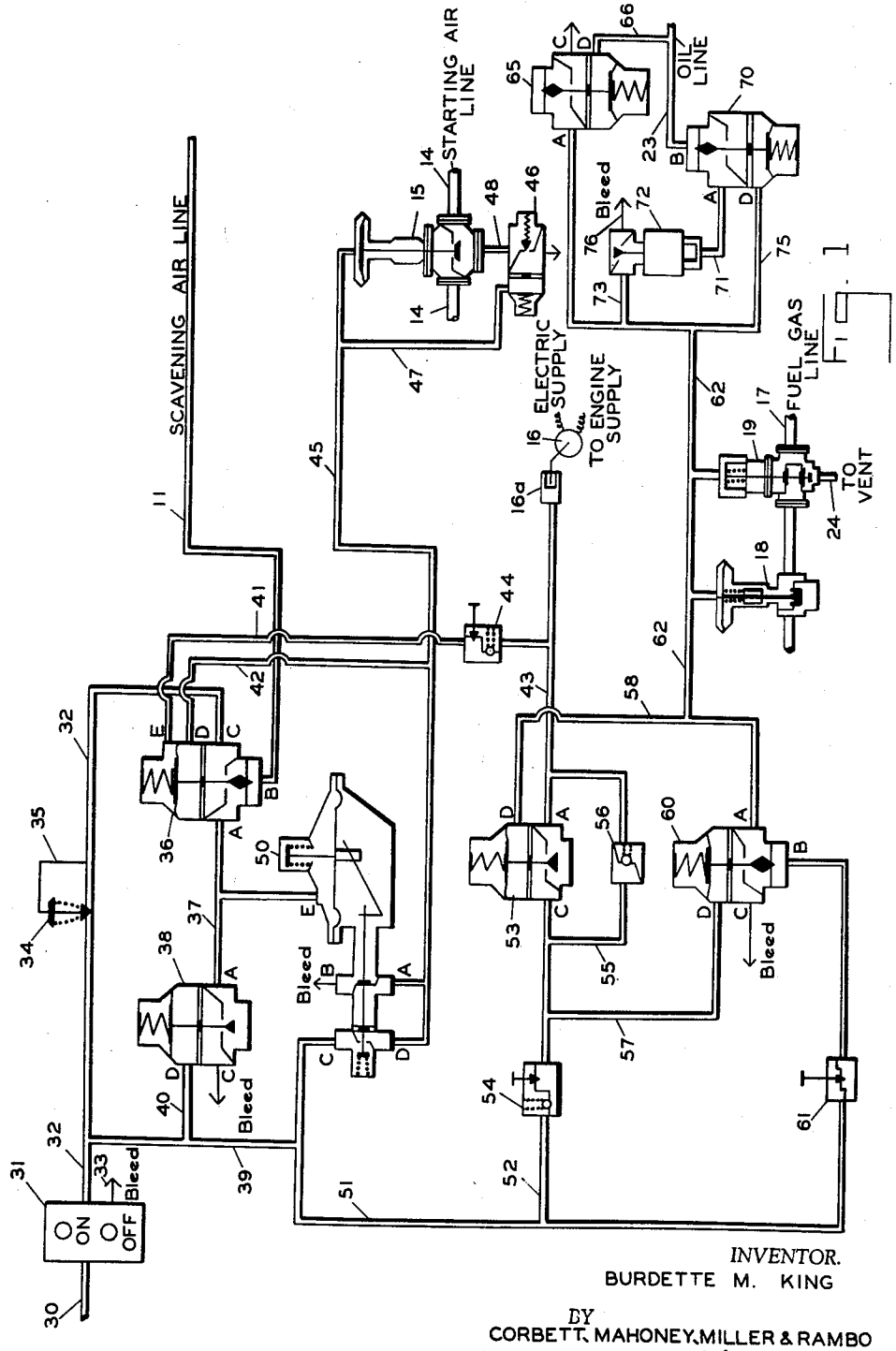
April 5, 1960 B. M. KING 2,931,166

SAFETY STARTING AND STOPPING SYSTEM OF THE PNEUMATIC TYPE FOR INTERNAL COMBUSTION ENGINES

Filed July 14, 1958

2 Sheets-Sheet 1



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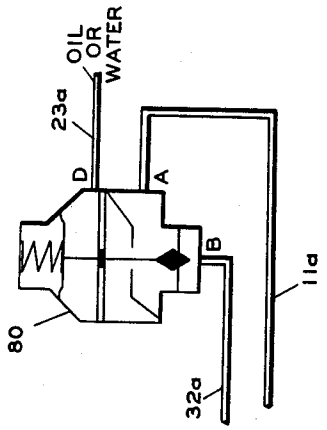

