In view of the foregoing disadvantages and limitations associated with known
load-carrying vehicles, a commercial need exists for an improved load-carrying vehicle
15 combination for use both aboveground and in underground mines that overcomes at least some of the abovementioned problems or provides the public with a useful alternative.

SUMMARY OF THE INVENTION

Accordingly, the present invention discloses a control system for use in multi-
20 combination vehicles that enables operation of the multi-combination vehicle or "road-train" even when one of the engines has failed or is inoperable. This enables the operator of the multi-combination vehicle to continue operating the vehicle until it is moved to a safe position and is not blocking a road within the underground mine or the decline providing ingress and egress to and from the mine. This provides significant operational
25 advantages for the operator of the vehicle. According to one aspect of the present invention, a system is provided for the control of multiple engines in a multi-combination vehicle having at least two engines, with each of the engines having its own electric power source and an electronic control module powered by said source. According to one embodiment of the present invention, the system includes:

30 an electronic throttle control, said electronic throttle control having a power input and a variable output representative of a desired operation of each of the engines;

a throttle control module which is provided power from each of the electronic control modules and selectively provides power to said power input of said electronic throttle control from a selected one of the electronic control modules;

said variable output of said electronic throttle control being in communication
5 with at least the selected one of the engine control modules.

According to a second aspect of the present invention, a multi-combination vehicle provided. According to one embodiment of the present invention, the multi-combination vehicle is includes:

a powered towing unit having a first engine, said first engine including a first
10 electric power source and a first electronic control module powered by said first source;

a plurality of trailers, said powered towing unit and said trailers being mechanically coupled to one another in a series arrangement;

a power trailer having a second engine, said second engine having a second electric power source and a second electronic control module powered by said second
15 source, said power trailer mechanically coupled in said series arrangement to the plurality of trailers and said powered towing unit;

an electronic throttle control, said electronic throttle control having a power input and a variable output representative of a desired operation of said first and second engines;

20 a throttle control module which is provided power from said electronic control modules of said first and said second engines and selectively provides power to said power input of said electronic throttle control from a selected one of said electronic control modules;

said variable output of said electronic throttle control being in communication
25 with at least said selected one of said electronic control modules.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims and
30 accompanying drawings wherein:

- Figure 1 is a left side elevation of a multi-combination vehicle according to one embodiment of the present invention, with the vehicle incorporating several vehicle trailers and several power trailers;
- 5 Figure 2 is a front perspective view of a power trailer included in the multi-combination vehicle according to the present invention;
- Figure 3 is a rear perspective view of the power trailer of Figure 2;
- Figure 4 is a right hand side elevation view of the power trailer shown in Figure 2;
- Figure 5 is a left side elevation of the power trailer shown in Figure 2;
- 10 Figure 6 is a left side elevation view of a multi-combination vehicle according to an alternative embodiment of the present invention;
- Figure 7 is a rear perspective view illustrating an electronic throttle control according to the present invention;
- Figure 8 is a schematic illustration of a multi-combination vehicle and the included system for the control of multiple engines of the vehicle, according to one embodiment of the present invention;
- 15 Figure 9 is a schematic further illustrating the throttle control module shown in Figure 8;
- Figure 10 is a schematic illustration similar to Figure 9, with the throttle control module including additional, optional features associated with power takeoff;
- 20 Figure 11 is a flow chart illustrating the throttle control module according to the embodiment of the present invention illustrated in Figures 9 and 10; and
- 25 Figure 12 illustrates a system for the control of a multi-combination vehicle similar to Figure 8, but with the addition of a third power trailer.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following detailed description of the invention refers to the accompanying drawings. Although the description includes exemplary embodiments, other embodiments are possible, and changes may be made to the embodiments described without departing from the spirit and scope of the invention. Wherever possible, the same reference numbers will be used throughout the drawings and the following description to refer to the same and like parts.

Turning now to the drawings in detail there is shown in Figure 1 a multi-combination vehicle 10 including a truck 12 mechanically coupled to a plurality of trailers 14. A power trailer 16 extends from forwardly located trailers 14a and 14b and a further trailer 14c is coupled to the power trailer 16. A second power trailer 18 is coupled to the last trailer 14c. It is however to be understood that the multi-vehicle combination may be one or more power trailers, depending on the application.

The truck 12 includes a chassis or frame 20 and a rear axle assembly 22, which is suspended from and disposed below the chassis 20. Forward axle 24 comprises the steering axle of the truck 12. The rear axle assembly 22 is suspended from chassis 20 via suspension 26 and includes wheeled axles 28. Both of the wheeled axles may be driving axles, or alternatively only one is a driving axle. The driving axles may be a tridem axle assembly in lieu of the tandem axle assembly 22 and possibly suspended with a mechanical suspension.

The truck 12 further includes a motive power source 30 and a transmission (not shown) for transmitting torque from the motive power source 30 to the drive axles 28. Typically the motive power source comprises a diesel engine and the transmission for transmitting torque from the engine 30 to the drive axles 28 includes a gear box, a drive shaft, and a differential (not shown). Alternatively, the motive power source 30 may comprise other types of internal combustion engines utilising a variety of fuels.

The truck includes a draw frame 32 attached and rearwardly extending from the chassis 20. A coupling 34 is attached to the rear of the draw frame 32 and connected with a drawbar 36 on the trailer 14a. A bin 38 accommodates payload to be carried by the truck and may be adapted to be side tipping by being hingedly attached to the frame 20 (not shown).

Each of the trailers 14a, 14b, and 14c includes a converter dolly 40 and a semi-trailer 42, said semi-trailer having a chassis 44, a forward end with a coupling system 46 that pivotably attaches to a ball-race turntable 48 on the converter dolly. This enables the converter dolly to pivot relative to the semi-trailer about a generally vertical axis of rotation passing through the centre of the ball-race turntable. Other embodiments may however equally well be used, such as an oscillating ball-race turntable or a grease plate. The drawbar 36 is hingedly connected through pivot 50 to the chassis 52 of the converter dolly 40 and accommodates for any change in the grade of the road surface. As with the truck, the trailers 14a, 14b, and 14c, further include draw frames 54 attached and rearwardly extending from the chassis 44. A coupling 56 is attached to the rear of the trailer draw frames 54 and is connected with a drawbar 36 on the next trailer or power trailer. A bin 58 accommodates payload to be carried by the trailer and may be adapted to be side-tipping by being hingedly attached to the frame 52 (not shown). Each trailer includes a rear axle assembly 60 typically having three axles, the mechanical details of which are well known in the art.

Power trailer 16 is coupled to trailer 14b using coupling arrangements as described above. The power trailer 16 includes the same mechanical features as with the other non-powered trailers 14a, 14b, and 14c, such as semi-trailer 42, with the addition of an engine 62 suspended generally half-way along chassis 44 and a cooling means 64 located at the front of the power trailer 16 positioned to take into account the movement necessary during a turn. Extending the chassis 66 of the power trailer dolly 68 enables the addition of the cooling means. Alternatively, although not shown, the cooling means may be accommodated on the front of the chassis 70 of the power trailer by shortening the bin 72 when compared with the bin 58 of a non-powered trailer. A transmission system provides motive power to the rear axle assembly 74 of the power trailer 16.

Power trailer 18 also includes engine 62 mechanically coupled to the rear drive axle assembly 74 but includes the cooling means 64 located at the rear of the power trailer thereby eliminating the requirement for the extra length in the chassis of the dolly as was the case in power trailer 16 and instead extending the rear 76 of the chassis 70 to support the cooling means.

Referring to Figures 2-5, there is illustrated a power trailer such as power trailer 18 having the cooling means 64 at the rear end thereof but having a double axle rear axle

assembly 78. The power trailer includes semi-trailer 42 having a chassis 70 including a rear extension 76. The chassis 70 includes a pair of longitudinally extending side members 80 and a plurality of transverse cross-members (not shown) interconnecting and attached to the side members 80. The rear axle assembly 78 is suspended from
5 chassis 70 typically by air suspension (not shown). Alternatively the semi-trailer 42 may include a conventional mechanical spring assembly. The side members 80 support or form part of the load carrying structure such as bin 66. The load carrying structure may be a side tipping trailer, a stock crate, a fuel tank, or any other type of structure for supporting a load. As with the truck and non-powered trailers, the power trailer includes
10 a draw frame 82 attached and rearwardly extending from the chassis 70. A coupling 84 is attached to the rear of the draw frame 82 and connected with a drawbar 36 on the next trailer or power trailer and may be adapted to be side-tipping by being hingedly attached to the frame 70 (not shown).

The rear axle wheel assembly 78 includes wheeled axles 86. Extending above
15 said wheeled axles are members 88 that may be used to support mudguards and the like 90. The wheeled axles 86 include a plurality of tires 92 mounted thereon for supporting the semi-trailer as it travels over a road surface.

