Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2184593 C 2004/11/09

(11)(21) 2 184 593

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 1995/03/01
(87) Date publication PCT/PCT Publication Date: 1995/09/08
(45) Date de délivrance/Issue Date: 2004/11/09
(85) Entrée phase nationale/National Entry: 1996/08/30
(86) N° demande PCT/PCT Application No.: US 1995/002693
(87) N° publication PCT/PCT Publication No.: 1995/023919
(30) Priorité/Priority: 1994/03/01 (08/203,414) US

(51) Cl.Int.^{6}/Int.Cl.^{6} F02B 65/00, F02N 7/10, F02B 73/00

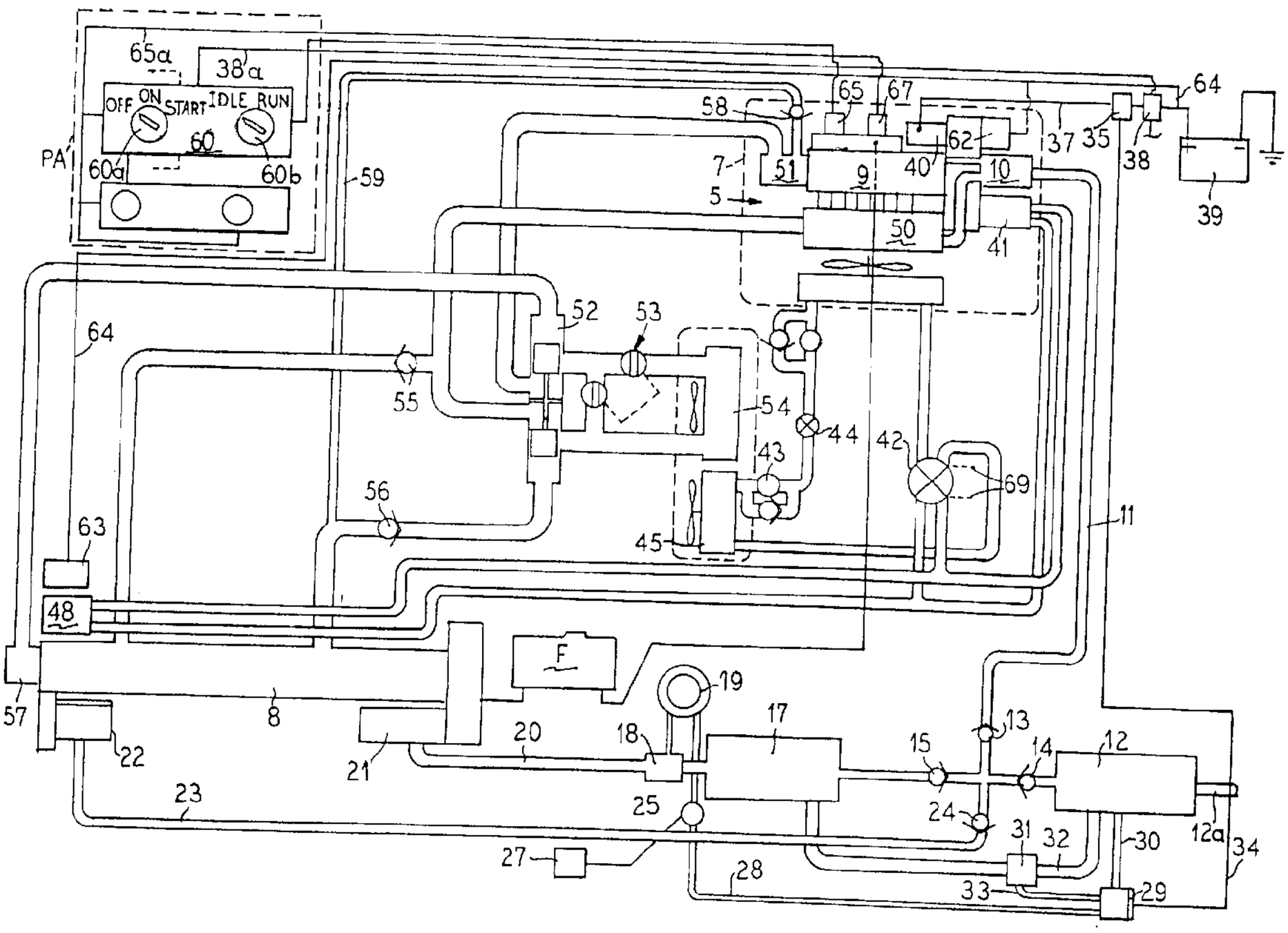
(72) Inventeur/Inventor:
WILLIS, GUY E., US

(73) Propriétaire/Owner:
AUXILIARY POWER DYNAMICS, LLC, US

(74) Agent: RICHES, MCKENZIE & HERBERT LLP

(54) Titre : SYSTEME COMPACT DE FOURNITURE D'ENERGIE AUXILIAIRE POUR MOTEUR DIESEL DE GRANDE PUISSANCE

(54) Title: SMALL COMPACT AUXILIARY POWER SYSTEM FOR HEAVY DUTY DIESEL ENGINE INSTALLATIONS



(57) Abrégé/Abstract:
An auxiliary diesel engine powering system (5) replaces conventional battery pack for starting a heavy duty diesel engine (8) with a pneumatic starter (21) utilizing compressed air (17) generated by an air compressor (10) operated by the auxiliary power system (5). The auxiliary power system (5) also has air-conditioning and coolant circulation capacity through the user of an air conditioner compressor (41) and a coolant circulation pump (41).