Fig 2

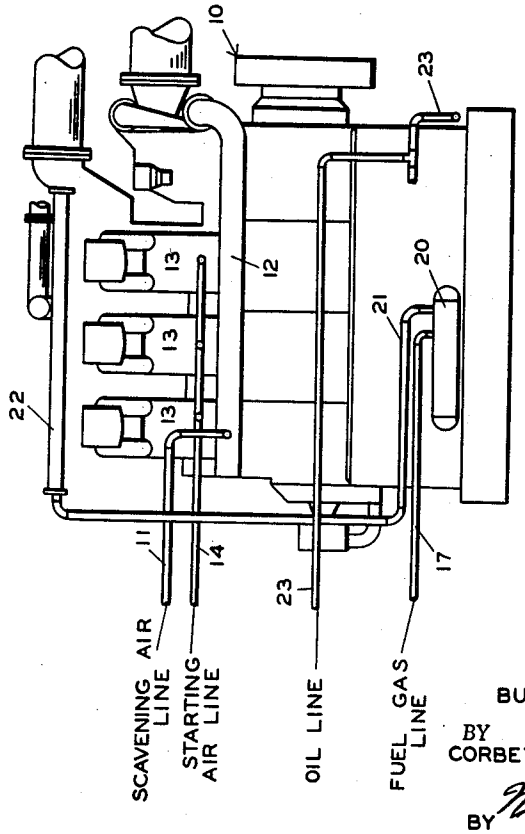

Fig 1a

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SAFETY STARTING AND STOPPING SYSTEM OF THE PNEUMATIC TYPE FOR INTERNAL COMBUSTION ENGINES

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12 Claims. (Cl. 60—16)

My invention is especially applicable for use with large heavy engines of the internal combustion type, such as engines which employ fuel gas as the fuel, liquid gasoline as the fuel, or diesel oil as the fuel, and particularly those engines of the cylinder and piston type where air under pressure is used for turning over the engine in the starting operation. My invention will be described hereinafter with particular reference to an internal combustion engine which uses fuel gas, but it is to be understood that it is not necessarily limited thereto.

A fuel gas engine of the type in question is usually started manually and the normal starting sequence requires the following-indicated seven manual operations:

(1) Reset the oil safety control which has dropped open due to no oil pressure when the engine was shut down.

(2) Close the vent valve between the air starting valve and the air injection valves in the cylinder heads.

(3) Turn on the starting air.

(4) Turn on the ignition switch.

(5) Turn on the fuel gas slowly.

(6) When it is determined that the engine is firing, turn off the starting air valve.

(7) Open the vent valve in the starting line to relieve the back pressure to the injection valves.

To shut down the engine, the following operations must be performed manually:

(8) Turn off the fuel gas.

(9) Turn off the ignition switch.

According to my invention, the actuation of various control components connected to the engine to accomplish the above-indicated nine operations is brought about automatically by my pneumatic control system by merely turning off or on a master air switching valve. My pneumatic control system is of the interlocking type so as to insure a predetermined proper sequence of operations in the starting and stopping of the engine. Due to a special interlocking arrangement in my safety pneumatic control system, the starting and stopping operations will always be in the said proper sequence. This will insure that in starting the engine, the ignition will come on before the fuel gas is supplied to the engine, whereas in stopping the engine, it will insure that the flow of gas to the engine will stop before the ignition is turned off. Also, with this interlocking arrangement, the starting air is turned off automatically when the engine starts. With this safety control system of my invention, starting of the engine, after it goes down for any reason, will be prevented without first resetting the master switching valve to release the lock-out arrangement and reset the system for the proper starting sequence.

With my pneumatic control system, the engine starts in less time and considerable starting air is thereby saved. With the system once adjusted, the starting time is always the same and reliance on the human element in selecting the periods of wait before operating the different control valves and ignition switch is not necessary. Also, remote control of the engine is possible since it is merely

necessary to control the master air switching valve which may be a solenoid actuated valve.

