Feb. 6, 1951

R. R. STEVENS

2,540,765

CONTROL APPARATUS

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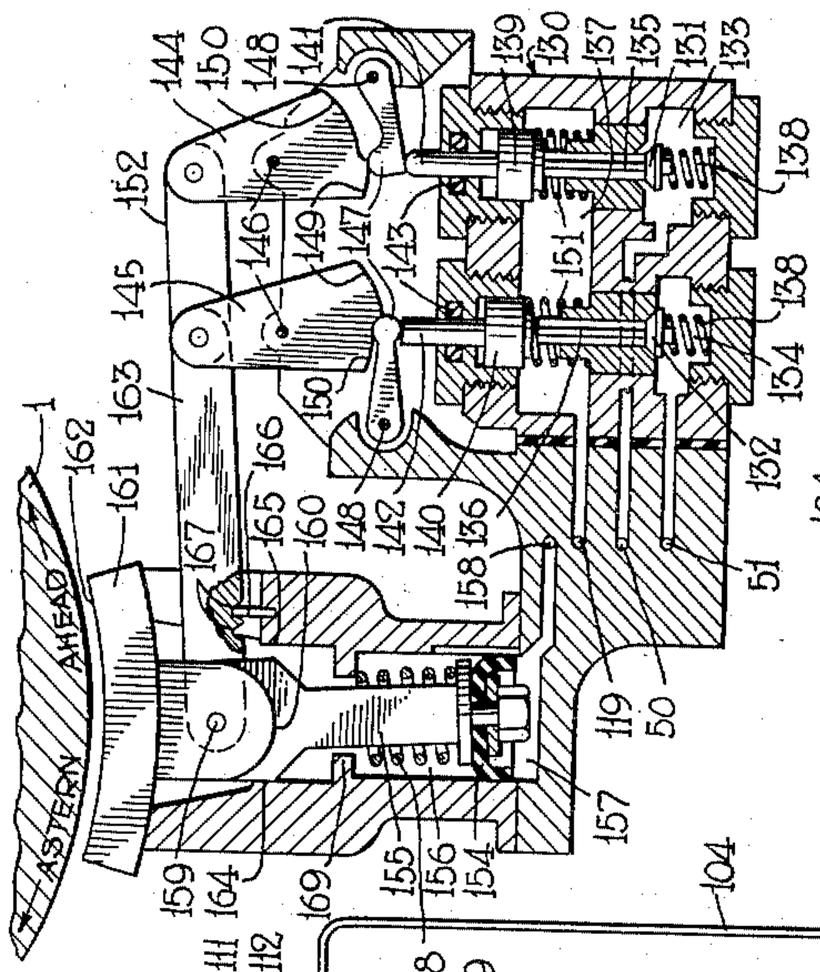

Fig. 2



Fig. 3

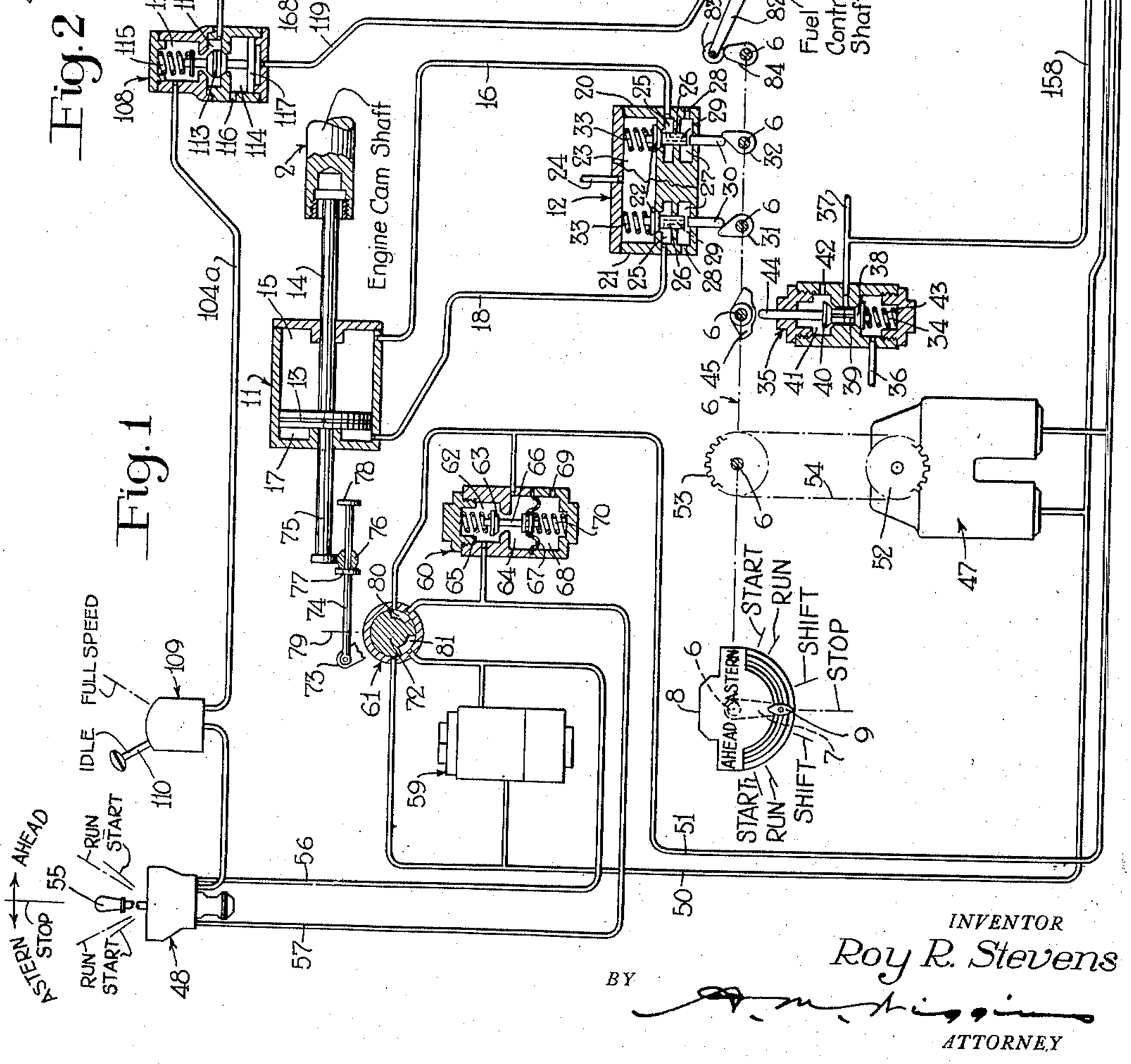


Fig. 1

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## CONTROL APPARATUS

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13 Claims. (Cl. 123—41)

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This invention relates to control apparatus and more particularly to apparatus arranged to control a plurality of operations in a desired sequence, such, for example, as operations incident to the control of a reversible prime mover.