Mounted within chassis 70 is a motive power source or engine 62 suspended generally centrally between the side members 80 and centrally within the chassis 70. A
20 transmission 94 provides driving power from the engine 62 to the axle assembly 78 where one or more of the wheeled axles 86 may be driven. The engine is typically a diesel engine and may be advantageously include a turbocharger (not shown). To be able to fit the engine 62 in between the side members 80, the separation between the side members 80 is generally larger than that conventionally found on existing semi-trailers.
25 However, the standard width of the wheeled axles is kept the same to keep the vehicle roadworthy. This has necessitated mounting the power trailer suspension under the side members rather than on their side. The engine 62 is supplied combusting air through an air inlet 96. The air is then fed through to the engine via air pipe 98 and through appropriate filters. Exhaust gases are vented from the engine through exhaust outlet
30 100.

The cooling means 64 includes a radiator 102 to assist in cooling the engine by using an appropriate cooling fluid or coolant. In this particular advantageous

embodiment the engine cooling means or the radiator 102 is mounted at the rear of the power trailer on top of frame extension 76 that extends further rearwardly from the chassis 70. Typically, the length of the frame would be extended to accommodate the radiator positioned along the frame. However, the frame may very well remain the same length as in conventional trailers, but the length of the bin 66 would be shortened to provide sufficient space to accommodate the radiator.

The radiator 102 includes coolant coils mounted in a housing 106. An air fan 108 is mounted behind coils and is driven to draw air through the coils. Located in front of the coils is a grill 110 to offer some protection to the coils from damage by debris. The air fan 108 typically includes a hydraulic motor 112 driven by the supply of hydraulic fluid through conduits 114 and 116. The air fan 108 is also housed in a protective grill 118 and is supported in position by support bars 120 extending between the top and bottom of the housing 106.

Coolant is supplied to the radiator through inlet pipe 122 and back to the engine through outlet pipe 124. The significant distance between the radiator and the engine means that the length of pipes transporting the coolant is quite long. This in itself provides an advantage in that the volume of coolant for the engine system has been greatly increased as compared to conventional engine designs where the radiator is located in front of the engine. The volume of the pipes effectively acts as a large coolant store.

Located around the engine are various compartments 126 and 128 that house the necessary control and sensing equipment for the engine such as engine starting controls and diagnostic instruments. Typically these systems include communication means with the truck so that the driver is kept advised as to the general status of the power trailer engine.

Power trailer fuel tanks 130 are located above the right hand side of the rear axle assembly 78 and act as pseudo mudguards. Side-tipping hydraulic arms 132 and 134 are provided at the front and rear of the bin respectively whilst arms 136 and 138 control opening the side of the bin 66.

Figure 6 illustrates a multi-combination vehicle 135 wherein instead of a power-trailer as illustrated earlier, there is at least one "B-double" trailer 137 incorporating a

power trailer 140 coupled to a trailer 142. The trailer 142 includes a rear axle assembly 144 that acts as a dolly for the power trailer 140. Power trailer 140 includes a tri-axle rear axle assembly 146, the configuration of the other components being similar to those described earlier and well known in the art. Rear axle assembly 144 is a quad-axle assembly. It is however to be understood that the assembly may have less axles than shown, such as a tri-axle assembly. A B-double trailer 137 configuration has been found to provide improved directional stability. In the case of a long multi-combination vehicle, this enables the operator to assemble a multi-combination vehicle having a total combination of approaching up to 10 trailers and power trailers.

The above description illustrates a multi-combination vehicle 135 having multiple power trailers and a single prime mover or truck. We now discuss the operating control systems of such a multi-combination vehicle. For ease of understanding we will discuss an embodiment where there is only one truck and one power trailer. It is however to be understood that the control system may equally well apply to one or more power trailers and it is not intended to limit the present application to a multi-combination vehicle having only one power trailer.

The throttle control of the engines of a truck and the power trailer depend on the configuration of the transmission system of the truck and the transmission system of the power trailer. Since a driver would not be able to control manual transmission systems of two engines, the transmission system of the power trailer is an automatic one.

Each of the engines includes engine on-board computer management systems, which not only measure a number of parameters such as the torque, fuel injected, and the engine rpm's (revolutions per minute) but also enable a throttle input to be used to drive the engine. Whilst its own throttle may control each engine separately those skilled in the art would appreciate the difficulty of controlling such a multi-combination vehicle where there were separate throttles and typically the power trailer engine is operated assuming a load all the time, that is, "flat out". This is undesirable for many reasons including stability of the multi-combination vehicle as well as fuel consumption.

If the truck transmission system is a manual one then there must be separate throttle controls since the gearing of the transmission systems would work against each other. However in the case where the engine and transmission system configuration of both the truck and the trailer are automatic, it has been discovered by the present

applicant that such a configuration may be controlled by one throttle unit 148 only as illustrated in Figure 7.

The throttle unit, or electronic throttle control 148 includes a pedal 150 pivoted at 152 on a base 154. A biasing means 156 having a rotatable wheel 158 is pivotably
5 attached to the pedal and rotates along arm 160 to provide resilience for the pedal in operation. Attached to the side of the pedal is a housing 162 housing a potentiometer, a shaft operatively connecting the pedal 150 and the potentiometer so that as the pedal is depressed the potentiometer is rotated providing a variable voltage output.

Illustrated in Figure 8 is a schematic illustration of a multi-combination vehicle
10 and system, according to one embodiment of the present invention, for the control of multiple engines of the multi-combination vehicle. The throttle pedal is electronically connected through cable cluster 164 to a throttle control module (TCM) 166 and is typically provided power from a truck engine control module (ECM) 190. As discussed
15 above, should the truck engine and its power system fail for whatever reason, an alternative source of power needs to be provided to the electronic throttle control 148 to enable the operator to provide a throttle input to the power trailer engine. The TCM 166 enables the operator to select and alternate power source for the electronic throttle control 148 so that the multi-combination vehicle can still be driven even if one of the
20 engines were to fail. This ability allows the multi-combination vehicle to be at the very least moved out of the way so that other vehicles may use a roadway and at best still deliver any load and be driven to an appropriate area for repair.

With reference to Figure 8, a first vehicle, typically truck 168 includes engine 170 providing power through transmission system 172 to drive shaft 174 and onto rear axle assembly 176. The truck 168 is mechanically coupled via coupling 178 to power
25 trailer 180 having engine 182 providing power through transmission system 184 to drive shaft 186 and onto rear axle assembly 188.

Each of the engines has an associated Engine Control Module (ECM), ECM 190 coupled to engine 170, and ECM 192 coupled to engine 182. Similarly each transmission has an associated Engine Control Unit (ECU), ECU 194 coupled to
30 transmission 172, and ECU 196 coupled to transmission 184. The ECM and ECU unit of each vehicle are connected to the vehicles' power supply.

As discussed earlier the electronic throttle control or pedal 148 is operatively connected to throttle control module (TCM) 166 and includes a ground 198a, power 200a, and variable throttle output 202a. The TCM is operatively coupled to the ECM 190 of the truck and ECM 192 of the power trailer. The truck ECM 190 associated with
5 truck 168 is connected with the TCM to provide power 200b, a common ground 198b whilst receiving the throttle pedal output 202b. Similarly the power trailer ECM 192 associated with power trailer 180 is connected with the TCM to provide power 200c, a common ground 198c whilst receiving the throttle pedal output 202c. Selector switch 204 selects the power input that is fed through the TCM 166 to the electronic throttle
10 control 148, that is, whether electronic throttle control 148 receives power from ECM 190 or ECM 192. A warning system, such as a buzzer and/or light 220 is operatively coupled to the selector switch to indicate to an operator when the present configuration of the TCM 166 has failed.

Typically, power is fed from ECM 190 of the truck to the ECM 190, although it
15 is to be understood that power may alternatively be supplied from ECM 192 to TCM 166. If ECM 190 senses serious engine problems, such as high temperature or low coolant, the ECM shuts the engine 170 down. The operator then operates switch 204 in the event of the power from ECM 190 dying (or limited to battery power) which will re-route the power previously came from ECM 190 to the electronic throttle control 148
20 through the TCM 166 to power coming from ECM 192 through TCM 166 and to the electronic throttle control 148.

When ECM 190 stop providing power and in the event that power is not re-routed from the ECM 192, the power trailer engine 182 will also power down since it will not receive any variable output from the electronic throttle control 148.

25 Although not shown it is to be understood that various visual and audio indicators may be provided to the operator regarding the status of the ECM's 190 and 192 and electronic throttle control 148 as well as switch 204 at any one time. It is to be further understood that switch 204 may also be used to control the display of various parameters from the engine ECM from which power is fed into the electronic throttle
30 control 148.