The accompanying drawing is a diagrammatic illustration of my invention applied to a fuel gas engine but as previously stated, my invention is not necessarily limited to this type of engine.

In the drawing:

Figure 1 is a schematic diagram of my pneumatic control system.

Figure 1*a* is a diagrammatic view of a fuel gas engine indicating how the system of Figure 1 is connected thereto.

Figure 2 illustrates a modification of the system.

In Figure 1*a*, I have illustrated an engine **10** as an example of an engine with which my pneumatic control system can be used. The engine itself is of the usual cylinder and piston type internal combustion engine which uses fuel gas as the fuel. It may, for example, be used for driving the compressor at a station for supplying pressure for a gas transmission line.

As shown in Figure 1*a*, this type of engine usually includes a scavenging air pressure line **11** which is connected to the scavenging air header **12** that is connected to the various cylinders **13** of the engine, and supplies thereto air under pressure from a suitable source for scavenging the cylinders. It also includes the starting air pressure line **14** which leads from a suitable source of starting air to the various cylinders **13** for supplying starting air thereto. As shown in Figure 1, this line **14** is controlled by a starting air valve **15** which is of the usual two-way type and is normally closed by spring pressure to interrupt flow through the line **14** and opened by pressure on the actuating diaphragm thereof. The engine also includes the ignition control electric switch **16** of the usual type which is shown in Figure 1 and which is connected in the ignition system of the engine so as to control it in the usual manner. For supplying fuel gas to the engine from a suitable source, it includes the usual fuel line **17**. This line is controlled by the pressure supplying valve **18** of the two-way type and by the vent valve **19** of the three-way type, both of which are shown in Figure 1 but which may be embodied in a single valve. The valve **18** is normally closed by spring pressure to interrupt flow through the line **17** and the valve **19** is normally set by spring pressure to connect the line **17** beyond the valve **18** to the vent **24**. As indicted in Figure 1*a*, the fuel line **17** connects to a fuel-supply tank **20** and the fuel line **21** leads therefrom to a manifold **22** which supplies fuel to the various cylinders **13**. As shown in Figure 1*a*, the engine may also have the usual oil pressure lubricating system to which the oil pressure line **23** is connected.

The control system of my invention is applied to the engine having the usual components as indicated above and is indicated in detail in Figure 1. The system comprises a source of pressure for actuating the various control components of my system, which I will term instrument air, and from which the line **30** leads. This line **30** connects to the master air switching valve **31** which may be of the three-way push button type, being connected to the instrument air line **32** and being provided with a bleed outlet **33**. When "off," this valve serves to connect line **32** to the bleed port **33** and to close the line **30**. When "on," it serves to connect the lines **30** and **32** and to disconnect both of them from the bleed port **33**. Thus, this master switch valve **31** can be manually operated to supply actuating air to the control system. However, if desired, the valve **31** may be of the solenoid-controlled type so that it can be actuated from a remote location.

A pressure regulator **34** is provided in the line **32** which is set to regulate the pressure in the line **32** above that of the scavenging air starting pressure. The pres-

sure-setting spring of the regulator 34 is opposed by pressure in the branch line 35 which is connected to the line 32 beyond the regulator 34. The line 32 is connected to the port C of an additional diaphragm-type three-way valve 36, the port A thereof being connected to a line 37 which connects to the port A of the diaphragm-type two-way bleed valve 38. The valve 36 is normally spring-set to connect ports A and C and disconnect port B from ports A and C. The line 37 is also conected to the actuating-pressure side, at the diaphragm port E, of a diaphragm valve 50 which is normally spring-set in the position shown in Figure 1. The port B of the valve 36 is connected to the scavenging air line 11 of the engine. The valve 38 is provided with a bleed outlet C. Normally, the ports A and C of the valve 38 are connected. Instrument air or actuating pressure is supplied to the valve 38 to close the valve by means of a line 39 branching from the line 32 between the master valve 31 and the regulator 34 and an additional branch 40. These lines 39 and 40 supply instrument or actuating air through the diaphragm port D to the valve 38. Actuating air is supplied to the valve 36 to connect the ports A and B and disconnect the port C from both A and B, by means of a line 42 connected to the diaphragm port D of the valve, and actuating air is supplied by the line 41, connected to the diaphragm port E, to actuate the valve to connect port C to the port A and to disconnect the port B from both the ports C and A. The line 41 is connected to the ignition switch actuating pressure line 43 through a first adjustable timing valve 44 of the needle type which has a ball-check for quick reversible flow. This type of valve permits controlled flow of air in one direction and open flow in the reverse direction. The line 43 connects to the piston and cylinder unit 16*a* of the pneumatic ignition switch 16. The line 42 is connected to the line 45 which controls the starting air line control valve 15. The valve 15 is of the two-way diaphragm-actuated type and is normally spring-closed. Associated with this valve 15 is a diaphragm-type bleed valve 46 which is normally spring-opened. Actuating pressure for closing the bleed valve is supplied by a branch line 47 connected to the line 45 ahead of the connection of the line 45 to the valve 15. A bleed line 48 runs from the valve 15 to the bleed valve 46.