In my Patent 2,482,301 of September 20, 1949, there is disclosed an apparatus of the above type for controlling the operation of a reversible Diesel engine. This apparatus embodies an operator's maneuvering control device for controlling the starting, stopping and reversing of the engine and an operator's speed control device arranged to control a speed governor for regulating the supply of fuel to the engine. Structure controlled and adjustable by the maneuvering control device is also provided to limit to any preselected degree the maximum amount of fuel that can be supplied to the engine by operation of the speed control device. The purpose of this fuel limiting structure is to prevent the engine governor from operating to increase the supply of fuel to the engine to a degree exceeding that selected by the maneuvering control device in case the load on the engine is increased to an excessive or abnormal degree; or in other words, the limiting structure prevents undue straining of the engine under such a condition.

One object of the invention is the provision of an improved control apparatus of the above general type.

A more specific object of the invention is the provision of a control apparatus of the above general type embodying in the operator's speed control device, and therefore independent of the operator's maneuvering control device, control of the fuel limiting means for the purpose above set forth.

Other objects and advantages will be apparent from the following more detailed description of the invention.

In the accompanying drawing: Fig. 1 is a diagrammatic view, partly in section and partly in outline, of an apparatus for controlling the operation of a reversible prime mover, such as a Diesel engine and embodying one form of the invention; Fig. 2 is a sectional view of a directional control device shown in side elevation in Fig. 1 and taken on the line 2—2 therein; and Fig. 3 is a sectional view of another embodiment of the invention.

Except as hereinafter pointed out the apparatus shown in the drawing may be substantially like that disclosed in the aforementioned pending application.

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*Description Figs. 1 and 2*

As shown in the dawing, the reference numeral 1 indicates an engine crank shaft and the reference numeral 2 indicates a cam shaft for said engine. The engine is of the type in which the cam shaft 2 is shiftable longitudinally to different positions which determine the direction of operation of the engine, and said cam shaft may therefore have what may be called an astern position, in which it is shown in the drawing, and may be shiftable from this position in the direction of the right hand to an ahead position. As above used, the term "astern" indicates operation of the engine in one direction and the term "ahead" indicates operation of the engine in the opposite direction, and these terms are employed merely for illustration and are to be considered synonymous with said one and opposite directions.

The reference numeral 3 indicates a fuel control shaft for the engine. The fuel control shaft 3 may have a fuel cut-off position, such as indicated by a dot and dash line 4, and may be rockable out of said position in a counter-clockwise direction, as viewed in the drawing, through a fuel control zone for increasing the supply of fuel to the engine. A dot and dash line 5 indicates a position which the fuel control shaft 3 may assume to provide a maximum amount of fuel to the engine, while a dot and dash line 5A between the dot and dash lines 4 and 5 indicates a position which said shaft may assume to provide fuel to the engine in an amount to obtain idling operation of said engine.

The numeral 6 indicates a maneuvering control shaft for the engine. An operating lever 7 secured to one end of shaft 6 for turning same is disposed behind an escutcheon plate 8 and is operatively connected to an operating knob 9 in front of said plate. The knob 9 is provided for the operator to grasp to operate lever 7 to turn the shaft 6. The lever 7 has a "stop" position in which it is shown in the drawing, and is movable from this position either in a counterclockwise direction toward the legend "Astern" on plate 8, or in the opposite direction toward the legend "Ahead" on said plate. At the "astern" side of "stop" position the lever 7 has "Shift," "Run" and "Start" positions arranged in the order named with the "shift" position adjacent the "stop" position, while corresponding but reversely arranged positions are provided at the opposite or "ahead" side of "stop" position. Movement of lever 7 to any one of these different po-

sitions will correspondingly position the maneuvering shaft 6.

The reference numeral 11 indicates a reversing motor for moving the engine cam shaft 2 to its different positions, while the reference numeral 12 indicates a control valve mechanism arranged for control by the maneuvering shaft 6 for controlling operation of said motor.

The reversing motor 11 comprises a casing containing a piston 13 having a piston rod 14 extending through the casing in coaxial relation with and having its end connected to the cam shaft 2 whereby reciprocation of said piston will move said cam shaft longitudinally. At one side of piston 13 is a pressure chamber 15 connected to a control pipe 16, while at the opposite side of said piston is a pressure chamber 17 connected to a control pipe 18. When fluid under pressure is supplied to pipe 16 at a time when chamber 17 is open to atmosphere by way of pipe 18, piston 13 will be moved to the position in which it is shown in the drawing for moving the cam shaft 2 to its astern position to provide for operation of the engine in the astern direction. On the other hand, when pipe 16 and thereby pressure chamber 15 are open to atmosphere and fluid under pressure is supplied through pipe 18 to pressure chamber 17 the piston 13 will be moved to the opposite or right hand end of its cylinder to thereby move the cam shaft 2 to its ahead position.

The control valve mechanism 12 comprises an astern valve device 20 for controlling the supply and release of fluid under pressure to and from pipe 16 and an ahead valve device 21 for controlling the supply and release of fluid under pressure to and from the pipe 18. The ahead and astern valve devices 20 and 21 are identical in structure, each comprising a supply valve 22 contained in a chamber 23, which chamber is common to the two valves and is adapted to be constantly supplied with fluid under pressure from any suitable source by way of a pipe 24. Each of the valves 22 is arranged to control flow of fluid under pressure from chamber 23 to a chamber 25 and is provided with a stem 26 extending through the latter chamber and through a bore in the casing into a chamber 27 which is open to atmosphere by way of a port 28. Chamber 25 in the ahead valve device 21 is connected to pipe 18 while chamber 25 in the astern valve device 20 is connected to pipe 16. Each valve stem 26 is provided with an axial bore 29 open at one end to chamber 25 and open at the opposite end through the end of said stem to chamber 27. A plunger 30 slidably mounted in a bore in the casing extends into chamber 27 in coaxial relation with the adjacent end of each valve stem 26, and one end of said plunger constitutes a valve arranged to cooperate with a seat on the end of said stem for closing communication between bore 29 and chamber 27. A spring 33 contained in chamber 23 acts on each supply valve 22 for urging it to its closed position.

Two identical but reversely arranged cams 31 and 32 are mounted on the maneuvering shaft 6 for cooperation with the two plungers 30 to control operation of the ahead and astern valve devices 21 and 20, respectively. With the operator's control lever 7 in the "astern" "shift" position the cam 32 is adapted to seat plunger 30 in the astern valve device 20 against the end of the respective supply valve stem 26 and to open the respective supply valve 22 for supplying fluid under pressure to pipe 16, while in all other positions of said lever said cam is adapted to permit closing of said valve by the respective spring 33 and to also permit movement of the respective plunger 30 to the position shown in the drawing for releasing fluid under pressure from chamber 25 and pipe 16 through bore 29 in the respective supply valve stem 26 to chamber 27 and thence to atmosphere. In a like manner the cam 31 is adapted to operate the ahead valve device 21 upon movement of the operator's control lever 7 to the "ahead" "shift" position to supply fluid under pressure to pipe 18 and in all other positions of said lever to open said pipe to atmosphere.



It will thus be apparent that when the operator's control lever 7 is moved to the "astern" "shift" position the control valve device 12 will operate to supply fluid under pressure to chamber 15 to effect operation of the reversing motor 11 to move the cam shaft 2 to its astern position to provide for operation of the engine in the one direction, but movement beyond this "shift" position to the "astern" "run" and "start" positions will cause operation of the control valve mechanism 12 to release fluid under pressure from said piston chamber. Likewise, if the operator's control lever 7 is moved to the "ahead" "shift" position the control valve mechanism 12 will be operated to supply fluid under pressure to chamber 17 in the reversing motor 11 to effect operation of said motor to move the engine cam shaft 2 to its ahead position, while movement past the "ahead" "shift" position will cause operation of said device to release fluid under pressure from chamber 17. It will thus be seen that since fluid under pressure is released from chambers 15 and 17 when lever 7 is out of the "shift" positions it is necessary for the operator in reversing the direction of operation of the engine to allow said lever 7 to remain in the "astern" "shift" position or in the "ahead" "shift" position for a period of time sufficient for the reversing motor 11 to properly position the cam shaft 2.