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F02B 73/00, F02N 7/00, 7/10 — A1

(11) International Publication Number: WO 95/23919

(43) International Publication Date: 8 September 1995 (08.09.95)

(21) International Application Number: PCT/US95/02693

(22) International Filing Date: 1 March 1995 (01.03.95)

(30) Priority Data:
08/203,414 1 March 1994 (01.03.94) US

(71) Applicant: AUXILIARY POWER DYNAMICS, LLC [US/US]; P.O. Box 70280, Reno, NV 89570 (US).

(72) Inventor: WILLIS, Guy, E.; 2565 Camelot Way, Reno, NV 89509 (US).

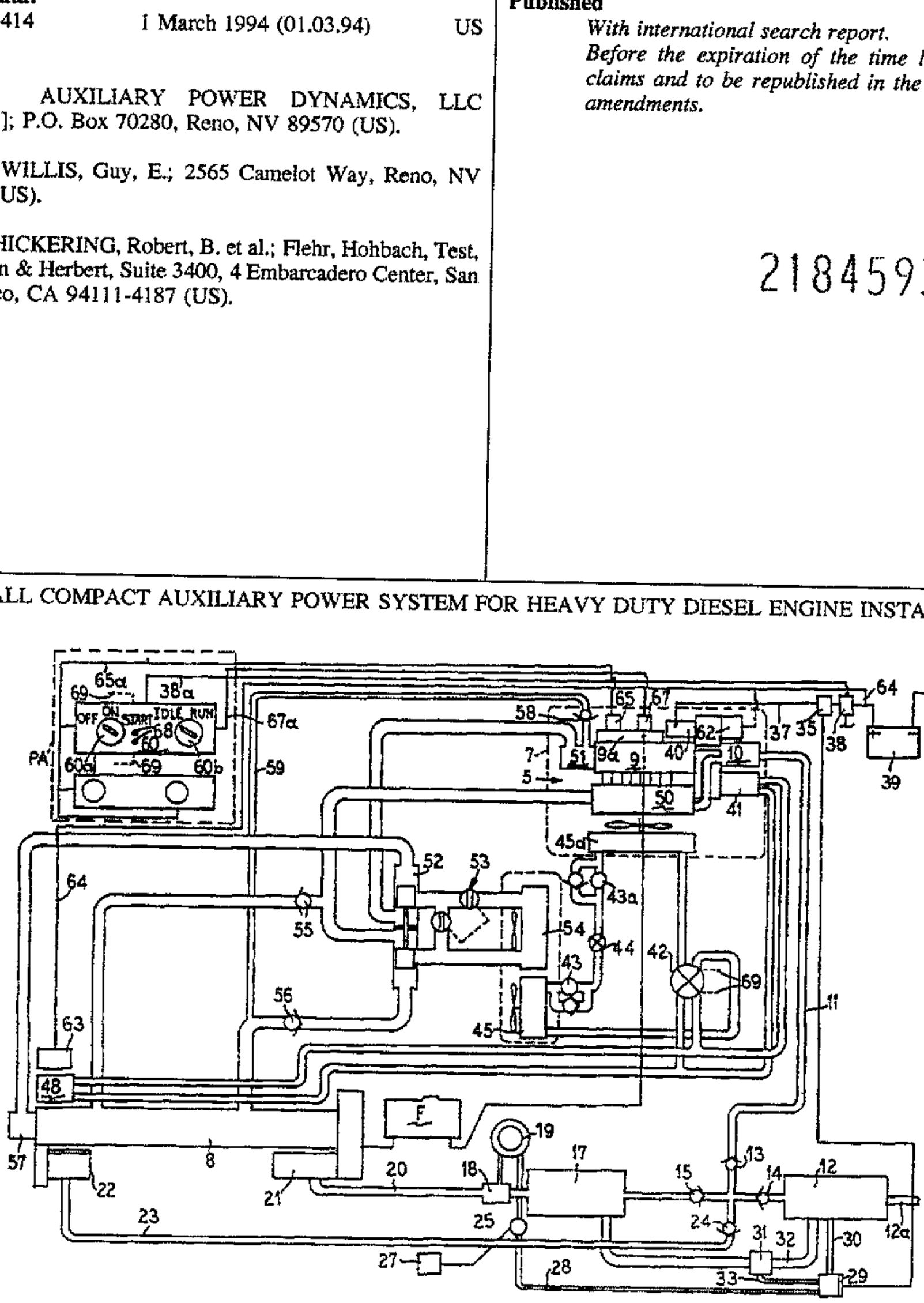
(74) Agents: CHICKERING, Robert, B. et al.; Flehr, Hohbach, Test, Albritton & Herbert, Suite 3400, 4 Embarcadero Center, San Francisco, CA 94111-4187 (US).