The first-control valve 50 is of the four-way diaphragm type and controls the line 45 which controls the starting air valve 15. The line 45 connects to the port A of the valve 50 and to the port D thereof. The valve 50 is further provided with the bleed port B and with the port C. This valve is normally spring-actuated to disconnect port A from the bleed port B and to connect the ports C and D. A line 51 is connected to the port C and receives pressure from the line 39. This line 51 is connected to the instrument air pressure line 52 which leads to a diaphragm-actuated second control valve 53 of the two-way type which controls the line 43 that controls the ignition switch 16. The line 52 is connected to the port C of the valve 53 and is provided with a second timing valve 54 of the adjustable needle type with quick-reversing ball-check. The line 43, previously mentioned and which leads to the pneumatic ignition switch 16, is connected to the port A of the valve 53. The valve 53 is normally spring-opened to connect the ports C and A. A by-pass 55 leads around the valve 53 from the line 52 to the line 43 and is controlled by means of the normally spring-closed ball-check valve 56 connected therein. Branching from the line 52 between the valve 54 and the connection of the by-pass line 55, is a line 57 which connects to the diaphragm port D at the actuating pressure side of a third control valve 60 of the diaphragm type which controls the line 62 that controls the fuel valve 18 and the vent valve 19. This valve 60 is a three-way valve and the port B thereof has the line 51 connected thereto. In the line 51, between the valve 60 and its point of connection to the line 52, is a third timing needle valve 61. The port C of the valve 60 is a bleed port and the port A thereof is connected to a line 62. Normally, the valve 60 is spring-opened to connect the port A to the port C and to disconnect the port B from both. A branch 58 from the line 62 leads to the diaphragm port D of the valve 53. The line 62 connects to the pressure-actuating side of the fuel gas control valve 18 which is preferably of the diaphragm type and to the pressure-actuating side of the vent valve 19 which is preferably of the piston type.

The line 62 is continued beyond the valve 19 to connect to one side of a safety valve 65 which is preferably of the diaphragm type. This valve 65 is of the two-way type having a port A connected to the line 62, and a bleed port C. Normally, the valve is spring-opened to connect the port A with the bleed port C but can be pressure-actuated to disconnect the port A from the bleed port C. The pressure-actuating side of the valve is connected to an oil line 66 which leads from the oil line 23 of the engine, previously mentioned, to the valve diaphragm port D so that the valve will be actuated when there is sufficient oil pressure in the line 23 to disconnect the ports A and C. The line 23 is also connected to the port B of a two-way equalizing valve 70 of the diaphragm type and the port A of the valve is connected to the branch line 71. This line 71 is connected to the pressure-actuating means of an oil-safety shut-down valve 72 which includes a bleed port 76 which is normally open. The port 76 controls bleeding of a branch line 73 connected thereto and leading from the line 62. The valve 70 is normally spring-set to disconnect the port A from the port B. The valve is pressure-actuated to connect the port A to the port B by instrument air pressure supplied by a line 75 branching from the line 62 and connected to the valve 70 at the diaphragm port D.

In the schematic illustration of the control system, I have shown the various valves in the positions they occupy when the valve 31 is "off." In describing the operation of this system, I will refer to certain air pressures and time intervals in an actual control system which I have used but it is to be understood that these pressures and intervals are not the only ones which can be used but are given, as examples, to facilitate understanding of the operation of the system.