In the event where one requires a power take off (PTO), switch 206 coupled to the TCM 166 ensures that the variable throttle output is disconnected from the ECM to

which the PTO is related to and to limit the speed of the engine to a speed that is a less than the maximum speed. The PTO is typically selected when one requires power when the vehicle is not moving, such as that when it is unloading. Those skilled in the art will appreciate that the selector switch 204 is typically an electric switch and the PTO switch
5 206 typically a pneumatic switch.

One can now appreciate that a single electronic throttle control can be used to operate two engines in a parallel type of arrangement. That is, the engines do not communicate with each other but rather independently from the one electronic throttle control 148. When the ECM of either engine is inoperative, it is not fatal if they are still
10 provided a throttle control signal 202a. Under those circumstances, signals 202b and 202c may be coupled outside of the TCM 166 through connection 208.

A Gear Selector Control Module 210 (GSCM) is operatively connected to the ECU of both the truck and the power trailer through connections 212a and 212b respectively. The GSCM enables the operator to control both transmissions with a
15 single gear selector panel (GSP) 214, allowing the operator to select any gear, neutral or reverse. The GSCM eliminates the possibility of an operator selecting a gear on a single selector only, the GSCM enabling the operator with one selection to select the nominated gear in both transmissions 172 and 184.

The GSCM 210 is provided power from either the truck ECU 194 or the power
20 trailer ECU 192. Selector switch 204 is also operatively coupled to the GSCM 210. By selecting the appropriate position on switch 204 power is fed from the power trailer ECU 196 instead of the truck ECU 194.

GSP connection 216 includes a large number of independent wires that carry signals. Some of these signals can be provided directly to and from either ECU 194 or
25 196 and accordingly these can bypass the GSCM 210. These signals may include common data bits. The gearshift selector displays are selected via the GSCM. Other signals 218 that relate to the provision of power and sensor power and other transmission specific data have to be alternatively selected through the GSCM 210 and are then appropriately provided to the ECU's, signal 212a feeding ECU 194 and signal 212b
30 feeding ECU 196.

Figure 9 illustrates in more detail the TCM 166. Two relays 228 and 230 are shown in the de-energised position. One side of each relay has two connections to the truck and the power trailer ECM's 190 and 192 respectively whilst the other has a single connection to the electronic throttle control 148. In the energised position, power 200 to the electronic throttle control 148 is provided from the truck ECM 190 via connection 200b. When the relays are de-energised the relays now connect power 200c from the power trailer ECM 192 to the electronic throttle control 148 that then provides the output signal 202a through to the ECM 192 via connection 202c.

Since the variable signal 202a does not interfere with an ECM that has failed, one could, as mentioned above, couple the variable output of the throttle control to the two ECM's through connection 208. This has application where the engines may be coupled in series rather than parallel.

Although not shown it is understood that the selector switch 204 may be an automated function. For example, a voltage sensor may be used to determine when the voltage in the power supplies of either the truck or the power trailer falls below a threshold value. If it does, an automatic switch may be used to select the power for the TCM 166 from either the truck or the trailer. In the event that there are multiple power trailers the selector switch may very well have more than two selections.

Illustrated in Figure 10 is the PTO option that is required when the vehicle needs to be operated at a constant rpm or speed. Two relays 232 and 234 are provided in the TCM 166. First relay 232 input is placed in the variable throttle output signal 202a between the throttle control unit and the TCM. The de-energised output 236 of the relay 232 is connected to relay 228 that selects either the truck or the power trailer. Output 236 is also connected by connection 238 to the energised output of the relay 234. The input of relay 234 is provided power from connection 200 but in between two resistive elements 240 and 242 providing the relay 234 an input 244 that is less than the power signal 200. In the de-energised position the output 246 is a dead-end. In the energised position relay 234 provides input 244 to the input of relay 228 which is a fixed value proportional to the power signal 200. Pre-determining the values of the resistive elements 240 and 242 enables one to select the input signal 244 and hence the value of the signal seen by the truck ECM 190.

Figure 11 is a flow chart illustrating the logic behind the operation of the TCM 166 incorporating PTO. A determination is first made if there is Truck Ignition On 248. If No 250, then there is Nil Response 252 from the multi-combination vehicle. If the Truck Ignition On 248 is Yes 254 then the question is whether the Truck Ignition circuit is OK 256. If Yes 258 the question is whether the TCM is Relaxed 260, the TCM provided power from the Truck ECM 262 that is provided power from the Truck ECM Input Power 264. If the TCM is relaxed, that is Yes 266, there must be a broken input to throttle 268, and there is Nil Response 270 from the system. If the TCM Relaxed is Yes 272 then input is supplied to the throttle 274, the throttle having 5 Volts power 276 and providing a variable throttle output 278.

If the truck ignition circuit is not running 280 the emergency selector switch 282 can be used to provide power. If the switch is Off 284 then neither the truck or the power trailer engine 286 and 288 respectively will be running. If the switch 282 is On 290, the TCM should be energised 292. If it is Not energised 294 than input to the throttle 296 is broken and there is nil response 298 from the system. If the TCM energised 292 question is Yes 300, then power is supplied to the throttle 302.

When the PTO relay 304 is activated it provides both a truck and trailer ECM input signal 306 and 308, that controls the RPM of the truck engine 310 if the PTO is connected to the truck, and the trailer engine 312 if the POT is connected to the trailer engine.

Illustrated in Figure 12 is a schematic diagram showing a truck operatively coupled to two power trailers. As was the case for Figure 8, the TCM enables power to be supplied from one of the three separate units, the power initially supplied by the truck.

It is to be understood that reference in the present specification to a power source may include a battery that is connected in series to the power source of the engines, the engine power sources feeding the battery that than links to the various modules and control units.

Those skilled in the art will appreciate that the present invention complements and further enhances the multi-combination vehicles whose details were described in the

United States and International Applications discussed earlier and that provide significant advantages and cost savings when hauling ore.

Further advantages and improvements may very well be made to the present invention without deviating from its scope. Although the invention has been shown and
5 described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope and spirit of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices and apparatus.

CLAIMS

What is Claimed is:

1. A system for the control of multiple engines in a multi-combination vehicle having at least two engines, each engine having its own electrical power source and an
5 electronic control module powered by said source, said system comprising:

an electronic throttle control, said electronic throttle control having a power input and a variable output representative of a desired operation of each of the engines;

a throttle control module which is provided power from each of the electronic control modules and selectively provides power to said power input of said electronic
10 throttle control from a selected one of the electronic control modules;

said variable output of said electronic throttle control being in communication with at least the selected one of the engine control modules.

2. The system as recited in claim 1, wherein:

15 said throttle control module includes a manual switching device, said manual switching device being operably effective for selectively providing power to said power input from the selected one of the engine control modules, said manual switching device being operable by an operator of the multi-combination vehicle.

20 3. The system as recited in claim 2, wherein:

said throttle control module is operably effective for automatically, selectively providing power to said power input of said electronic throttle control from one of the engine control modules.

25 4. The system as recited in claim 1, further including:

a warning device viewable by an operator of the multi-combination vehicle, said warning device being operatively coupled to each of the engine control modules whereby said warning device is operatively effective for providing an indication to the
30 operator of the multi-combination vehicle of a failure of at least one of the engine

control modules.

5. The system as recited in claim 1, wherein the multi-combination vehicle includes a powered towing unit and a power trailer, one of the engines being mounted on and
5 operatively effective for providing power to at least one driving axle of the powered towing unit, another of the engines being mounted on and operatively effective for providing power to at least one driving axle of the power trailer, wherein:

said throttle control module is provided power from the electronic control module of the engine of the powered towing unit for an initial start-up of the powered
10 towing unit;

said variable output of said throttle control module is in communication with the electronic control module of the powered towing unit.

6. The system as recited in claim 1, wherein the multi-combination vehicle includes
15 at least three engines, each engine having its own power source and an electronic control module, wherein:

said throttle control is provided power from the electronic control of each of the three engines and selectively provides power to said power input of said electronic throttle control from a selected one of the three electronic control modules;

20 said variable output of said electronic throttle control is in communication with said selected one of the engine control modules and at least one of the other engine control modules.

7. A multi-combination vehicle comprising:

25 a powered towing unit having a first engine, said first engine including a first electric power source and a first electronic control module powered by said first source;
a plurality of trailers, said powered towing unit and said trailers being mechanically coupled to one another in a series arrangement;

a power trailer having a second engine, said second engine having a second
30 electric power source and a second electronic control module powered by said second source, said power trailer mechanically coupled in said series arrangement to the plurality of trailers and said powered towing unit;

an electronic throttle control, said electronic throttle control having a power input and a variable output representative of a desired operation of said first and second engines;

5 a throttle control module which is provided power from said electronic control modules of said first and said second engines and selectively provides power to said power input of said electronic throttle control from a selected one of said electronic control modules;

said variable output of said electronic throttle control being in communication with at least said selected one of said electronic control modules.