Fluid under pressure is released from pressure chamber 15 or 17 in the reversing motor 11 after said motor has operated to properly position the cam shaft 2, as above described, in order to remove thrust on the connection between the reversing piston 13 and the cam shaft 2.

The reference numeral 35 indicates an engine starting air valve device which is operative to supply engine starting air from a supply pipe 36 to a pipe 37 which is adapted to conduct such starting air to the starting mechanism (not shown) of the engine for starting the engine to turn in a direction determined by the position of the cam shaft 2.

The starting air valve device 35 comprises a casing having a chamber 34 connected to the supply pipe 36 and containing a valve 38 arranged to control flow of starting air from said chamber to pipe 37. The valve 38 has a fluted stem 39 engaging a like stem on an oppositely seating valve 40 contained in a chamber 41 which is open to atmosphere through a port 42. The valve 40 is arranged to control communication between pipe 37 and the atmospheric port 42. A spring 43 in chamber 34 acts on the supply valve 38 for urging it to its seated position and for opening the valve 40. A stem 44 projecting from valve 40 through chamber 41 and a bore in the casing is provided for closing valve 40 and for opening valve 38 against the opposing force of spring 43. A cam 45 secured to the maneuvering shaft 6 for operation thereby is arranged to operate stem

44 to close valve 40 and open valve 38 in the two "start" positions of the operator's control lever 7 and to permit closure of valve 38 and opening of valve 40 by spring 43 in all other positions of said lever. It will thus be seen that when the operator's control lever 7 is moved to either of the two "start" positions engine starting air will be supplied to pipe 37 to effect starting of the engine, while in all other positions of said lever pipe 37 will be open to the atmosphere.

The reference numeral 47 indicates a power means in the form of a fluid motor adapted to be controlled by an operator's control device 48 which may be located at a remote station if desired, for effecting movement by power of the maneuvering shaft 6 to its different positions.

The power means 47 and operator's control device 48 may be generally similar to devices fully disclosed in Patent No. 2,379,306 issued to Arthur G. Larson and Cecil S. Kelley on June 26, 1945, and since reference may be made to this patent the following description of said power means and operator's control device will be limited to only such detail as is deemed necessary to a clear understanding of the present invention.

Briefly, the power means 47 is arranged to be operated by fluid under pressure supplied to either an ahead pipe 50 or to an astern pipe 51 to turn the maneuvering shaft 6 in, respectively, either the ahead direction or in the astern direction, through the medium of a sprocket wheel 52 associated with the motor, a sprocket wheel 53 secured to the maneuvering shaft 6 and a connecting driving chain 54. The motor 47 is adapted to assume different positions corresponding to different pressures of fluid in either the ahead pipe 50 or in the astern pipe 51, so that by providing different selected pressures of fluid in the ahead pipe 50, for instance, the maneuvering shaft 6 can be caused to turn to and stop in any selected position at the ahead side of stop position, while the provision of the same selected pressures of fluid in the astern pipe 51 will cause the maneuvering shaft 6 to turn to and assume the corresponding positions at the astern side of stop position. When the same pressures of fluid are provided in both pipes 50 and 51, the motor 47 will operate to move the maneuvering shaft 6 to its stop position.

The operator's control device 48 which is provided to control the pressure of fluid in pipes 50 and 51 comprises a lever 55 having a neutral or "stop" position and at one or the "astern" side thereof "run" and "start" positions, and at the opposite or "ahead" side of "stop" position reversely arranged "run" and "start" positions, these positions, it will be noted, correspond in name and disposition to the different positions of the operator's control lever 7 and the maneuvering shaft 6, with the exception that lever 55 has no "shift" positions for reasons which will be later brought out. The operator's control device 48 is arranged to control directly the supply and release of fluid under pressure to and from two pipes 56 and 57 which are adapted to be connected to pipes 50 and 51, respectively, by means to be later described. In "stop" position of lever 55, the operator's control device 48 is adapted to provide in both pipes 56 and 57 fluid at the same and at a minimum degree of pressure to cause operation of motor 47 to move the maneuvering shaft 6 to the corresponding or "stop" position. Movement of the operator's control lever 55 to either the "run" or "start" position at the "ahead"



side of "stop" position is adapted to open the astern pipe 57 to atmosphere and to provide fluid in pipe 56 at pressures such as required to effect operation of motor 47 to move the maneuvering shaft 6 to the position corresponding to that of said lever. Movement of the operator's control lever 55 to the "run" and "start" position at the "astern" side of "stop" position will open pipe 56 to atmosphere and supply fluid to pipe 57 at a pressure corresponding to the position of said lever to thereby effect operation of motor 47 to correspondingly position the maneuvering shaft 6. In other words, when the operator's control lever 55 is moved to any selected position the fluid motor 47 will act to move the maneuvering shaft 6 to the corresponding position.

Interposed in the communication between pipes 56 and 50, and pipes 57 and 51 are two pressure limiting valve devices 59 and 60, respectively, and an interlock valve device 61.

Each of the pressure limiting valve devices 59 and 60 comprises a casing having a chamber 62 containing a valve 63 arranged to control flow of fluid under pressure from said chamber to a chamber 64. A spring 65 in chamber 62 acts on valve 63 for urging it to its seat. The valve 63 has a stem 66 extending into chamber 64 wherein it engages one side of a flexible diaphragm 67 which forms one side of chamber 64. At the opposite side of diaphragm 67 is a chamber 68 which is open to atmosphere through a passage 69, and which contains a spring 70 acting on the diaphragm in a direction to unseat the valve 63. The pressure of spring 70 on diaphragm 67 is such as to permit deflection of said diaphragm and closing of valve 63 by spring 65 when the pressure of fluid in chamber 64 is increased to a certain chosen degree, for reasons which will be later brought out. In the pressure limiting valve device 59 chamber 62 is connected to pipe 56 and chamber 64 is connected to pipe 50, while in the limiting valve device 60 the corresponding chambers are connected, respectively to pipes 57 and 51.

The pipes 56, 57, 50 and 51 all lead to the interlock valve device 61 which may comprise a rotary valve 72 having two different operating positions and which is arranged to be moved to said positions by a lever 73. The lever 73 is operatively connected to a rod 74 which has a lost motion connection with a rod 75 through the medium of an arm 76 on rod 75 and spaced collars 77, 78 on rod 74. The rod 75 is connected to the reversing piston 13 at the side opposite the piston rod 14.