The sequence of operation of the system in the starting of the engine is as follows:

When the manual or remote air switch 31 is opened, 20 p.s.i.g. instrument air, for example, flows from the line 30 into the line 32 to the regulator 34 which is set above scavenger air starting pressure, for example, at 1.2" Hg and, therefore, the regulator will allow instrument air of 1.2" Hg to reach the line 32 and the port C of the valve 36. At the same time, air pressure supplied from the line 32 will flow through the line 40 to the diaphragm port D of the valve 38, operating the valve 38, for example, at 3 p.s.i.g., which disconnects the bleed port C from the port A thereof. Also at the same time, air pressure supplied from the line 32, will flow through the line 39 to the line 51, through the connected ports C and D of the first control valve 50 and, since the port B of the valve 50 is disconnected from the port A thereof, and, consequently, from the line 45 and the line 42, on to the diaphragm port D of the three-way valve 36, operating the three-way valve 36, to disconnect the port C thereof from the port A thereof and to connect the port B to the port A thereof. The scavenging air pressure in the line 11, at this time, is not of sufficient pressure to actuate the valve 50, even though it is supplied thereto from the line 11, through the connected ports B and A of the valve 36 and the line 37. The scavenging air pressure will not be of sufficient pressure to operate the valve 50 until the engine subsequently starts and speeds up. Instrument air pressure will also pass from the line 45 to act on the diaphragm

of the valve 15 to open that valve and allow starting air pressure to flow through the line 14 to the engine, starting the engine to roll. The instrument air will also flow from the line 51 into the line 52 and pass the timing needle valve 54, and on through the second control valve 53, since the ports C and A are still connected, due to the fact that instrument air has not yet reached the port D thereof. Air also passes through the by-pass check-valve 56. In a short interval, as determined by the valve 54, for example, in 10 seconds, the line 43 will build up to sufficient pressure to actuate the ignition switch 16. Thus, actuation of this switch will be delayed a short interval after the starting air is supplied to the engine. At the same time that the instrument air is started through the valve 54, it is also started through the timing valve 61 to the port B of the third control valve 60 which is closed. When the line 43 to the switch 16 builds up to 12 p.s.i.g., for example, this pressure, through the line 57, will actuate the valve 60 to disconnect the port C from the port A and connect the port B to the port A. Air from the timing valve 61 will pass from the line 51 to the line 62 and will act through the line 58 to actuate the valve 53 to disconnect the ports A and C thereof. Since the valve 53 is now closed, the valve 56 will permit a supply of air from the line 52 to by-pass the valve 53 to the line 43. The check in the valve 56 is provided to maintain pressure in the line 43 after the valve 53 is closed. When the pressure in the line 62 reaches 5 p.s.i.g., for example, it will start to slowly open the fuel valve 18 and quickly open the valve 19 at 6 p.s.i.g., for example, so as to close the vent 24 to permit passage of gas through the line 17. Thus, fuel gas will reach the engine and since the ignition switch 16 has been previously actuated, the gas will be fired as it reaches the engine. This will build up scavenging air pressure in the line 11 so as to actuate, through the valve 36, the valve 50 to disconnect the port C from the port D and connect the port A to the port B which will bleed the line 45 to zero pressure to permit the valve 15 to close, thereby interrupting the flow of starting air to the line 14. This will also open the bleed valve 46 since the pressure in the line 47 is removed and the starting air line 14 will, therefore, be bled. Also, the line 42 to the valve 36 vents, through the line 45 so that this valve 36 is actuated to close off the scavenging air line 11 by disconnecting the port B from the port A. Also, actuation of the valve 36 will connect the port C to the port A allowing 1.2" Hg air pressure from the line 32 to act on the diaphragm of the valve 50 to lock this valve in the bleed position. Thus, the valve 50 is locked in bleed position and cannot let air into the starting valve 15 if the engine should stall, since the scavenging air has been blocked and is not used until another engine starting operation.