(81) Designated States: BR, CA, MX, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

2184593

(54) Title: SMALL COMPACT AUXILIARY POWER SYSTEM FOR HEAVY DUTY DIESEL ENGINE INSTALLATIONS



(57) Abstract

An auxiliary diesel engine powering system (5) replaces conventional battery pack for starting a heavy duty diesel engine (8) with a pneumatic starter (21) utilizing compressed air (17) generated by an air compressor (10) operated by the auxiliary power system (5). The auxiliary power system (5) also has air-conditioning and coolant circulation capacity through the user of an air conditioner compressor (41) and a coolant circulation pump (41).

SMALL COMPACT AUXILIARY POWER SYSTEM FOR HEAVY DUTY DIESEL ENGINE INSTALLATIONS

Background of the Invention

The present invention relates to improvements in diesel power systems, and is more particularly concerned with a small compact auxiliary power system for heavy duty diesel engine installations.

Although there have been proposed auxiliary power apparatus for association with the main drive diesel engines of heavy duty vehicles, such as large commercial haulage trucks, such apparatus has been of "add-on" type, adding to the critical weight and space requirements of the vehicle. Payload weight and space savings are especially essential to the economics of the trucking industry, but also advantageous for other heavy duty diesel powered installations.

Summary of the Present Invention

An important object of the present invention is to provide a small, compact auxiliary system for heavy duty diesel engine installations, substantially without adding payload-reducing weight or space requirements to the associated installations.

Another object of the present invention is to provide a new and improved small compact auxiliary power system for heavy duty diesel engine installations, and which can be

accommodated within space made available by the elimination of conventional apparatus from such installations.

A further object of the present invention is to provide a new and improved small compact auxiliary power system for use with air starter-equipped heavy duty diesel engines installations.

Yet another object of the invention is to provide a new and improved multi-utility small, compact auxiliary power system for heavy duty diesel engine installations.

The present invention allows the main engine with which a small compact auxiliary diesel power system is associated, to be started with an air starter and permits the battery pack, usually consisting of four large batteries and related hardware in heavy duty diesel motivated apparatus to be eliminated from such apparatus and replaced by the auxiliary diesel engine power system. An economical means is provided for assuring air conditioned comfort to the cab and sleeper compartments of a road transportation truck and for maintaining operating temperatures for the main engine, and for maintaining electrical power when parked with the main engine shutdown. There is also provided a redundancy to the air, electrical and air conditioning systems integrated into the other systems in the assembly. If the air pressure in the main system reservoir drops to a minimum safe value while the vehicle is underway and the auxiliary system has been shut down, an emergency valve between a starting tank and an air reservoir is opened to immediately supply adequate air pressure; and the auxiliary engine starts automatically to supply additional air to the system. These events allow the operator of the associated heavy duty apparatus, e.g., truck, military tank, road building equipment, and the like, more than double the capability to bring a heavy and dangerous vehicle to a normal stop should a major air leak develop. Additional safety is provided for

a vehicle, for example, stranded in blizzard conditions or by a mechanical breakdown.

Because of the modest displacement of the small, fuel efficient, diesel engine powering the auxiliary system, fuel consumption and exhaust emission are held to a minimum. Since the large battery pack formerly required in such heavy duty equipment is eliminated, environmental improvement is effected. In addition, disposal of the large batteries, which are usually of the acid battery type, is avoided when their usual limited life is over.

Start-up of the one large main engine which can be maintained warm during shutdown, significantly reduces pollutants versus a cold engine. The small auxiliary engine is also easier to muffle and insulate for nose elimination.

The systems of the present invention are designed to use as many industry standard components as possible, thereby assuring reliability and compatibility.

Pursuant to the principles of the present invention, there is provided in combination with a heavy duty diesel engine installation, means providing a conventional apparatus space associated with such installation, a small compact auxiliary power system occupying said space instead of said conventional apparatus, and means cooperatively connecting said auxiliary power system with said heavy duty diesel engine installation.

In one aspect, the present invention provides in combination with a heavy-duty diesel engine installation: a space equivalent to four diesel engine batteries; a small compact

auxiliary power system occupying said space; and pneumatic means for creating and storing pneumatic energy in a compressed gas to start the diesel engine, said means receiving energy from said auxiliary power system.

In another aspect, the present invention provides in combination with a heavy-duty diesel engine installation: means providing a conventional apparatus-receiving space associated with such installation; a compact auxiliary power system occupying said space instead of said conventional apparatus; a pneumatic assembly cooperatively connecting said auxiliary power system with said heavy-duty diesel engine installation; and wherein said auxiliary power system comprises a diesel engine and operating equipment therefor, a compressor operated by said small diesel engine, and air storage reservoir supplied by said compressor.

In yet another aspect, the present invention provides an auxiliary power assembly for use with a heavy-duty diesel engine comprising: an auxiliary, internal combustion engine; an air compressor coupled to and driven by said internal combustion engine; a compressed air reservoir adapted to be mounted proximate said internal combustion engine and coupled to said air compressor for fluid communication therewith; said auxiliary engine and said air compressor having a combined volume not substantially greater than the combined volume of a battery pack for said heavy-duty diesel engine; and a pneumatic starter adapted to be mounted on and for starting said heavy-duty diesel engine and coupled to said air reservoir to receive compressed air from said air reservoir and said air compressor.