When the reversing piston 13 is in its astern position in which it is shown in the drawing, engagement between arm 76 on rod 75 and collar 77 on rod 74 will position the rotary valve 72 in what may be called an astern position in which it also is shown in the drawing. When, however, the reversing piston 13 is moved to its ahead position at the opposite or right-hand end of the cylinder, the arm 76 will engage collar 78 on rod 74 just before the piston attains said position in order to actuate lever 73 to turn rotary valve 72 to its other position, which may be called an ahead position, and in which said lever will occupy a position such as indicated by a line 79. It will be apparent that movement of piston 13 from its ahead position to its astern position will turn the rotary valve 72 to the position in which it is shown in the drawing.

The rotary valve 72 is provided with two cavities 80 and 81, the cavity 80 being adapted to

establish communication between pipes 57 and 51 in the astern position of said valve, while the cavity 81 is adapted to establish communication between pipes 56 and 50 in the ahead position of said valve. When communication is established between pipes 57 and 51 the communication between pipes 56 and 50 will be broken, and vice versa.

In operation, if the operator moves the control lever 55 from "stop" position to the "ahead" "start" position to supply fluid to pipe 56 at the pressure required for operating motor 47 to turn the maneuvering control shaft 6 to its "ahead" "start" position, fluid will flow from pipe 56 to chamber 62 in the pressure limiting valve device 59 and thence past the respective open valve 63 to pipe 50 leading to the motor 47, it being noted that communication between pipes 56 and 50 through the interlock valve device 61 is closed at this time. When the pressure of fluid thus supplied past valve 63 in limiting valve device 59 and acting on the respective diaphragm 67 is increased to a degree sufficient to overcome the opposing force of spring 70, said diaphragm will deflect against said spring to permit closure of valve 63 to thereby limit the pressure of fluid obtained in pipe 50 to a degree determined by the pressure of said spring. The pressure of spring 70 in the limiting valve device 59 is such as to limit the pressure of fluid thus provided through pipe 50 in the reversing motor 47 to a degree which will cause operation of said motor to turn the maneuvering control shaft 6 only to the "ahead" "shift" position.

Operation of the motor 47 to turn the maneuvering control shaft 6 to its "ahead" "shift" position will effect operation of the control valve mechanism 12 and thereby of the reversing motor 11 to move the cam shaft 2 from its astern position, in which it is shown in the drawing, to its ahead position. When the cam shaft 2 attains its ahead position the interlock valve device 61 will have been operated by the reversing piston 13 to establish communication between pipes 56 and 50 by way of cavity 81 in said valve device, so that fluid at the pressure provided in pipe 56 by the operator's control valve device 43 with lever 55 in its "ahead" "start" position will then become effective through pipe 50 in motor 47 and cause operation of said motor to turn the maneuvering shaft 6 to its "ahead" "start" position, for thereby operating the starting air valve device 35 to supply starting air to pipe 37 to effect starting of the engine to turn in the direction determined by the position of the operator's control lever 55 and thereby of the cam shaft 2. After fuel is supplied to the engine, in a manner which will be later described, and the engine fires and is running on fuel the operator will then move lever 55 from the "ahead" "start" position to the adjacent "run" position to thereby cause operation of motor 47 to turn the maneuvering control shaft 6 to the corresponding "run" position for effecting operation of the starting air valve device 35 to cut off the supply of starting air to the starting air pipe 37. While the engine is running the operator's control lever 55 will then be left in the "run" position.

On the other hand, if the operator desires to operate the engine in the astern direction he will move lever 55 to the "astern" "start" position to thereby cause operation of motor 47 to first move the maneuvering control shaft 6 to its "astern" "shift" position, as limited by operation of the limiting valve device 60, and then to the "astern" "start" position upon operation of the interlock valve device 61. In the "astern" "start" position of the maneuvering shaft 6 the starting valve device 35 will be operated to supply starting air through pipe 37 to the engine, and after the engine fires and is running on fuel the operator will return lever 55 to its "astern" "run" position in which it will then remain during operation of the engine in the astern direction.

It will now be seen that upon movement of the operator's control lever 55 to either of its "start" positions the limiting valve device 59 or 60 acts to limit operation of the fluid motor 47 to prevent turning of the maneuvering control shaft 6 to the corresponding "start" position to effect starting of the engine, until after the cam shaft 2 has been positioned according to the operation of said lever, but immediately upon proper positioning of the cam shaft, the motor 47 operates to cause operation of starting air valve device 35 to effect starting of the engine. After the engine is started the operator moves the control lever 55 back to the adjacent "run" position in which it is then allowed to remain during operation of the engine in the selected direction.

The structure will operate in the manner just described in starting the engine from stop in either one direction or in the opposite direction, or in quickly reversing the engine from operation in one direction to operation in the opposite direction, it being noted that in reversing the engine from ahead to astern, for example, the ahead pipe 56 will be vented at the same time as fluid is supplied to the astern pipe 57, so that the motor 47 will promptly move the maneuvering control shaft 6 in accordance with the operation of lever 55 and as governed by the limiting valve device 59 or 60 and interlock valve device 61. The structure will also operate in the same manner in case the operator moves lever 55 from the "astern" "run" position to the "ahead" "start" position to start and operate the engine in the ahead direction. It is merely desired to point out, however, that in quickly reversing the direction of engine operation, the cam shaft 2 may be operated to condition the engine for operation in the newly selected direction before the engine comes to a stop from operation in the opposite direction, in which case the starting air supplied by the starting air valve device 35 to the engine will initially act in the engine as a brake, in the usual well known manner, to promptly bring the engine to a stop and will then be immediately effective to start the engine turning in the new direction, as determined by the position of the cam shaft 2.

Connected to one end of the fuel control shaft 3 is one end of a lever 82 having in its opposite end a roller 83 which is adapted to engage the peripheral surface of a fuel cut-off cam 84 on the maneuvering shaft 6 which cam is different from a similar cam disclosed in the aforementioned pending application. When the shaft 6 is in "stop" position, the cam 84 is adapted to actuate lever 82 to move the fuel control shaft 3 to its fuel cut-off position indicated by the dot and dash line 4. The cam 84 is so designed, however, that when the maneuvering shaft 6 is in any position out of "stop" position, the lever 82 and fuel control shaft 3 are free to move, with respect to the maneuvering control shaft 6, from the fuel cut-off position indicated by the dot and

dash line 4 to any position up to and including the maximum fuel supply position indicated by the dot and dash line 5. It will thus be seen that the only control of engine fuel by the operator's control valve device 48 is that for cutting off fuel upon movement of lever 55 to "stop" position in order to effect stopping of the engine.

Also operatively connected to the fuel control shaft 3 is one end of a fuel control lever 86 the opposite end of which is connected by a link 87 to one end of a lever 88. The lever 88 is pivoted intermediate its ends on a fixed fulcrum pin 89 and the opposite end of said lever is operatively connected to a plunger 90 of a speed governor 97.

The speed governor 97 may, for the purpose of illustration, comprise a head 91 in which the plunger 90 is slidably mounted. Two centrifugal governor arms 92 are pivoted on pins 93 in the head 91 and are operatively connected to a collar 94 secured to plunger 90. The head 91 is operatively connected by gears 95, 96 to any suitable rotatable part of the engine such as the crank shaft 1. Upon an increase in speed of the crank shaft 1 the governor arms 92 will act through collar 94, plunger 90, lever 88, link 87 and lever 86 to move the fuel control shaft 3 in the direction of the fuel cut-off position indicated by the dot and dash line 4, while movement of lever 88 in the opposite direction against the opposing action of the governor arms 92 will actuate lever 86 to move the fuel control shaft 3 in the opposite direction or out of the fuel cut-off position for increasing the supply of fuel to the engine.