When the air in the line 62, to the gas valve 18, builds up to, for example, 17 p.s.i.g., it will act through the line 75 to actuate the valve 70 to connect the ports A and B thereof, which equalizes oil from the engine to trapped oil in the line 71 connected to the shut-down valve 72, which can then shut off the fuel, if the oil pressure fails, by venting the line 62 through the bleed port 76. When the engine is shut down, the valve 70 will actuate to disconnect the port A from the port B and trap oil in the line 71 to prevent the valve 72 from opening the bleed port 76. This will keep the valve 72 from opening the bleed port 76 each time the engine is shut down. The valve 65 closes at 3 p.s.i.g., and if the engine should not roll in starting, no oil pressure will be built up within the line 66 and the valve 65 will not close and, therefore, no air pressure can be built up in line 62 to actuate fuel valves 18 and 19. This acts as a safety since some engines have dead spots and have to be manually rolled over them.

The timing valve 44 is set to actuate the valve 36 a short interval, for example, thirty seconds, after the starting air valve 15 is opened, should the engine fail to start. This will turn off the starting air and lock it out the same as during normal start and thereby prevent waste of starting air.

The sequence in stopping the engine is as follows:

The manual or remote air switch 31 is turned off, blocking 20 p.s.i.g. instrument air and venting the system to atmosphere. When air in the system lowers to 12 p.s.i.g., the valve 60 is actuated to disconnect the ports A and B and connect the port A to the bleed port C, thereby venting the line 62 and closing the fuel valves 18 and 19. When air to the valve 70 lowers to 17 p.s.i.g., due to bleeding of the lines 62 and 75, the valve 70 is actuated to disconnect the port A from the port B thus trapping oil pressure in the line 71, and preventing the valve 72 from tripping when the oil pressure in the line 71 goes to zero. As the pressure in the line 62 decreases further, the fuel valve 19 closes and vents fuel gas from the engine to the atmosphere. The fuel valve 18 also closes and prevents flow of gas past this valve. When the pressure in the line 62 decreases to 3 p.s.i.g., the valve 53 acts to free the pneumatic ignition switch 16 of pressure by connecting the line 43 to the vented line 52. This lock-out system between the valves 60 and 53 safeguards shut down sequence so that the fuel gas has to be shut off before the ignition can be deenergized. To reset the valve 50, it is necessary to turn off the master switch valve 31 so as to bleed the system of instrument air, through the bleed 33 to atmosphere and, at 3 p.s.i.g., the valve 38 opens to vent the lock-out air trapped between the valves 34, 35, 38, and 50.

The reason for the checks in the valves 44 and 54 is to release air faster in a reverse flow than through the needle valves.

As indicated in Figure 2, the system can be modified slightly so that it can be adapted to a four-cycle engine. In this case, an additional valve 80 is provided. This valve is of the two-way diaphragm-actuated type. A line 32*a* leads from the port B of the valve 80 and is connected to the line 32 of Figure 1 at a point between the valve 36 and the regulator 34. The port A of the valve 80 is connected to a line 11*a* which leads to the port B of the valve 36. Oil or water pressure from the engine is connected through the line 23*a* to the diaphragm port D of the valve 80 to move the valve into open position from its spring-pressed closed position. Operation of this modification of the system will be the same as in the previously described system except that the operation will be triggered by the oil or water pressure in the line 23*a* instead of scavenging air pressure in a line corresponding to the line 11 of Figure 1.

Although I have specified that the control system of my invention is actuated by air pressure, it is to be understood that it can be actuated by other types of fluid-pressure, such as hydraulic fluid or gas.

It will be apparent that this fluid actuated starting and stopping system will perform the various operations in starting and stopping automatically and will perform them only in proper sequence due to the interlocking arrangements provided in the system. Reliance on the human element is entirely eliminated since the engine can be started or stopped merely by the control of the master valve. Furthermore, with this system, remote control of the starting and stopping of the engine is possible.