In yet a further aspect, the present invention provides a method of operating a heavy-duty diesel engine installation in a vehicle having a battery pack and a framework providing a battery pack space, comprising: removing said battery pack from said space; and installing in said space an auxiliary power unit, and connecting said auxiliary power unit and said heavy-duty diesel engine through an air supply system coupled to pneumatic starting assembly for said heavy-duty diesel engine.

In yet another further aspect, the present invention provides a method of retrofitting a heavy-duty diesel engine with an auxiliary power assembly, said heavy-duty diesel engine having an electric starter operably coupled to start said heavy-duty diesel engine and a battery assembly mounted in a space proximate said heavy duty diesel engine and electrically connected to said electric starter, said method comprised of the steps of: removing said electric starter from said heavy-duty diesel engine; removing said battery assembly from said space; coupling a pneumatic starter to said heavy-duty diesel engine; mounting an auxiliary power assembly including an independently operable auxiliary internal combustion engine coupled to drive a compressed gas generation assembly in said space, said auxiliary power assembly having an overall size not substantially greater than said battery assembly; and connecting said compressed gas generation assembly to said pneumatic starter for use in starting said heavy-duty diesel engine.

In another further aspect, the present invention provides a method of providing an auxiliary power assembly for a truck powered by a heavy-duty diesel engine comprising the steps of: coupling a pneumatic starter to said diesel

engine; mounting an auxiliary power assembly including an independently operable auxiliary engine coupled to drive a compressed gas generation assembly in said truck in a space not substantially greater than the space occupied by a conventional battery assembly for an electric starter for said diesel engine; and connecting said compressed gas generation assembly to said pneumatic starter for use in starting said diesel engine.

Brief Description of the Drawings

Other objects, features and advantages of the present invention will be readily apparent from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawing, although variations and modifications may be effected without

department from the spirit and scope of the novel concepts of the disclosure, and in which:

The figure is a schematic illustration of a best mode of the present invention.

Detailed Description

An auxiliary, small compact power system 5 is dimensioned to fit within the confines of a space provide by means 7 for accommodating conventional apparatus, such as a battery pack (not shown) customarily associated with large heavy duty main power source diesel engine 8 installations such as of the kind used for powering large vehicular units, e.g., over the road truck/tractors, military tanks, heavy road equipment such as tractors, loaders, graders, etc., especially where required to operate in frigid environments. Through this arrangement, instead of being an "add-on" system which increases the critical weight and space requirements in heavy duty equipment, the auxiliary power system of the present invention provides the distinct advantage of simply displacing and substituting for eliminated apparatus without adding any significant weight or requiring any new space. In the trucking industry, this has significant payload economies advantages. This will be especially appreciated when it is considered that the usual battery pack of four large batteries and related hardware are removed from within the space 7 in a truck in which the auxiliary system 5 of the present invention is installed. Such a battery pack may weigh as much as 250 pounds.

A primary component of the auxiliary system 5 is an auxiliary small diesel engine 9 which drives an air compressor 10 connected by pneumatic conduit means 11 to a compressed air reserve or reservoir tank 12 through check valves 13 and 14. In addition, the compressed air from the compressor 10 is supplied through a check valve 15 to a compressed air reservoir start tank 17 which is adapted to

supply compressed air through a start control valve 18 operated by a start switch 19 conveniently located, for example, in the cab of the associated vehicle. The compressed air is conducted by a duct 20 to an air starter 21 for starting the diesel engine 8. After the main power diesel engine 8 has been started, it operates an air compressor 22 connected by a pneumatic duct 23 and a check valve 24 with the air tanks 12 and 17.

Safety and control means associated with the compressed air tank arrangement include a control valve 25 operated by a speed sensor 27 in an air line 28 connected with a pressure (i.e. 120 psi) sensor 29 connected by an air duct 30 with the reserve air tank 12. An emergency air supply valve 31 is located in a duct 32 connecting the air tanks 12 and 17. Air duct means 33 connect the emergency air supply valve 31 and the pressure sensor 29. An electrical connection 34 operatively connects the pressure sensor 29 with an auxiliary engine auto-start 35 located in an electrical connection 37 between a start solenoid 38 and a small auxiliary engine battery 39 on one hand and an auxiliary engine starter 40 on the other hand.

A common diesel fuel source F supplies both the auxiliary engine 9 and the main power drive engine 8 through suitable fuel lines.

By virtue of the compressed air start tank 17, and the air starter 21, the main power plant engine 8 can be shut down when the associated equipment, e.g., heavy duty truck, military tank, road building equipment, marine equipment, etc., is out of service, even for a short time, with an attendant savings in fuel, avoidance of air pollution, and the like. The engine 8 can be quickly started by the operator activating the start switch 19 so that the start valve 18 is opened to release compressed air from the start tank 17 to the air starter 21 to start the engine 8.