The governor 97 further comprises a control spring 98 having one end connected to lever 88 between the fulcrum pin 89 and the link 87 and is provided to oppose the action of centrifugal force on the governor arms 92. The opposite end of spring 98 is connected to one end of a rod 99 of a governor control motor 100 which is operative to adjust the force of said spring on said lever.

The motor 100 comprises a cylinder 101, containing a piston 102 to which the rod 99 is operatively connected. At one side of piston 102 is a control chamber 103 connected to a control pipe 104, while at the opposite of said piston is a non-pressure chamber 105 which is open to atmosphere through a passage 106 and which contains a control spring 107 acting on piston 102 in opposition to pressure of fluid in chamber 103.

The pipe 104 is adapted to be connected through an interlock valve device 108, constituting a part of the invention, to a pipe 104*a* leading to an operator's fuel or speed control valve device 109 which is provided for controlling the pressure of fluid in chamber 103 of the governor control motor 100. The speed control device 109 may be of any suitable type which will vary the pressure of fluid in chamber 103 in proportion to the extent of movement of a control lever 110 out of an engine "idle" position, in which it is shown in the drawing, and in which a minimum of pressure of fluid, such as ten pounds per square inch, will be provided in pipe 104A. A maximum pressure of fluid will be obtained in pipe 104A with lever 110 moved to a position designated in the drawing by the legend "Full speed." Any desired pressure between the maximum and minimum pressures may be provided in pipe 104A by suitable adjustment of lever 110 between its "idle" and "full speed" positions.

The interlock valve device 108 comprises a casing having a chamber 111 open to pipe 104A, and another chamber 112 open to pipe 104. A double seating valve 113 contained in chamber 112 is arranged to control communication between said chamber and the chamber 111 at one side of the valve and a chamber 114 at the opposite side. A spring 115 in chamber 111 acts on the valve 113 for moving it to the position in which it is shown in the drawing, in which position communication is opened between chambers 111 and 112 and thereby between pipes 104A and 104, while chamber 112 and pipe 104 are disconnected from chamber 114 which is open to atmosphere through a port 116. Chamber 114 is formed at one side of a piston 117 which is operatively connected to valve 113. At the opposite side of piston 117 is a chamber 118 which is open to a control pipe 119.

Associated with the fuel control shaft 3 and preferably with the adjusting lever 86 is a maximum fuel limiting device which is preferably in the form of a fluid pressure adjustable stop 120 constituting another part of the invention. This device comprises a cylinder 121 containing a piston 122 having a rod 123 projecting from one face and arranged to engage or to be contacted by the fuel control lever 86. At one side of piston 122 is a pressure chamber 124 open to pipe 104 while at the opposite side is a non-pressure chamber 125 which is open to atmosphere through a port 126. A spring 127 in chamber 125 acts on piston 122 in opposition to pressure of fluid in chamber 124.

It will be noted that pipe 104 is connected to pressure chamber 103 in the governor control motor 100 and also to pressure chamber 124 in the maximum fuel limiting device 120, whereby, in accordance with the invention, the pressure of fluid in both of these chambers is adapted to be controlled in unison by operation of the operator's speed control device 109 when pipe 104 is connected to pipe 104A, while both of these chambers are adapted to be opened to atmosphere together when valve 113 in the interlock valve device 108 is moved to the position to close the communication between chambers 112 and 111 and to open chamber 112 to the atmospheric chamber 114. The control of the interlock valve device 108 will be hereinafter described.

In the governor control motor 100 the pressure of spring 107 on piston 102 is such, according to the invention, as to prevent movement of said piston out of the normal position in which it is shown in the drawing against the minimum pressure (10 pounds) of fluid provided by the operator's speed control device 109 with the lever 110 thereof in its "idle" position, but to permit movement of said piston against said spring a distance in proportion to the increase in pressure in said chamber in excess of 10 pounds as the operator's speed control lever 110 is moved out of "idle" position in the direction of "full speed" position.

In the minimum fuel limiting device 120 the pressure of spring 127 on piston 122 is such that when the minimum pressure of fluid is effective in chamber 124 the piston 122 and rod 123 will be moved against spring 127 to a position which will allow movement of the fuel control lever 86 by spring 98 out of the fuel cut-off position to a position slightly above the engine idle position indicated by the dot and dash line 5*a*. When the pressure of fluid in chamber 124 is then increased above the minimum value of 10 pounds the piston 122 will move in unison with the governor control piston 102, and the rod 123 will remain out of contact with the lever 86 except under a condi-

tion to be later described. When pipe 104 is open to atmosphere by way of the interlock device 108, spring 127 in the maximum fuel limiting device 120 is adapted to operate piston 122 and thereby rod 123 to move the fuel control lever 86 to its fuel cut-off position indicated by the dot dash line 4.

Let it be assumed that the parts of the interlock valve device 108 are in the position shown in the drawing opening communication between pipes 104 and 104A, and that the operator's speed control lever 110 is in "idle" position and that piston 122 and rod 123 in the maximum fuel limiting device are moved to the position to permit movement of the fuel control lever 86 and shaft 3 by spring 98 to a position slightly above the engine idling position indicated by the dot and dash line 5*a*. Let it further be assumed that in response to operation of the operator's maneuvering control valve device 48 the starting air valve device 35 has been operated to supply starting air to the engine and that the engine is turning under the influence of such air in the direction determined by the position of the cam shaft 2. With the fuel control lever 86 positioned to supply fuel to the engine the engine will fire upon being placed in motion by the starting air and will then run on fuel following which lever 55 of the maneuvering control device 48 will be moved from whichever "start" position it may be in to the adjacent "run" position to thereby effect operation of the starting air valve device 35 to cut-off the supply of starting air to the engine. The engine will then continue to run on fuel.

As soon as the engine starts to operate as just described the speed governor 97 will act to rock lever 88 against spring 98 and thus pull the fuel control shaft 3 in a clockwise direction to reduce the amount of fuel supplied to the engine, and this action will continue until a balance is obtained between the centrifugal force of the governor arms 92 and the pressure of spring 98, at which time the fuel control lever 86 will assume its engine idling position, indicated by dot and dash line 5*a*, so that the supply of fuel to the engine will be such as to allow operation of the engine at idling speed.

If the operator now desires to increase the speed or power output of the engine he will move lever 110 away from "idle" position to thereby increase the pressure of fluid in pipe 104 to a degree corresponding to the position of said lever. This pressure of fluid in pipe 104 effective in chamber 103 of the governor control motor 100 and in chamber 124 of a maximum fuel limiting device 120 will move the respective pistons 102 and 122 in unison. This movement of piston 122 will be without effect except to maintain the rod 123 out of contact with the fuel control lever 86, but the movement of piston 102 to a position corresponding to that of the operator's speed control lever 110 will act to correspondingly increase the force of the governor control spring 98 against lever 88. The lever 88 will thereby be operated to turn the fuel control shaft 3 in the direction of the maximum fuel position indicated by the dot and dash line 5 to increase the supply of fuel to the engine. The engine will then accelerate and cause operation of the speed governor 97 to rock lever 88 against spring 98 and thus move the fuel control shaft 3 in the opposite direction to reduce the supply of fuel to the engine, and this action will continue until a balance is obtained between the centrifugal force of the governor arms 92 and the adjusted force of spring 98, whereby the supply of fuel to and thus the speed of the engine will be increased to a degree corresponding to the increase in pressure of fluid in the control pipe 104 and thus corresponding to the position of lever 110 out of "idle" position.