According to the provisions of the patent statutes, the principles of this invention have been explained and have been illustrated and described in what is now considered to represent the best embodiment. However, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

Having thus described my invention, what I claim is:

1. In combination with an engine of the internal com-

bustion type having a line connected thereto for supplying starting air to turn over the engine for starting, a fuel line for supplying fuel to the engine, an ignition circuit for igniting the fuel supplied to the engine, and a fluid-pressure system which develops pressure during starting of the engine by means of the starting air; a fluid-pressure actuated starting and stopping system including a fluid circuit having connected therein a pressure-actuated starting air valve member for controlling the flow of starting air through said starting air line, a pressure-actuated fuel valve member for controlling the flow of fuel through said fuel line, a pressure-actuated ignition switch member for controlling said ignition circuit, a source of fluid under pressure for said fluid circuit, a master control valve in said fluid circuit for controlling the flow of actuating fluid into said circuit from said source, a first control line in said circuit connected between said master valve and said fluid-actuated starting air valve for supplying actuating pressure thereto, a second control line in said circuit connected between said master control valve and said fluid-actuated ignition switch for supplying actuating pressure thereto, a third control line in said circuit connected between said master valve and said fluid-actuated fuel valve for supplying actuating pressure thereto, a first control valve connected in and controlling the first control line, a second control valve connected in and controlling the second control line, a third control valve connected in and controlling the third control line, pressure-responsive means for actuating the first control valve and comprising a connection between it and said master valve and a connection between it and said fluid-pressure system of the engine, pressure-responsive means for actuating the second control valve and comprising a connection between it and the master valve and a connection between it and the third control line, and pressure-responsive means for actuating the third control valve and comprising a connection between it and the master valve.

2. In combination with an engine of the internal combustion type having a line connected thereto for supplying starting air to turn over the engine for starting, a fuel line for supplying fuel to the engine, an ignition circuit for igniting the fuel supplied to the engine, a fluid lubricating system which develops pressure after the engine is started, and an additional fluid system which develops pressure during starting of the engine by means of the starting air; a fluid-pressure actuated starting and stopping system including a fluid circuit having connected therein a pressure-actuated starting air valve member for controlling the flow of starting air through said starting air line, a pressure-actuated fuel valve member for controlling the flow of fuel through said fuel line, a pressure-actuated ignition switch member for controlling said ignition circuit, a source of fluid under pressure for said fluid circuit, a master control valve in said fluid circuit for controlling the flow of actuating fluid into said circuit from said source, a first control line in said circuit connected between said master valve and said fluid-actuated starting air valve for supplying actuating pressure thereto, a second control line in said circuit connected between said master control valve and said fluid-actuated ignition switch for supplying actuating pressure thereto, a third control line in said circuit connected between said master valve and said fluid-actuated fuel valve for supplying actuating pressure thereto, a first control valve connected in and controlling the first control line, a second control valve connected in and controlling the second control line, a third control valve connected in and controlling the third control line, pressure-responsive means for actuating the first control valve and comprising a connection between it and said master valve and a connection between it and said first fluid-pressure system of the engine, pressure-responsive means for actuating the second control valve and comprising a connection between it and the master valve and a connection between it and the third control line, pressure means for actuating the third control valve and comprising a connection between it and the master valve, said third control line which controls said fuel valve also being connected to and controlled by said pressure lubricating system of the engine.

3. The combination of claim 1 in which the connection between said first valve and said master valve comprises an additional pressure-responsive control valve which controls the application of actuating pressure to said first valve from said master valve through one connection and from said engine fluid-pressure system, a pressure-responsive bleed valve connected to said additional valve and to said first valve and also connected to said master valve by a second pressure-actuating connection, and connections between said first and second control lines and said additional valve so that it is responsive to the differential pressure therein in its control of the application of actuating pressure to said first valve.

4. The combination of claim 3 including a pressure regulator in the first connection between the master valve and the additional control valve.

5. The combination of claim 4 including a timing valve in the connection between the second control line and said additional valve for timing the application of actuating pressure thereto from said second control line, including a second timing valve in the connection between said master valve and said second control valve for timing the application of actuating pressure to the second control valve, and including a third timing valve in the connection between said master valve and said third control valve for timing the application of actuating pressure to the third control valve, said third control valve being also connected to the connection between said second timing valve and said second control valve.

6. The combination of claim 5 in which a checked bypass is provided around said second control valve for permitting flow around said valve in one direction only to said ignition switch.

7. The combination of claim 5 in which the engine is provided with an additional fluid-pressure system which develops pressure after the engine starts, and means for connecting said system to said third control line beyond the third control valve relative to said master valve, said last-named connecting means including a shut-down valve connected to the fuel line for bleeding such line and means responsive to the pressure of said additional fluid-pressure system of the engine for controlling said shut-down valve and including a safety valve connected between said engine fluid-pressure system and said shut-down valve and set to operate at a predetermined pressure of said system so as to prevent closing of said shut-down valve unless said pressure is reached, and a pressure equalizing valve connected between said shut-down valve and said fluid-pressure system of the engine.