10

8. The multi-combination vehicle as recited in claim 7, further comprising:

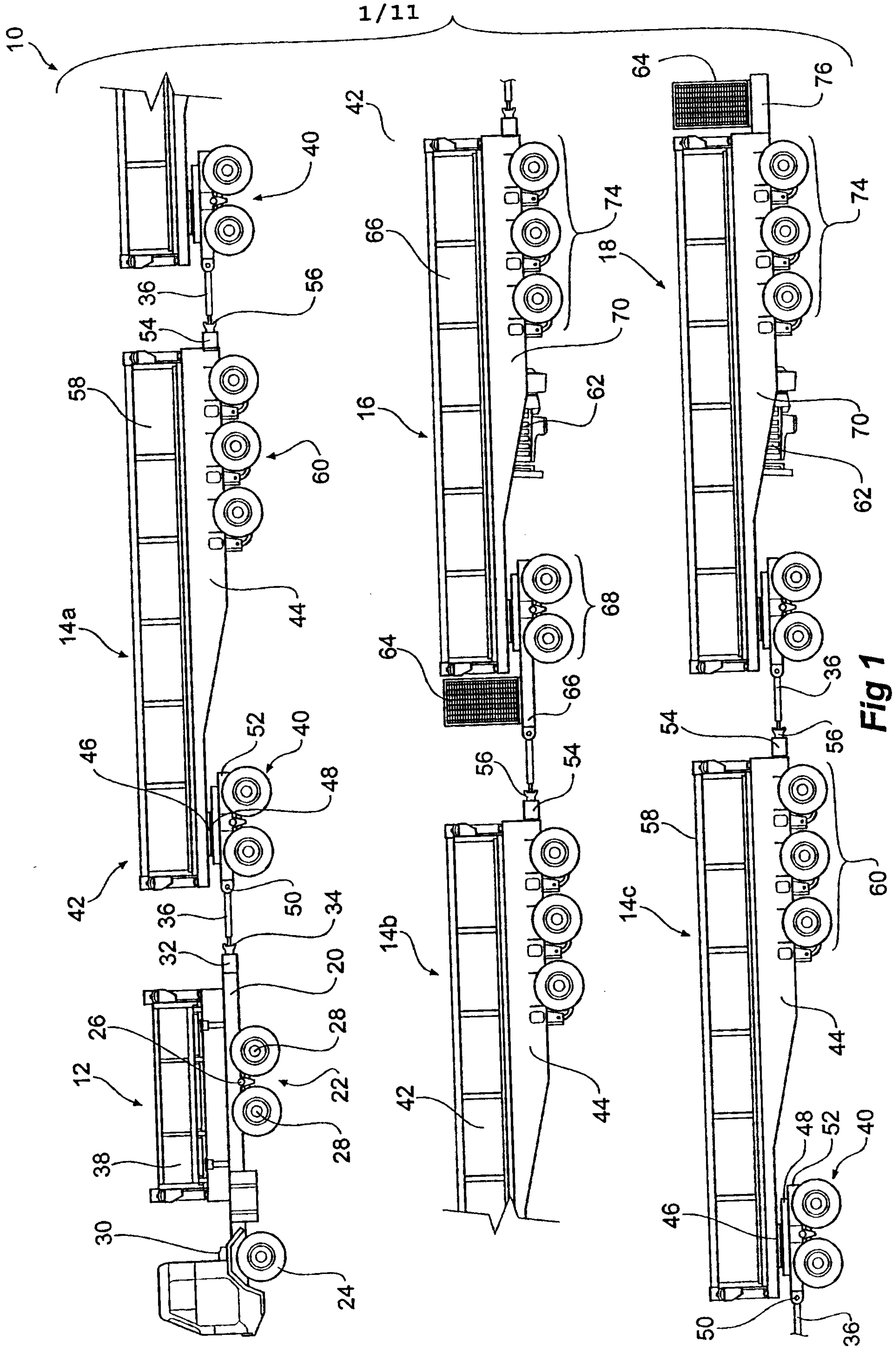
a third engine having a third electric power source, said third engine being mounted on and drivingly coupled to one of said trailers, said third engine having a third electronic control module powered by said third electric power source ;

15 said variable output of said electronic throttle control being representative of a desired operation of said first engine, said second engine and said third engine;

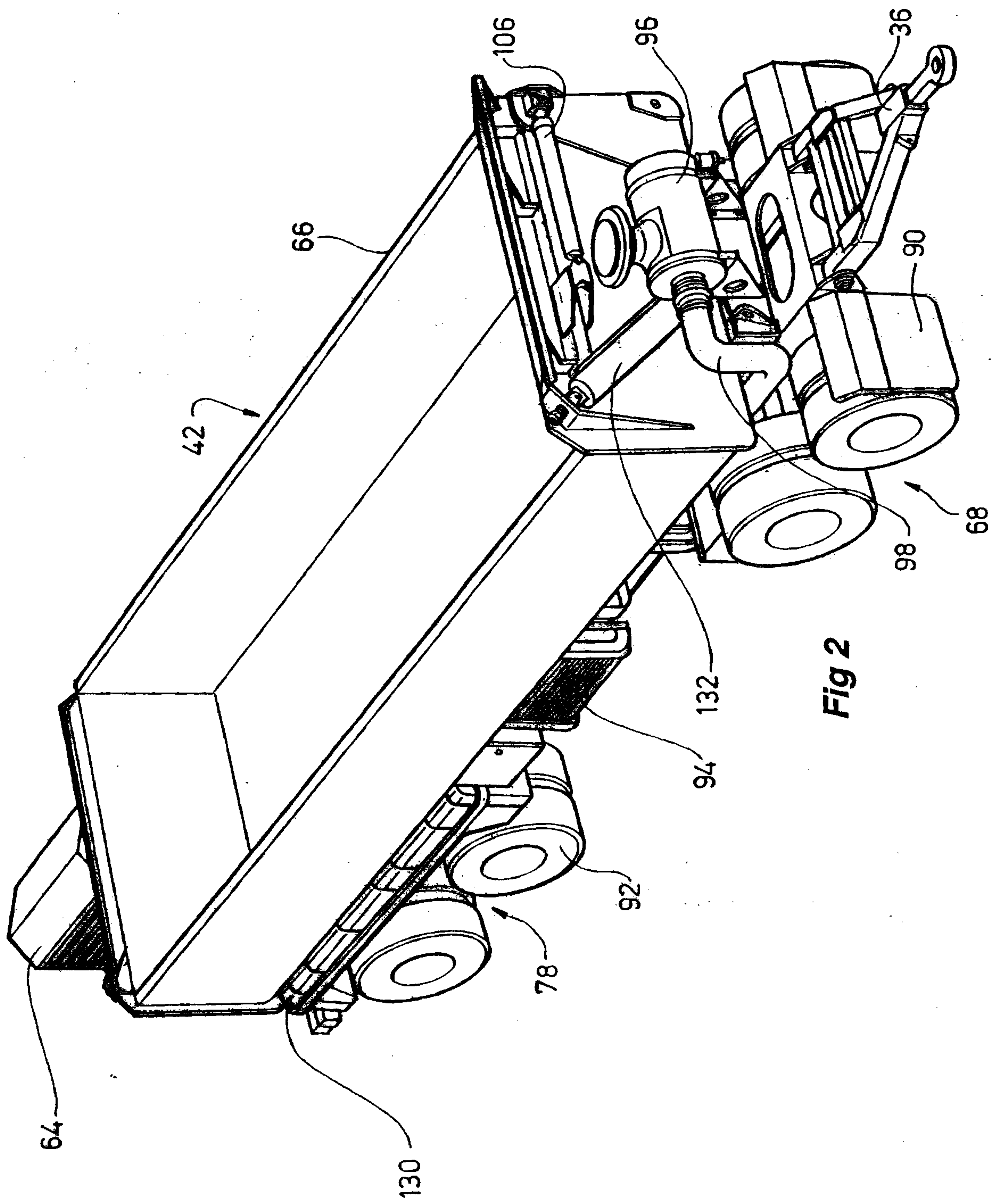
said throttle control module being provided power from said electronic control modules of said first engine, said second engine and said third engine and selectively providing power to said power input of said electronic throttle control from a selected
20 one of said electronic control modules;

said variable output of said electronic throttle control being in communication with at least said selected one of said electronic control modules and an additional one of said electronic control modules.