On the other hand if the engine is operating at a certain speed and the operator desires to reduce the speed he will move lever 110 back in the direction of "idle" position to thereby reduce the pressure of fluid in the control pipe 104 to allow movement in unison of the governor control piston 102 and of the maximum fuel limiting device piston 122 by their respective springs 107 and 127 to a new position corresponding to the new position of lever 110. This movement of the governor control piston 102 will act to reduce the force of spring 98 on lever 88, and the speed governor 97 will then operate to correspondingly change the position of the fuel control lever 86 and reduce the supply of fuel to the engine so that the engine will decelerate to a speed corresponding to the change in position of the operator's control lever 110. It will thus be seen that by suitable adjustment of lever 110, any desired rate of fuel supply to and thus speed of the engine may be attained.

During normal operation of the engine under control of the governor motor 100, as above described, the maximum fuel limiting device 120 serves no useful purpose, since piston 122 moves in unison with piston 102 and maintains rod 123 out of contact with the fuel control lever 86, but it should be noted that the piston 122 and rod 123 always assume an adjusted position corresponding to that of the governor control piston 102 and therefore corresponding substantially to the amount of fuel which the operator desires to supply to the engine. The purpose of thus adjusting the maximum speed limiting device 120 in synchronism with the fuel governor motor 100 is to prevent the supply of fuel to the engine being increased substantially in excess of that chosen by adjustment of the operator's fuel control lever 110, in case of what might be considered the application of an excessive or abnormal load to the engine, so as to thereby prevent undue straining of the engine under such a condition as will now be described in greater detail.

Let it be assumed that the engine is operating at a chosen speed corresponding to the preselected position of the operator's speed control lever 110, under which condition piston 122 and rod 123 of the maximum fuel limiting device 120 will be correspondingly adjusted, and an excessive or abnormal load is imposed upon the engine. Due to this abnormal load the engine will tend to slow down and reduce the centrifugal force of the governor weights 92 and thereby render spring 98 effective to rock lever 88 and move the fuel control lever 86 and shaft 3 in a direction to increase the supply of fuel to the engine so as to maintain the engine at the speed corresponding to the adjustment of the governor motor 100. The slight distance which the fuel control lever 86 can thus be moved by the governor spring 98 is, however, limited by contact between said lever and the piston rod 123 which at this time acts as a stop to prevent further movement by the governor control spring 98, so as to thereby limit the increase in fuel supply to the engine to a relatively small degree in excess of that preselected by the position of

the speed control lever 110. It will thus be seen that regardless of the position of the operator's control lever 110 between the "idle" and "full speed" positions, the maximum fuel limiting device 120, being adjusted in accordance with the position of said lever, will act to prevent any substantial increase in fuel supply to the engine over that preselected by the operator, in case of the sudden application of an excessive or abnormal load to the engine, whereby the engine will be prevented from working under a load substantially in excess of that selected by the adjustment of the control lever 110.

Pipe 119 connected to piston chamber 118 in the interlock valve device 108 leads to a directional control device 130, which comprises (Fig. 2) two poppet valves 131 and 132 contained in chambers 133 and 134 which are open to the ahead and astern pipes or 50 and 51, respectively. The poppet valves 131 and 132 are arranged side by side with parallel extending fluted stems 135 and 136, respectively, which extend into a chamber 137 to which is connected pipe 119. The valves 131 and 132 are provided to control communication between chambers 133 and 134, respectively, and chamber 137, and a spring 138 in each of the chambers 133 and 134 acts on the respective valves 131 and 132 to urge them to their closed position.

The valve stems 135 and 136 engage, respectively, two spaced operating plungers 139 and 140 which are slidably mounted in the casing and which are provided with stems 141 and 142 extending to the exterior of the casing through sealing rings 143 which are adapted to prevent leakage of fluid under pressure from chamber 137 past the respective plungers and stems to atmosphere. Two rockable cams 144 and 145, fulcrumed on pins 146 in the casing, are provided for controlling the plungers 141 and 142 respectively. These cams are of identical structure but are reversely arranged and each is connected to the respective plunger 141 or 142 through the medium of a pressure transmitting element 147 which is rockably mounted on a pin 148 secured in the casing. Each of the cams 144 and 145 is provided with a surface 149 which, when in contact with the respective pressure transmitting element 147, will unseat the respective valve 131 or 132. Adjacent the surface 149 each cam is provided with a recess 150 adapted to receive the respective element 147 to permit movement of the respective plunger 139 or 140 by a spring 151 to a position to permit closure of the respective valve 131 or 132 by the respective spring 138.

The two cams 144 and 145 are operatively connected for movement in unison by a link 152 and since the cams are reversed as above mentioned movement of the link and cams to the position in which they are shown in the drawing will effect opening of valve 131 and closure of valve 132, while movement of said link and cams in a counterclockwise direction as viewed in the drawing to a position in which surface 149 on cam 145 engages the respective element 147 will effect opening of valve 132 and closing of valve 131.

The directional control device 130 further comprises a control piston 154 and a piston rod 155 having one end connected to said piston and extending through a non-pressure chamber 156 at one side of said piston. At the opposite side of piston 154 is a pressure chamber 157 which is in



constant communication through a pipe 158 with the engine starting air pipe 37.

The opposite or outer end of piston rod 155 is pivotally connected by a pin 159 to a lug 160 projecting from the back face of a friction shoe 161. The opposite face of shoe 161 is concave providing a surface 162 which is arranged to frictionally engage the peripheral surface of crankshaft 1. Also connected to pin 159 is one end of a link 163 the opposite end of which is operatively connected to the adjacent end of a cam operating link 152.

The piston rod 155 is capable of side movement in the non-pressure chamber 156 from the position in which it is shown in the drawing, and which is defined by contact with a surface 164 in the casing, to a position in which said rod engages a surface 165 in the casing. Adjacent the surface 165 the casing is provided with a pin 166, and the link 163 has two receses 167, one of which is arranged to receive the pin 166 with the piston rod 155 in the position in which it is shown in the drawing, while the other recess 167 is arranged to receive pin 166 in the other position of said rod.

The piston rod 155 is encircled within chamber 156 by a spring 168 one end of which engages the piston 154 while the opposite end is supported on a shoulder 169 in the casing. This spring is under pressure and adapted to move the piston 154 to the position in which it is shown in the drawing when pressure chamber 157 is open to atmosphere. When fluid under pressure is supplied to pressure chamber 157, in a manner which will later be described, the piston 154 is adapted to move against spring 168 to operate rod 155 to move the friction shoe 161 into contact with the crankshaft 1. When the shoe 161 is in contact with the crankshaft, the link 163 will be elevated to a position in which it will be disconnected from the pin 166. When fluid under pressure is released from chamber 157 spring 168 is adapted to actuate piston 154 and rod 155 to move the shoe 161 out of contact with the crankshaft, under which condition pin 166 will enter either one of the two recesses 167, to secure the links 163 and 152 and thereby cams 144 and 145 against accidental movement out of the selected position.