With the auxiliary engine operated air compressor 10 constantly available and integrated into the air system of the vehicle, it allows repeated start attempts for the main engine 8 and gives redundancy, for example, to the brake system of the vehicle as by means of an air connection 12a from the tank 12. The air pressure in the tanks 12 and 17 is maintained at a minimum safe value while the vehicle is under way. When the auxiliary system including the engine or motor 9 is shut down, the emergency valve 31 will immediately open between the start tank 17 and the air reservoir tank 12 for immediately supplying air pressure if there is a drop in pressure in the air reservoir 12. The auxiliary engine or motor will start automatically to supply additional air to the system. These events allow the operator of a so-equipped vehicle more than double the capacity to bring the heavy, and possibly dangerous, vehicle to a normal stop should a major leak develop.

The auxiliary system also has the capability of maintaining a comfortable environment for the occupants of the associated vehicle for an extended period of time due to minimal fuel consumption by the auxiliary engine. Means for attaining these results may include an air conditioner compressor 41 through fluid/gas (previously freon CFC, now replaced in the industry by 134) lines through a reversing valve 42 to determine the direction of the 134 fluid/gas to a coil 45, a filter dryer 43, an expansion valve 44, a coil 45, and return to the compressor 41. The director of the 134 fluid/gas determines if heat or cooling is provided to the coil in the cab of the vehicle.

If the main engine 8, and compressor 48, are in use, both compressors 41 and 48 may operate in parallel.

The economy of this system provides additional environmental safety to the occupants of the vehicle if stranded in blizzard conditions or by a mechanical breakdown.

With the auxiliary engine 9 operating and the main engine 8 shut down, coolant exchange means for preheating the main engine 8 include a water pump 51 of the auxiliary engine 9, supplying coolant through a shuttle valve 52, by-pass valves 53 or heater core 54, check valve 56, main engine 8, check valve 55, exhaust heat exchanger 50, air compressor 10, and back through auxiliary engine 9.

With the main engine 8 operating and the auxiliary motor 9 shutdown, coolant exchange is by means of a water pump 57 of the main engine 8, through the shuttle valve 52, the bypass valves 53 or the heater core 54, the exhaust heat exchanger 50, the air compressor 10, the auxiliary engine 9 and back to the main engine 8 through a check valve 58 and a duct 59.

A small operator's panel 60 may be conveniently located, for example, in a panel area PA in a vehicle cab to facilitate access to control means for the system. To this end, an on-off switch 60a controls the auxiliary engine 9, by way of a connection leading to a shutdown solenoid 64 and including the battery 39. By way of a connection 38a, the start solenoid 38 and the starter 40 are controlled. The speed of the engine 8 is also controlled from this panel 60 by an idle run switch 60b controlling, through a connection 65a, throttle solenoid 65. Shutdown of the auxiliary motor 9 is also accomplished from this panel 60 by shutdown of the solenoid 64. Automatic shutdown is effected by means of sensors (not shown) for low oil pressure and high water temperature, indicated at display means that activate the shutdown solenoid 64. Other than in the small operator's panel area PA, and the start switch 19, operations are either automatic or controlled by heat and air conditioning controls that are normal to the vehicle in which the system is installed. Alternators 62 and 63 are connected by line 67 to the battery 39.

The integrated design of the compact power system 5 of the present invention permits the vehicle to complete its

mission or reach a repair station if a failure of the main air or generating units occurs.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the present invention.

What is claimed is:

1. In combination with a heavy-duty diesel engine installation:

a space equivalent to four diesel engine batteries;

a small compact auxiliary power system occupying said space; and

pneumatic means for creating and storing pneumatic energy in a compressed gas to start the diesel engine, said means receiving energy from said auxiliary power system.

2. A combination as defined in claim 1 wherein,

said auxiliary power system comprises a small diesel engine and operating equipment therefor.

3. A combination according to claim 1, including an air reservoir, and air compressor means operated by said auxiliary power system for pneumatically loading said air reservoir.

4. A combination according to claim 3, including air compressor means operated by said heavy duty diesel engine installation for maintaining the air pressure in said storage means when the heavy-duty diesel engine is operating.

5. A combination according to claim 1, including means operated by said auxiliary power system for air conditioning fluid and coolant fluid circulation purposes.

6. A combination according to claim 1, including heat exchanger means of said auxiliary power system integrated with a coolant system of said heavy-duty engine, and air-

conditioning system having air-conditioner compressors operated by respectively said heavy-duty diesel engine and said auxiliary power system.

7. A combination according to claim 1 wherein,

said means receiving energy from said auxiliary power system is a compressed gas accumulator fluid connected to a pneumatic starter formed for mounting on and starting of said heavy-duty diesel engine.

8. In combination with a heavy-duty diesel engine installation:

means providing a conventional apparatus-receiving space associated with such installation;

a compact auxiliary power system occupying said space instead of said conventional apparatus;

a pneumatic assembly cooperatively connecting said auxiliary power system with said heavy-duty diesel engine installation; and

wherein said auxiliary power system comprises a diesel engine and operating equipment therefor, a compressor operated by said diesel engine, and air storage reservoir supplied by said compressor.

9. A combination according to claim 8, wherein said heavy-duty diesel engine installation has an air starter, said air storage reservoir comprising a start tank for supplying air under pressure to said air starter, and an air reservoir comprising a brake tank connected with said start tank.