25



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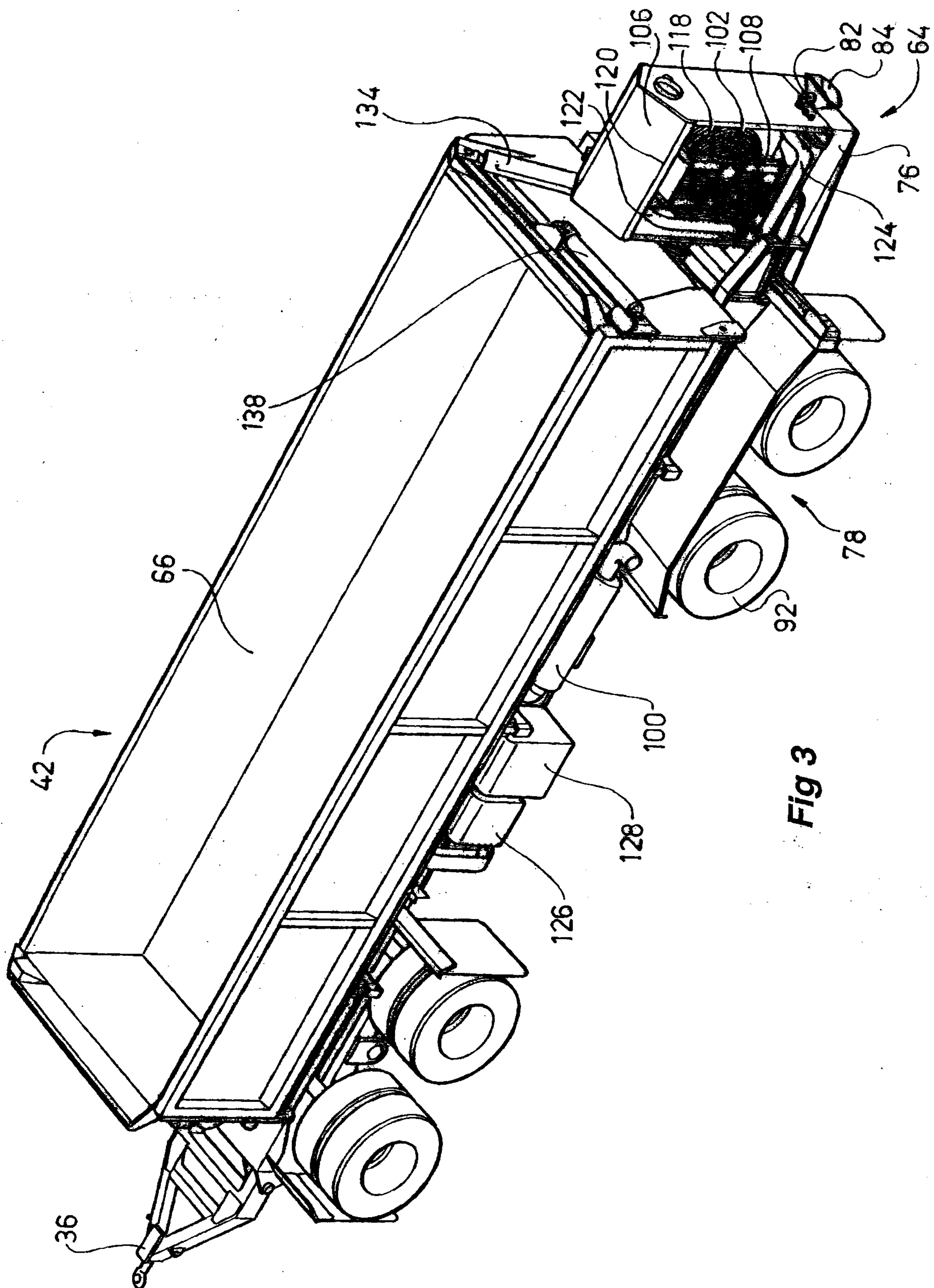