The interlock valve device 108, as controlled by the directional control device 130, is provided to render the maximum fuel limiting device 120 effective to actuate the fuel control shaft 3 to its fuel cut-off position, when the operator actuates lever 55 of the maneuvering control device 48 to reverse the engine from one direction of operation to the opposite direction, until after the engine starts to turn in said opposite or the selected direction under the influence of starting air supplied through pipe 37. More specifically let it be assumed that the engine is operating in the astern direction with the operator's control lever 55 in the "astern" "run" position, in which position pipes 57 and 51 will be charged with fluid under pressure, and the ahead pipes 56 and 50 will be open to atmosphere. In the directional control device 130 valve 132 will be closed while valve 131 will be open connecting pipe 119 from the interlock valve device 108 to the vented ahead pipe 50 for reasons which will later become apparent. With pipe 119 thus vented the parts of the interlock valve device 108 will be in the positions in which they are shown in the drawing, establishing communication between pipes 104 and 104*a*, whereby the operator by operation of lever

110 may control the governor motor 100 and thereby the amount of fuel being supplied to the engine.

With the engine operating in the astern direction let it be assumed that the operator desires to reverse the direction of operation from astern to ahead, in as short time as possible. To accomplish this he will move lever 55 of the maneuvering control device 48 from the "Astern" "run" position to the "ahead" "start" position to thereby open pipes 57 and 50 to atmosphere and at the same time to supply fluid under pressure to the ahead pipe 56 and thence to pipe 51 to effect movement of the cam shaft 2 to its ahead position, followed by operation of the starting air valve device 35 to supply starting air through pipe 37 to initiate starting of the engine. Fluid under pressure supplied to the ahead pipe 56 and to pipe 50 as just described will also flow to chamber 133 in the directional control device 130 and from said chamber 133 past the open valve 131 to chamber 137 and thence through pipe 119 to pressure chamber 118 in the interlock valve device 108. The interlock valve device 108 will thereby be operated upon initiating the reversal in direction of engine operation to close communication between pipes 104*a* and 104 and to open the latter pipe and thereby chambers 103 and 124 in the fuel control motor 100 and in the maximum fuel limiting device 120, respectively, to atmosphere. The maximum fuel limiting device 120 will then promptly operate, in response to operation of the maneuvering control lever 55 to reverse the direction of engine operation, to move the fuel control lever 86 to its fuel cut-off position to thereby cut off the supply of fuel to the engine so that the engine may be stopped under the influence of starting air as above mentioned, or by any other conventional means.

When the starting air valve device 35 is operated to supply starting air to the engine a portion of this starting air will flow through pipe 158 to piston chamber 167 in the directional control device 130 and therein act on piston 154 to force the friction shoe 161 into contact with the peripheral surface of the crankshaft 1. If at the time starting air is supplied to the engine and the shoe 161 is moved into contact with the crankshaft 1, the engine is still running in the direction of last operation, i. e., in the astern direction in the present instance, the shoe 161 and thereby the other parts of the directional control device 130 will remain in the position in which they are shown in Fig. 2. However, as soon as the engine and the crankshaft starts turning in the new, or the ahead direction after being brought to a stop from operation in the opposite direction, such turning of the crankshaft will move the shoe 161 from the position in which it is shown in Fig. 2 to the position defined by contact with surface 165 in the casing. This movement of shoe 161 will actuate cams 144 and 145 to permit closing of valve 131 and opening of valve 132, respectively. The closing of valve 131 will cut off the supply of fluid under pressure from the ahead pipe 50 to chamber 118 in the interlock valve device 108, while the opening of valve 132 will connect said chamber to the astern pipe 51 which at this time is open to atmosphere through the operator's maneuvering control device 48. Fluid under pressure will therefore be released from chamber 118 in the interlock device 108 just as soon as the engine starts to turn in the ahead direction and said device will then operate to reestablish communication between pipes 104 and 104*a*, whereby the pressure of fluid provided by the operator's speed control device 109 will then become effective in chamber 124 in the maximum fuel limiting device 120 and operate piston 122 to move rod 123 out of contact with the fuel control lever 86. The fuel control lever 86 will then be operated by the governor control spring 98 to a fuel supply position for supplying fuel to the engine. The engine will then fire and run on fuel.



As soon as the engine fires and is running on fuel as just described, the operator will move the control lever 55 to the "ahead" "run" position to effect operation of the starting air valve device 35 to cut off the supply of starting air to the engine and to open pipe 37 to atmosphere by way of port 42. Fluid under pressure will then be released from piston chamber 157 in the directional control device 130 by way of pipe 37 to permit movement of shoe 161 by spring 168 out of contact with the crankshaft. With the engine now running on fuel the operator by suitable adjustment of lever 110 can vary the fuel supply to the engine, as desired.

If the operator operates the maneuvering control lever 55 to reverse the direction of operation of the engine from ahead to astern, the interlock valve device 108, as controlled by the directional control device 130, will promptly operate to render the maximum fuel limiting device 120 effective to move the fuel control lever 86 to the fuel cut-off position in order to allow the engine to stop, and then immediately upon starting of the engine in the opposite or chosen direction under the influence of starting air, said devices will operate to effect operation of the maximum fuel limiting device to permit supply of fuel to the engine under the control of the governor motor 100, as will be apparent without further description.

Whenever the operator desires to stop the engine, regardless of the direction of operation, he need only move the maneuvering control lever 55 to "stop" position, to thereby cause operation of motor 47 to turn the maneuvering control shaft 6 to its "stop" position. This movement of the maneuvering control shaft 6 will operate cam 84 and thereby lever 82 to turn the fuel control shaft 3 to and then hold it in its fuel cut-off position, as long as the operator's control lever 55 is in "stop" position.

It will be noted that when the engine is stopped as just mentioned, pipe 119 will still be open to atmosphere through the ahead pipe 56 if the engine is stopped from operation in the astern direction, or through the astern pipe 57 if the engine is stopped from operation in the ahead direction, so that with the engine stopped, as well as in restarting the engine in the direction in which it last operated which will be presently described, the parts of the interlock valve device 108 remain in the position in which they are shown in the drawing so that the maximum fuel limiting device 120 has no control over the fuel control shaft 3. The cam 84 moves the fuel control shaft 3 to its fuel cut-off position in stopping the engine, as above mentioned.

To restart the engine in the direction in which it last operated, the operator will move the maneuvering control lever 55 to the proper "start" position to effect operation of the starting air valve device 35 and to turn cam 84 out of contact with roller 83. The fuel control shaft 3 will then be operated by the governor spring 98 to supply fuel to the engine so that as soon as the engine

starts to turn under the influence of starting air, it will fire on the fuel supplied. After the engine fires, the operator will then move the maneuvering control lever 55 to the adjacent "run" position to cut off the starting air. By suitable adjustment of the fuel control lever 110, any desired speed or power output of the engine may then be obtained.

From the above description it will now be noted that in order to stop the engine from operation in either direction the fuel is cut off by operation of cam 84 and lever 82, while in reversing the direction of engine operation from ahead to astern, or vice versa, the cam 84 is only momentarily effective as the maneuvering control shaft 6 passes through "stop" position, under which condition and during which operation, the fuel is cut off and maintained cut off by operation of the maximum fuel limiting device 120 until after the engine starts turning in the new or selected direction.