10. A combination according to claim 9, including a valve assembly for maintaining air pressure in said brake tank

above a predetermined threshold by dumping air pressure from said start tank to said brake tank.

11. A combination according to claim 8 wherein,

said means providing a conventional apparatus-receiving space is provided by a framework dimensioned to receive and support an assembly of lead-acid storage batteries.

12. A combination according to claim 11 wherein,

said framework is dimensioned to receive and support at least four lead-acid storage batteries of a size sufficient to start said heavy-duty diesel engine.

13. An auxiliary power assembly for use with a heavy-duty diesel engine comprising:

an auxiliary, internal combustion engine;

an air compressor coupled to and driven by said internal combustion engine;

a compressed air reservoir adapted to be mounted proximate said internal combustion engine and coupled to said air compressor for fluid communication therewith;

said auxiliary engine and said air compressor having a combined volume not substantially greater than the combined volume of a battery pack for said heavy-duty diesel engine; and

a pneumatic starter adapted to be mounted on and for starting said heavy-duty diesel engine and coupled to said air reservoir to receive compressed air from said air reservoir and said air compressor.

14. The auxiliary power assembly as defined in claim 13 wherein,

said auxiliary, internal combustion engine further is coupled to drive an oil lubrication pump formed for fluid coupling to an oil lubrication system of said heavy-duty diesel engine.

15. The auxiliary power assembly as defined in claim 13 wherein,

said auxiliary, internal combustion engine includes a liquid coolant pump formed for fluid coupling to a liquid coolant system of said heavy-duty diesel engine.

16. The auxiliary power assembly as defined in claim 13 wherein,

said auxiliary, internal combustion engine is an auxiliary diesel engine and said auxiliary diesel engine is formed for fluid coupling to a fuel supply for said heavy-duty diesel engine.

17. The auxiliary power assembly as defined in claim 13 wherein,

said compressed air reservoir is provided by an accumulator.

18. The auxiliary power assembly as defined in claim 13 wherein,

said compressed air reservoir is a start tank formed for fluid coupling to a main air compressor driven by said heavy-duty diesel engine.

19. The auxiliary power assembly as defined in claim 18, and

a brake tank air reservoir fluid coupled to receive compressed air from said main air compressor and from said

air compressor coupled to said auxiliary, internal combustion engine.

20. The auxiliary power assembly as defined in claim 19, and

a pressure sensor coupled to sense pressure in said start tank and said brake tank;

a speed sensor positioned to sense a speed of a vehicle in which said main engine is mounted;

a valve assembly coupled to said pressure sensor and said speed sensor and responsive to both of a sensed pressure below a predetermined threshold in said brake tank and a sensed vehicle speed, to communicate pressure in said start tank to said brake tank.

21. The auxiliary power assembly as defined in claim 20, and

an automated start assembly coupled to said auxiliary engine to start said auxiliary engine when said valve assembly communicates pressure from said start tank to said brake tank.

22. A method of operating a heavy-duty diesel engine installation in a vehicle having a battery pack and a framework providing a battery pack space, comprising:

removing said battery pack from said space; and

installing in said space an auxiliary power unit, and connecting said auxiliary power unit and said heavy-duty diesel engine through an air supply system coupled to pneumatic starting assembly for said heavy-duty diesel engine.

23. A method according to claim 22 wherein, said pneumatic

starting assembly comprises an air reservoir tank and a starting supply tank and said air supply system comprises an air compressor and said method comprises the step of pneumatically loading said air reservoir tank and said starting supply tank with said air compressor.

24. A method according to claim 22 which includes operating air-conditioning and coolant circulation systems by running said auxiliary power unit.

25. A method of retrofitting a heavy-duty diesel engine with an auxiliary power assembly, said heavy-duty diesel engine having an electric starter operably coupled to start said heavy-duty diesel engine and a battery assembly mounted in a space proximate said heavy duty diesel engine and electrically connected to said electric starter, said method comprised of the steps of:

removing said electric starter from said heavy-duty diesel engine;

removing said battery assembly from said space;

coupling a pneumatic starter to said heavy-duty diesel engine;

mounting an auxiliary power assembly including an independently operable auxiliary internal combustion engine coupled to drive a compressed gas generation assembly in said space, said auxiliary power assembly having an overall size not substantially greater than said battery assembly; and

connecting said compressed gas generation assembly to said pneumatic starter for use in starting said heavy-duty diesel engine.

26. The method as defined in claim 25 wherein,

said mounting step is accomplished by mounting an auxiliary power assembly in said space which is comprised of an auxiliary internal combustion engine coupled to drive an air compressor; and said connecting step is accomplished by connecting said air compressor for communication of compressed air to an air storage reservoir fluid coupled to said pneumatic starter.

27. The method as defined in claim 26 wherein,

said mounting step is accomplished by mounting an auxiliary internal combustion engine in said space which is an auxiliary diesel engine, and the step of:

coupling said auxiliary diesel engine to receive fuel from a fuel source for said heavy-duty diesel engine.

28. The method as defined in claim 26 wherein,

said mounting step is accomplished by mounting an auxiliary power assembly and an oil pump in said space, and the step of:

connecting said oil pump to pressurize oil in said heavy-duty diesel engine.