Fig 3

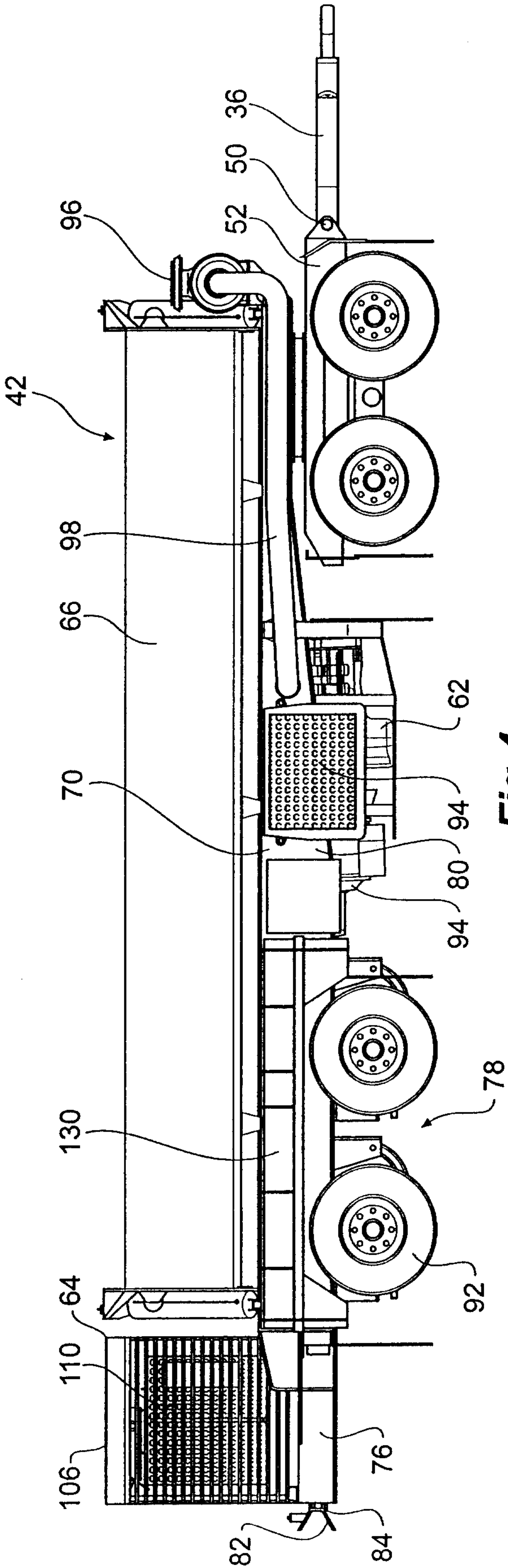


Fig 4

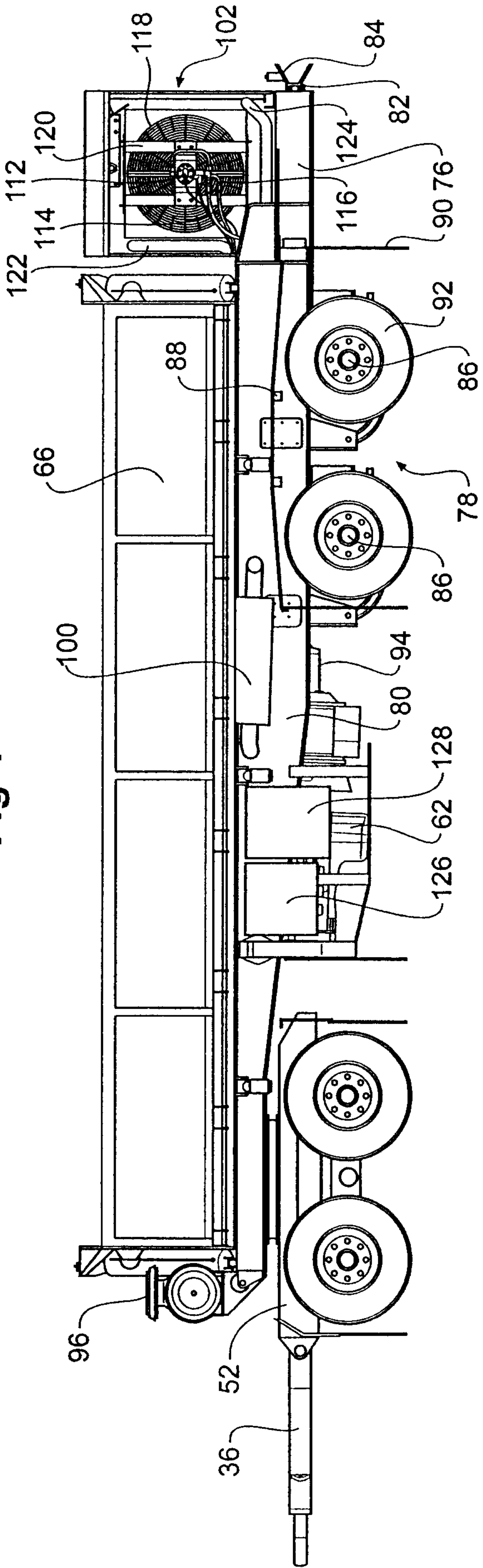


Fig 5

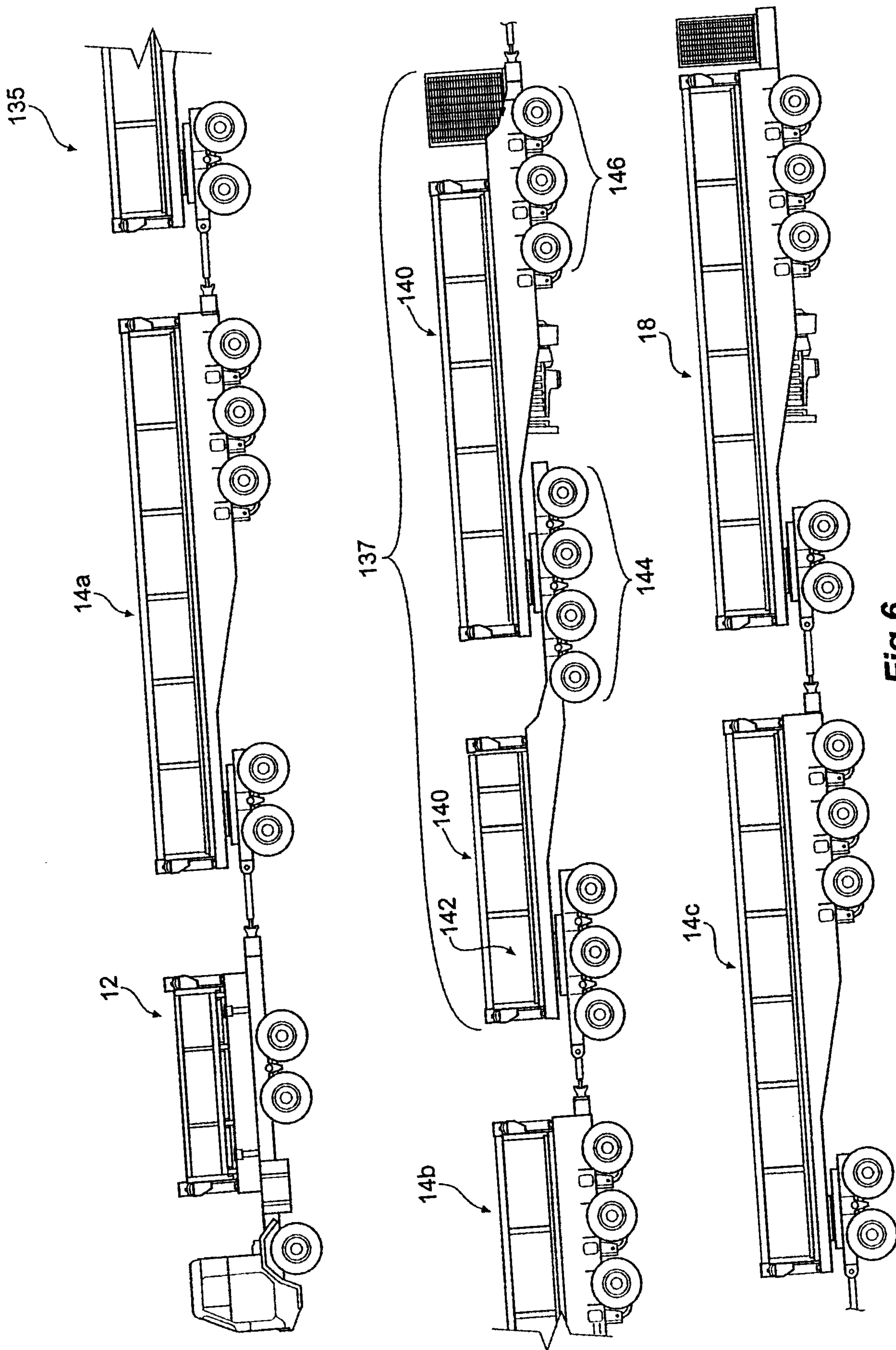
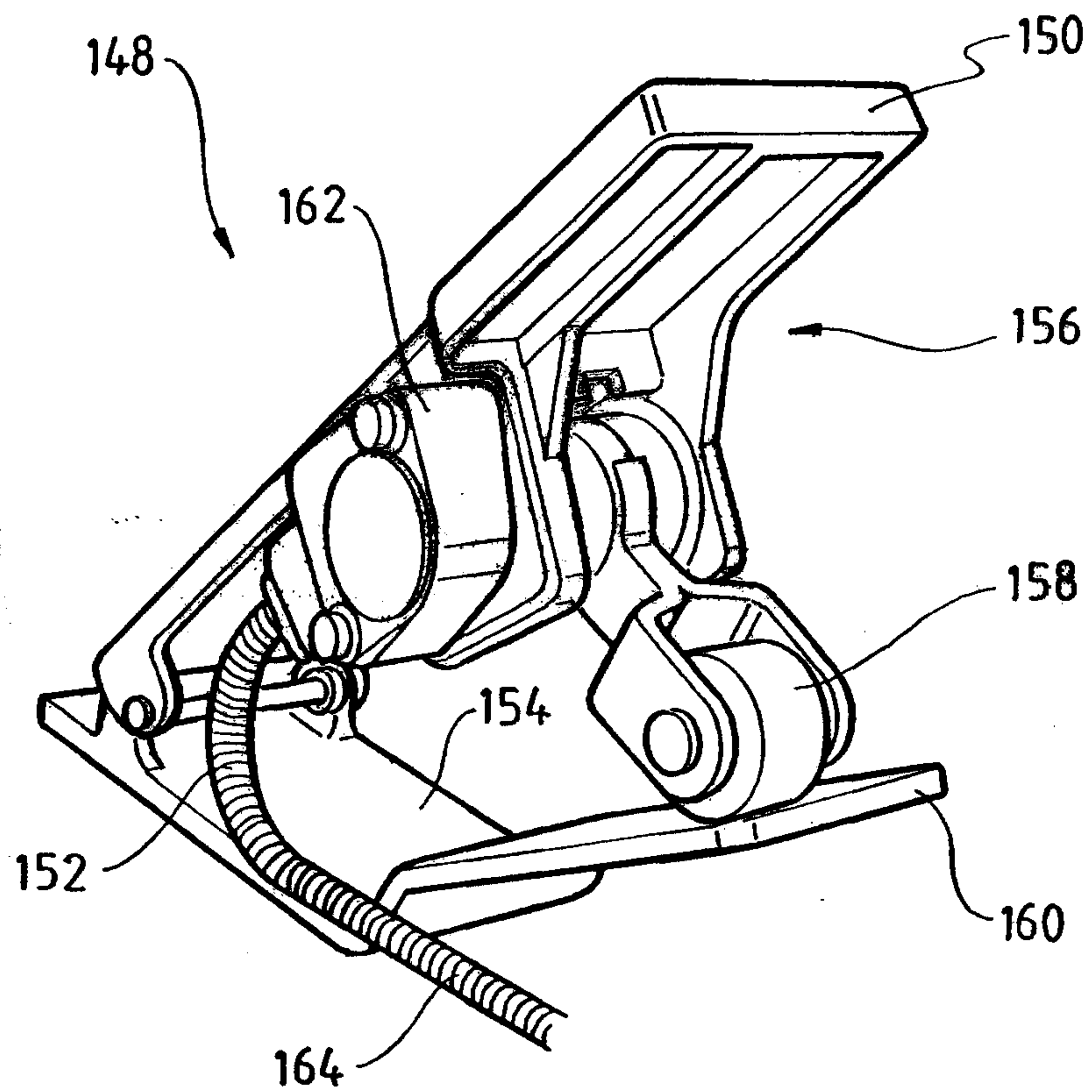