8. In combination with an engine of the internal combustion type having a line connected thereto for supplying starting air to turn over the engine for starting, a fuel line for supplying fuel to the engine, an ignition circuit for igniting the fuel supplied to the engine, and a fluid-pressure system which develops pressure during and after starting of the engine; a fluid-pressure actuated starting and stopping system including a fluid circuit having connected therein a pressure-actuated starting air valve member for controlling the flow of starting air through said starting air line, a pressure-actuated fuel valve member for controlling the flow of fuel through said fuel line, a pressure-actuated ignition switch member for controlling said ignition circuit, a source of fluid under pressure for said fluid circuit, a master control valve in said fluid circuit for controlling the flow of actuating fluid into said circuit from said source, a first control line in said circuit connected between said master valve and said fluid-actuated starting air valve for supplying actuating pressure thereto, a second control line

in said circuit connected between said master control valve and said fluid-actuated ignition switch for supplying actuating pressure thereto, a third control line in said circuit connected between said master valve and said fluid-actuated fuel valve for supplying actuating pressure thereto, a first control valve connected in and controlling the first control line, a second control valve connected in and controlling the second control line, a third control valve connected in and controlling the third control line, pressure-responsive means for actuating the first control valve and comprising a connection between it and said master valve, pressure-responsive means for actuating the second control valve and comprising a connection between it and the master valve and a connection between it and the third control line, and pressure-responsive means for actuating the third control valve and comprising a connection between it and the master valve.

9. The combination of claim 8 in which the connection between said first valve and said master valve comprises a pressure-actuated control valve which controls the actuation of actuating pressure to said first valve from said master valve and which is responsive to pressure of said engine fluid-pressure system.

10. The combination of claim 9 in which the connection between said first valve and said master valve comprises an additional control valve which also controls the application of actuating pressure to said first valve from said master valve, a pressure-actuated bleed valve connected to said last-named valve and to said first valve and also connected to said master valve by a second pressure-actuating connection, and means connected to said first and second control lines and responsive to the differential pressure therein for actuating said additional valve.

11. The combination of claim 9 in which said second pressure-responsive means includes an interlock for insuring that said igniting means will always function before said fuel supplying means will function and an additional interlock means which, in stopping the engine, will first actuate the second means to shut off the supply of fuel and will then deenergize the igniting means.

12. In combination with an engine of the internal combustion type having a line connected thereto for supplying starting air to turn over the engine for starting, a fuel

line for supplying fuel to the engine, and an ignition circuit for igniting the fuel supplied to the engine; a fluid-pressure actuated starting and stopping system including a pressure-actuated starting air valve for controlling the flow of starting air through said starting air line, a pressure-actuated fuel valve for controlling the flow of fuel through said fuel line, a pressure-actuated ignition switch for controlling said ignition circuit, a source of fluid under pressure connected to said pressure-actuated starting air and fuel valves and to said pressure-actuated switch, and means connected in said system and responsive to pressure from said source for opening the starting air valve to supply starting air to the engine, energizing said switch, opening said fuel valve to supply fuel to the engine, closing said starting air valve and venting said starting air line in sequence, a single master control valve connected in said system for controlling said last-named means so that when in its actuating position, the indicated sequence of operation of the system is produced, said control valve in its non-actuating position actuating said means to close the fuel valve to interrupt flow of fuel to the engine and vent the fuel from the engine and to subsequently actuate the ignition switch to deenergize it, said means including a first lock-out means connected between said master control valve and said pressure-actuated starting air valve for preventing opening of said starting air valve again until the system is reset by said master control valve, said first lock-out means being controlled by a fluid pressure system of the engine which develops pressure upon the supply of starting air to the engine and which is connected thereto, said pressure-responsive means also including a second lock-out means connected between said master control valve and said pressure-actuated fuel valve and ignition switch for insuring that the fuel valve cuts off the supply of fuel to the engine before said ignition switch is deenergized and which is connected to and controlled by an additional fluid-pressure system of the engine which develops pressure upon operation of the engine.

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