29. The method as defined in claim 28 wherein,

said mounting step is accomplished by mounting an auxiliary power assembly including a coolant pump in said space, and the step of:

connecting said coolant pump to pump coolant from a coolant system for said auxiliary internal combustion engine to a coolant system for said heavy-duty diesel engine and to pump coolant from said coolant system for said heavy-duty diesel engine to said auxiliary internal combustion engine.

30. The method as defined in claim 26 wherein,

said mounting step is accomplished by mounting an auxiliary power assembly including a coolant pump in said space, and the step of:

connecting said coolant pump to pump coolant from a coolant system for said auxiliary internal combustion engine to a coolant system for said heavy-duty diesel engine and to pump coolant from said coolant system for said heavy-duty diesel engine to said auxiliary internal combustion engine.

31. A method of providing an auxiliary power assembly for a truck powered by a heavy-duty diesel engine comprising the steps of:

coupling a pneumatic starter to said diesel engine;

mounting an auxiliary power assembly including an independently operable auxiliary engine coupled to drive a compressed gas generation assembly in said truck in a space not substantially greater than the space occupied by a conventional battery assembly for an electric starter for said diesel engine; and

connecting said compressed gas generation assembly to said pneumatic starter for use in starting said diesel engine.

32. The method as defined in claim 31, and during said mounting step, coupling a coolant system for said auxiliary engine to a coolant system for said diesel engine, coupling an oil pump driven by said auxiliary engine to an oil lubricating system for said diesel engine for maintaining pressure of oil in said auxiliary diesel engine, and coupling a refrigerant compressor and pump driven by said

auxiliary engine to a refrigerant system for said diesel engine.

33. The method as defined in claim 31 and the step of:

coupling said compressed gas generation assembly to provide compressed gas to a pneumatic system driven by said diesel engine.