Fig 6

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**Fig 7**

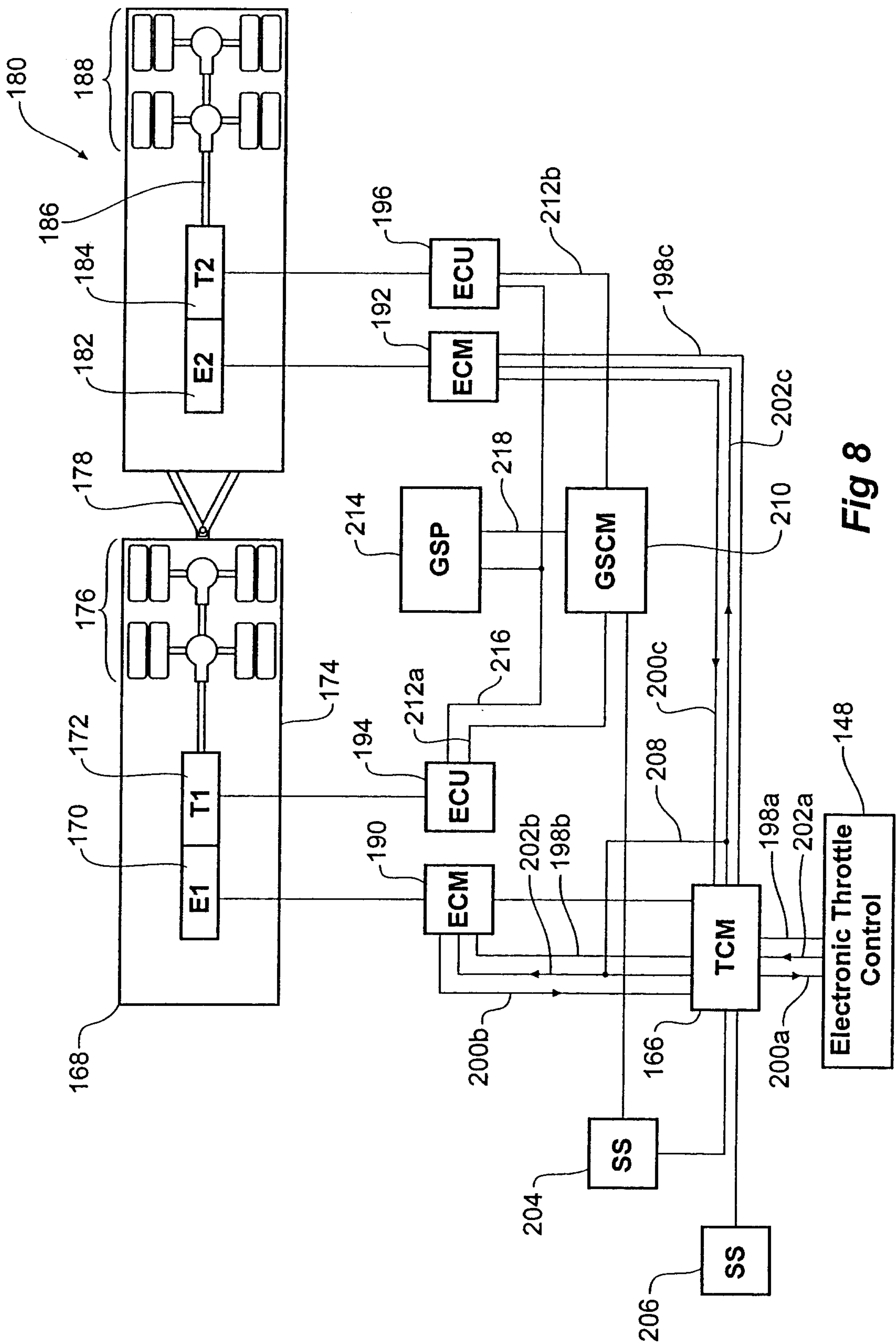


Fig 8

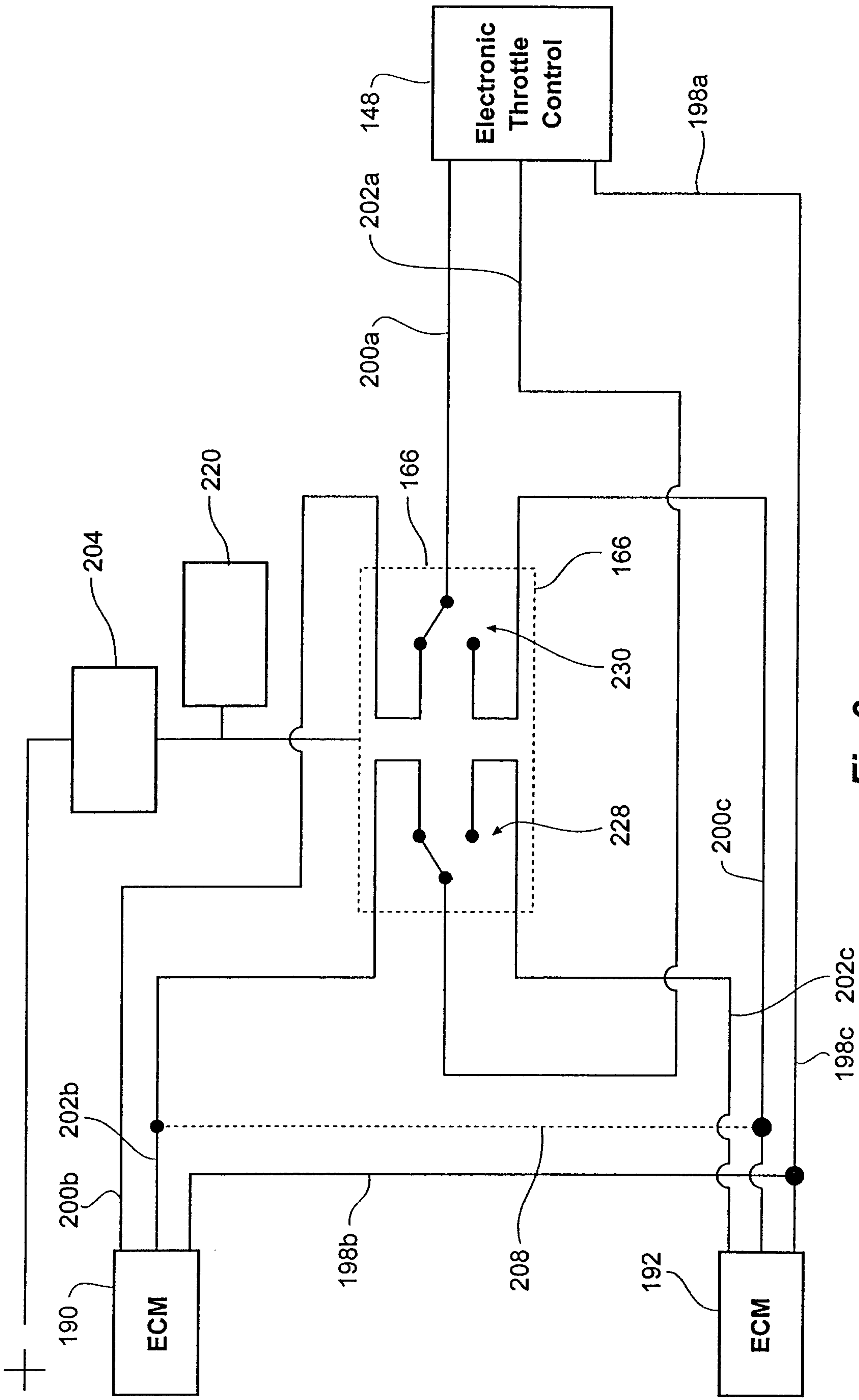


Fig 9

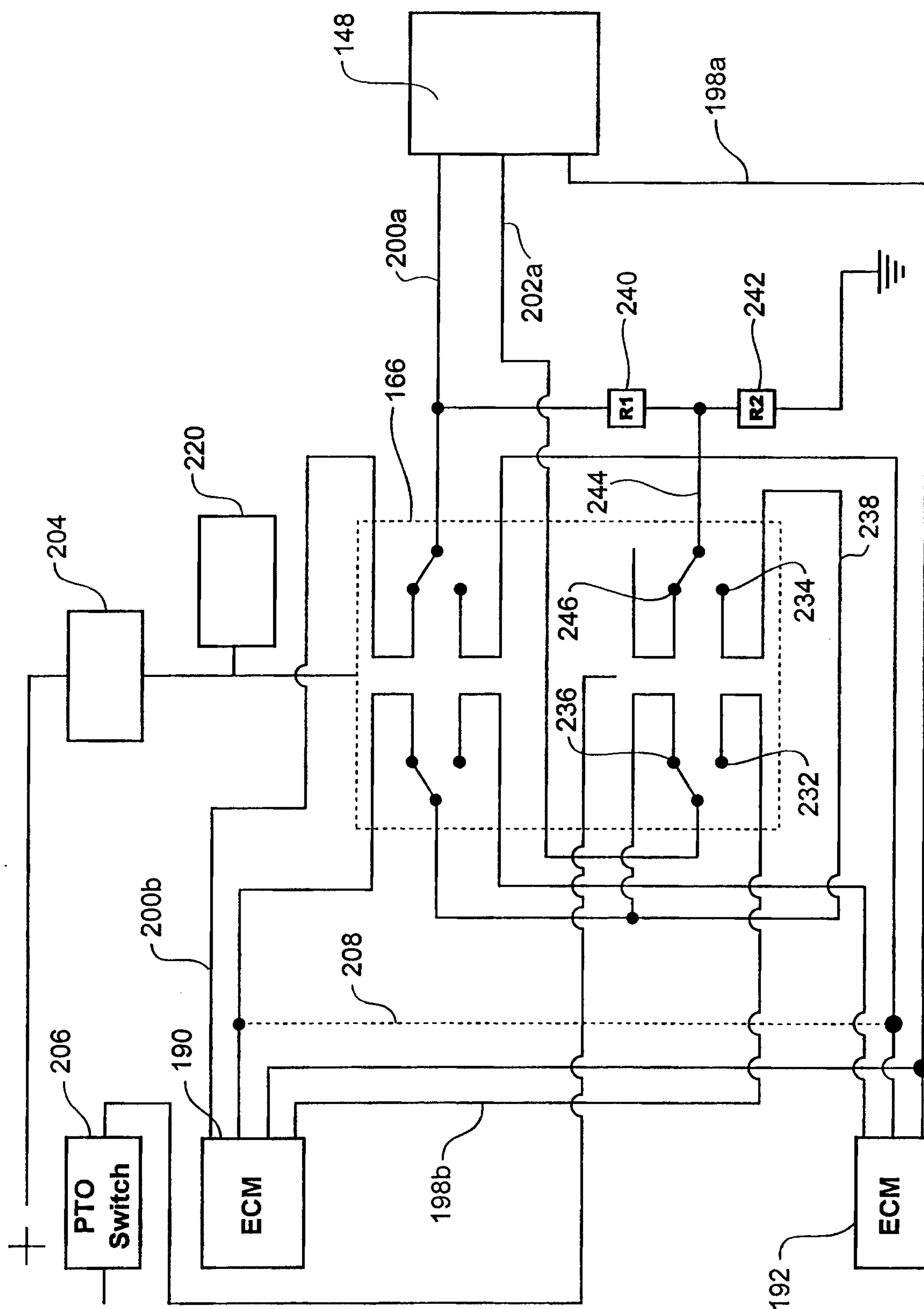