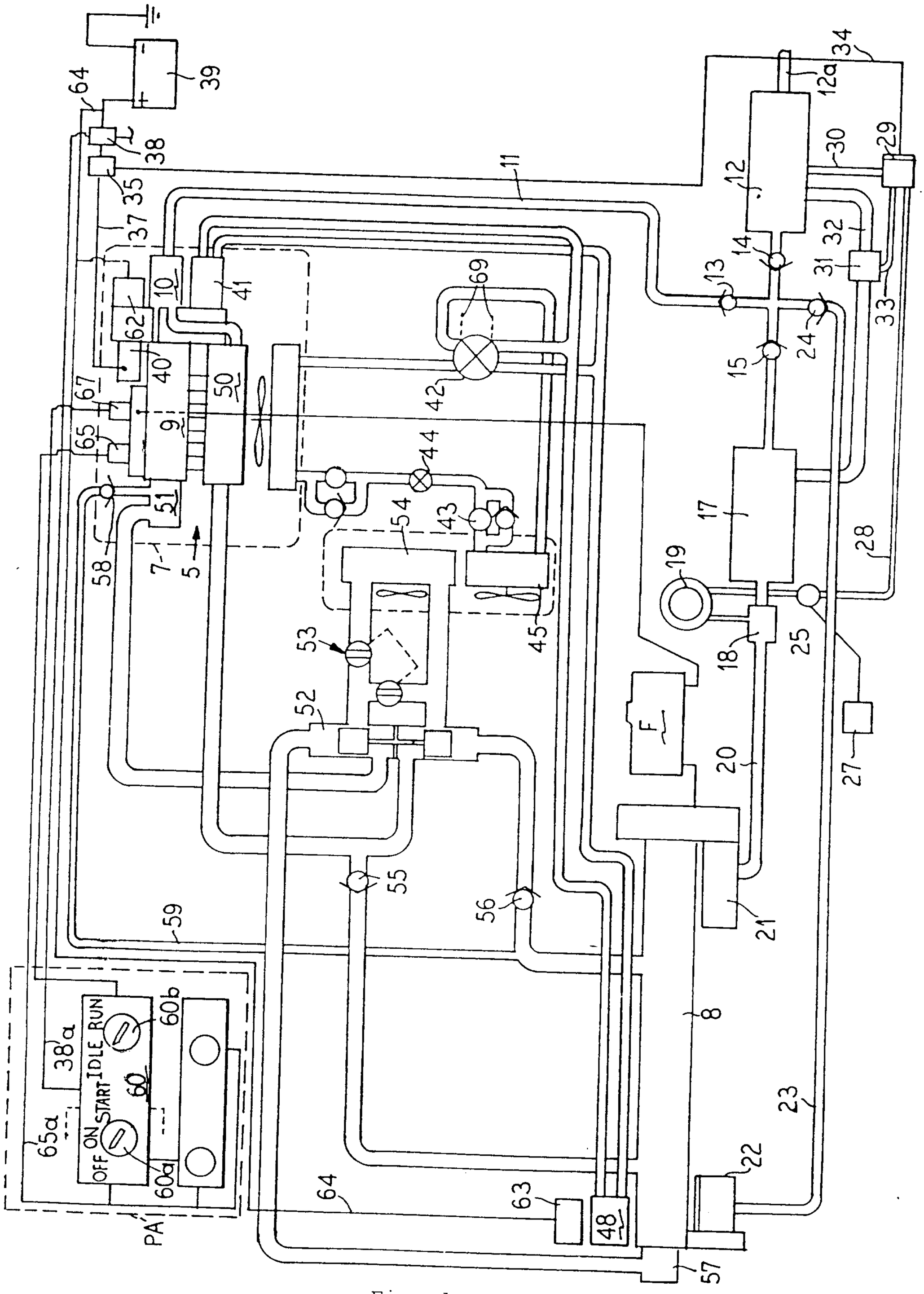
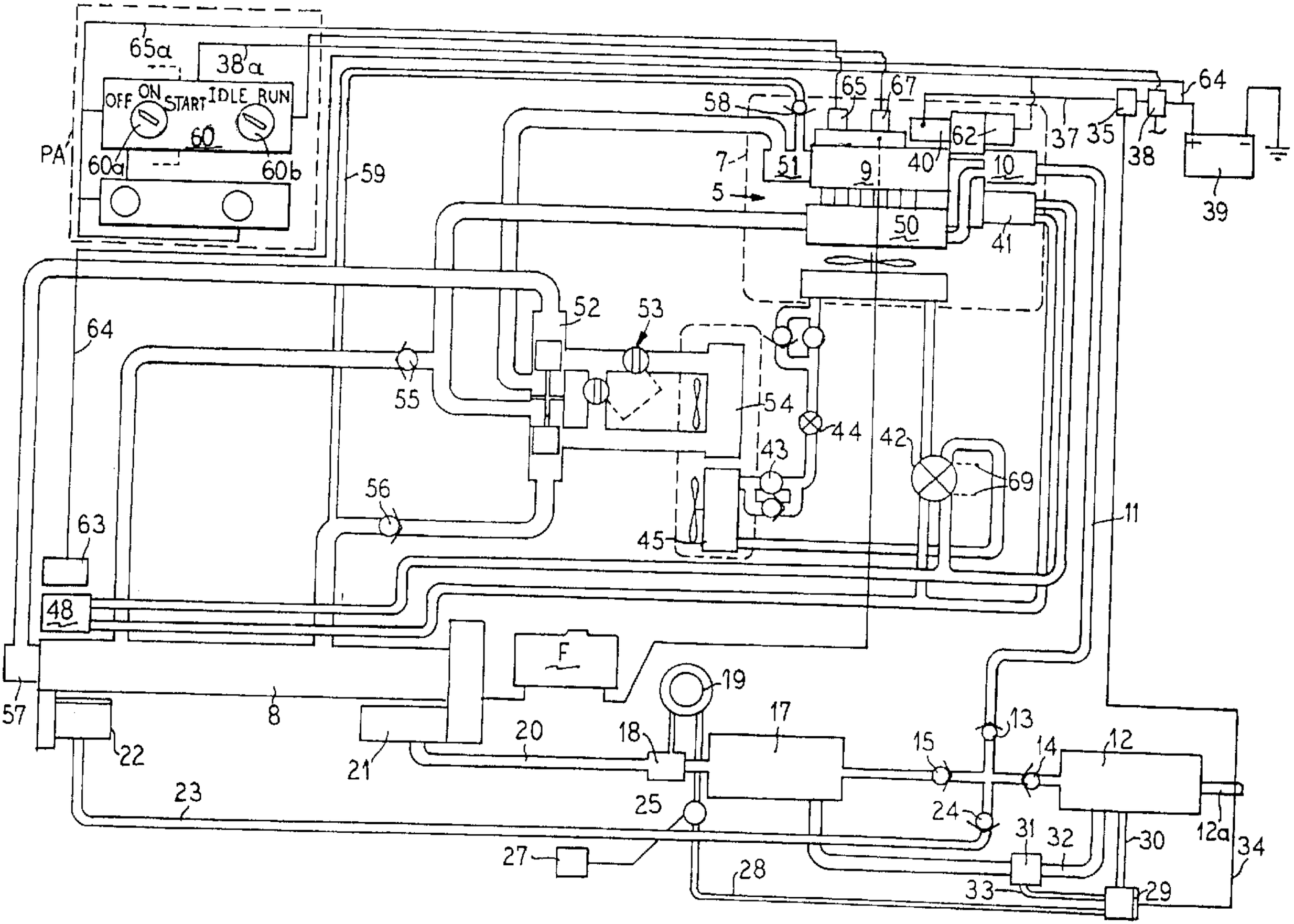

64
39
38
35
37
11
10
41
62
40
50
67
9
65
51
58
7
5
69
42
44
54
43
45
53
52
55
56
59
12a
34
30
29
12
14
32
31
13
24
33
15
17
19
28
18
25
F
20
21
27
8
23
22
63
48
57
38a
60b
60
60a
65a
OFF
ON
START
IDLE
RUN
PA

Fig. 1


65a
38a
OFF
ON
START
IDLE
RUN
60
60a
60b
PA
59
58
65
67
64
62
37
35
38
39
7
51
9
40
10
5
50
41
52
53
64
55
54
44
42
43
69
56
11
63
45
48
F
19
57
8
17
13
20
18
15
14
12
22
21
24
31
32
30
12a
34
23
25
27
28
33
29