Fig 10

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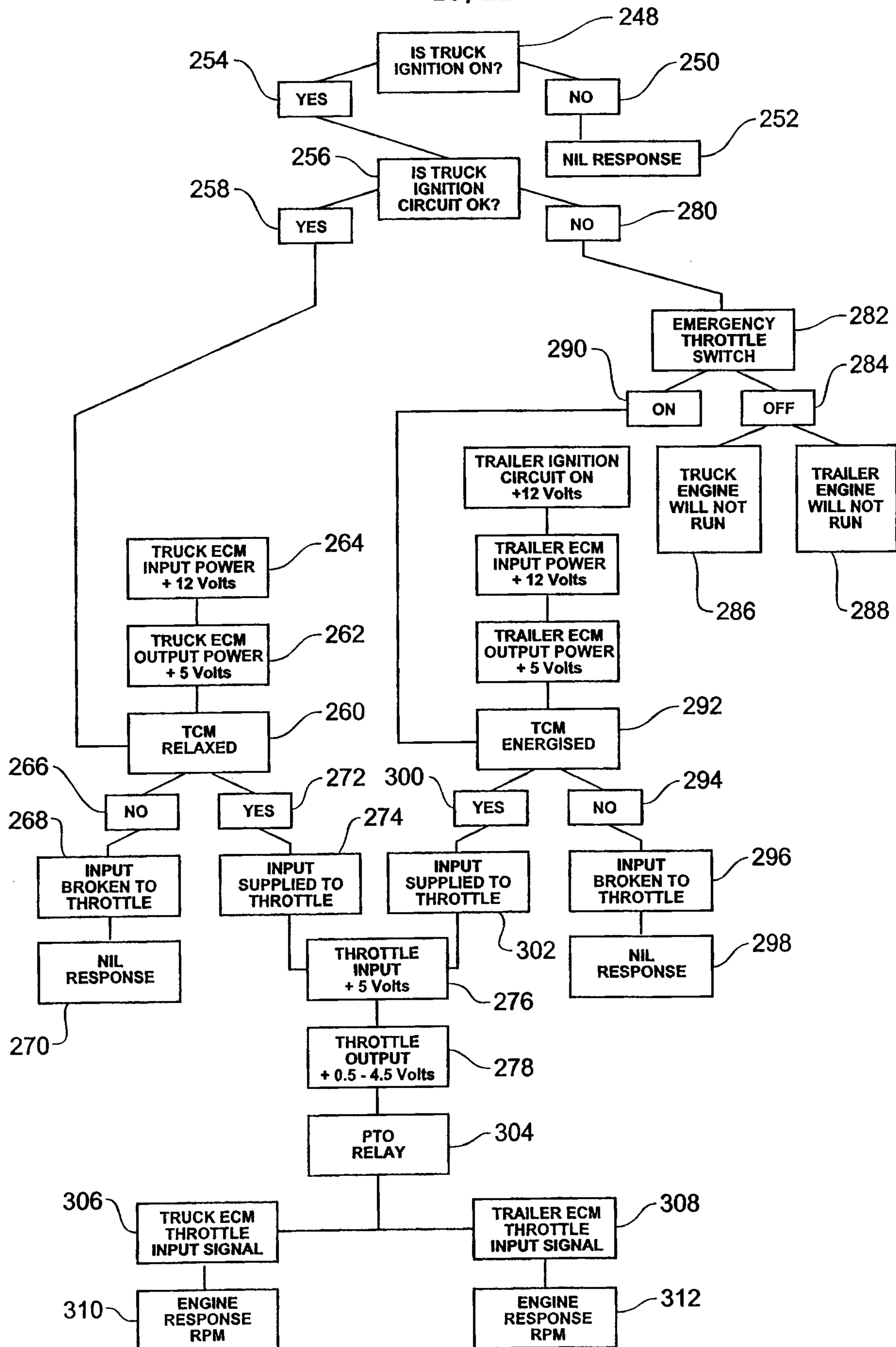
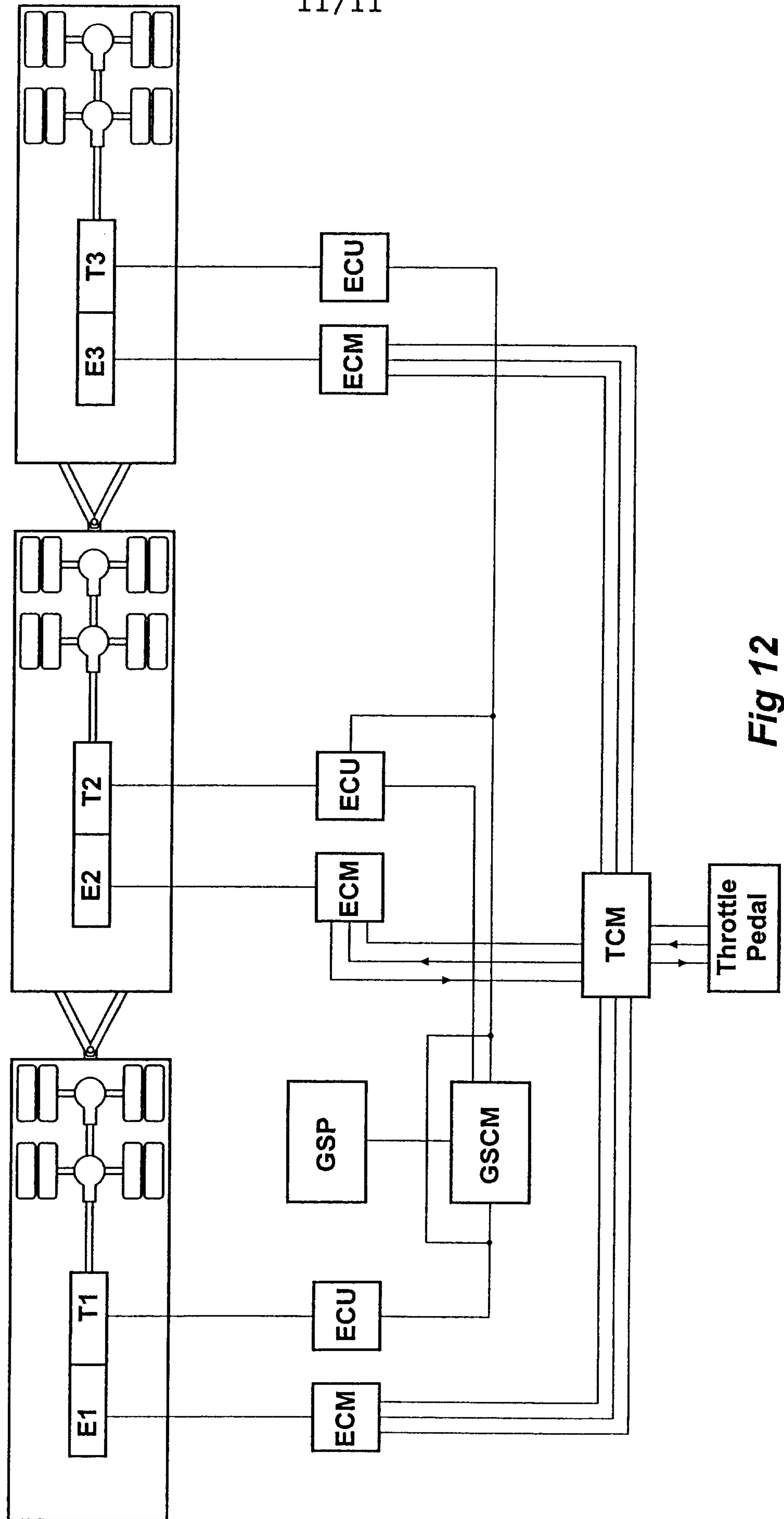


Fig 11

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**Fig 12**