*Description Fig. 3*

If desired, the functions of both the maximum fuel limiting device 120 and of the governor control motor 100 may, in accordance with a modification of the invention, be incorporated in a single control device 170, in the manner shown in Fig. 3 of the drawing.

The control device 170 comprises a casing containing a piston 171 which is connected by a rod 172 to the governor control spring 98. At one side of piston 171 there is a pressure chamber 173 connected to pipe 104 the pressure of fluid in which is arranged to be controlled through the interlock valve device 108 in the same manner as in the structure shown in Fig. 1 and above described. At the opposite side of piston 171 is a non-pressure chamber 174 open to atmosphere through a port 175 and containing a control spring 176 acting on piston 171.

According to the invention, a stop pin 177 encircled by the governor control spring 98 has one end adjustably connected to the piston rod 172 by screw-threads while its opposite end is arranged for contact with the governor control lever 88. When pipe 104 is open to atmosphere through the interlock valve device 108 during reversing of the engine, spring 176 will move piston 171 to a position in contact with the lower end of the casing. This movement of piston 171 will move the stop pin 177 into contact with the governor control lever 88 and operate said lever to move the fuel control lever 86 to and then hold same in its fuel cut-off position as long as pipe 104 is open to atmosphere. When pipe 104 is open to 104*a* through the interlock valve device 108 the minimum pressure of fluid provided in chamber 173 by the operator's speed control device 109, with lever 110 in "idle" position, will move piston 171 against spring 176 to the position in which it is shown in the drawing to draw the stop pin 177 out of contact with lever 88 and to tension the governor control spring 98 to provide for idling operation of the engine, the same as obtained when piston 102 of the governor control motor 100 (Fig. 1) is in contact with the lower end of its casing as shown in the drawing and above described. By varying the pressure of fluid in piston chamber 173, above the minimum pressure just mentioned, by operation of the operator's speed control device 109, the piston 171 will adjust itself against spring 176 to vary the force of spring 98 on the governor control lever 88 to thereby adjust the fuel control lever 86 to regulate the amount of fuel supplied to the engine, in



the same manner as obtained by operation of the governor control motor 100 in the structure shown in Fig. 1.

*Summary*

It will now be seen that I have provided an apparatus for controlling the starting, reversing and operation of a reversible prime mover embodying fuel control structure, including a speed governor, which is controlled by and is automatically adjustable in accordance with the adjustment of an operator's speed control device for limiting the supply of fuel to the prime mover to substantially the degree preselected by said device, under a condition which otherwise would cause the governor to operate to increase the fuel supply to maintain engine speed. Undue straining of the engine under such a condition is thereby avoided. The fuel governing structure is also automatically operative, as controlled by a directional control device, to cut off the supply of fuel to the engine to allow it to stop in reversing the engine from one direction of operation to the opposite direction, and to promptly permit resupply of fuel to the engine when the engine starts to turn in the new or selected direction.

Briefly, the structure embodying the invention differs from that disclosed in my copending application hereinbefore referred to in the arrangement which provides for control of both fuel supply and of the limiting means therefore (devices 100, 120 respectively in Fig. 1, and 170, 177 respectively in Fig. 2) in unison by the operator's speed control device 109, such control being interlocked through the interlock valve device 108 controlled by the directional control device 130 for, in reversing the engine, rendering the device 120 in Fig. 1 or 177 in Fig. 2 effective to cut off the fuel supply to the engine until after the engine stops from its last direction of operation and starts to turn in its new direction of operation.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member adjustable to vary the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable control means and being operable to adjust said fuel control member in accordance with the adjustment of said control means, an operator's control device operable to vary the adjustment of said control means, fuel limiting means adjustable to prevent movement of said fuel control member to increase the supply of fuel to said prime mover substantially in excess of that corresponding to the adjustment of said control means, and means connecting said limiting means with said control means for simultaneous adjustment therewith.

2. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member adjustable to vary the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable control means and being operable to adjust said fuel control member in accordance with the adjustment of said control means, an operator's control device operable to vary the adjustment of said control means, stop means adjustable to prevent movement of said fuel control member to increase the supply of fuel to said prime mover substantially above that corresponding to the adjustment of said control means, and means connecting said stop means to

said operator's control device for adjustment in unison with said control means.

3. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a fuel control member having a fuel control zone of movement and being operable upon movement in one direction in said zone to increase the amount of fuel supplied to said prime mover and upon movement in the opposite direction in said zone to reduce the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable control means, and being operable to adjust said fuel control member to a position in said zone corresponding to the adjustment of said control means, adjustable stop means operable to prevent movement of said fuel control member in the direction to increase the supply of fuel to said prime mover in excess of the adjustment of said stop means, an operator's control device, and means connecting both said control means and stop means to said control device for rendering said control device operable to vary simultaneously the adjustments of said control means and stop means.

4. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member adjustable to vary the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable pressure means and operable to adjust said fuel control member to supply fuel to said prime mover in an amount proportional to the pressure of said pressure means, a control motor operable by fluid under pressure to vary the pressure of said pressure means in proportion to the pressure of such fluid, a stop motor operable by fluid under pressure to limit movement of said fuel control member by said speed governor to increase the amount of fuel supplied to said prime mover to a degree substantially in proportion to the pressure of fluid in said stop motor, an operator's control device for varying pressure of fluid, and means connecting both said control motor and stop motor to said operator's control device for rendering same effective to vary simultaneously the pressure of fluid in both of said motors.

5. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member adjustable to vary the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable pressure means and operable to adjust said fuel control member to supply fuel to said prime mover in an amount proportional to the pressure of said pressure means, a control motor operable by fluid under pressure to vary the pressure of said pressure means in proportion to the pressure of such fluid, an operator's control device operable to vary the pressure of fluid in said control motor, stop means adjustable by fluid under pressure to limit movement of said fuel control member to increase the fuel to said prime mover to a degree substantially in proportion to the pressure of such fluid, and means for subjecting said stop means to pressure of fluid supplied by said control device.

6. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member adjustable to vary the amount of fuel supplied to said prime mover, a prime mover operated speed governor comprising adjustable pressure means and operable to adjust said fuel control member to supply fuel to said prime mover in an amount proportional



to the pressure of said pressure means, a control motor operable by fluid under pressure to vary the pressure of said pressure means in proportion to the pressure of such fluid, an operator's control device operable to vary the pressure of fluid in said control motor, stop means adjustable to limit movement of said fuel control member in the direction to increase the amount of fuel supplied to said prime mover, and means operable by said motor to adjust said stop means substantially in accordance with the pressure of said pressure means.

7. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member for said prime mover having an idling position and being movable out of said idling position to increase the supply of fuel to said prime mover, a prime mover operated speed governor comprising a control spring operable to move said member in the direction out of idling position, and means driven by said prime mover and cooperative with said spring to position said member to supply fuel to said prime mover in an amount proportional to the force of said spring, an operator's control device adjustable to vary the force of said spring, stop means adjustable to limit movement of said fuel control member out of idling position by said spring, and means controlled by said operator's control device for adjusting said stop means to a position substantially corresponding to the adjustment of said operator's control device.

8. An apparatus for controlling the supply of fuel to a reversible prime mover comprising in combination, a movable fuel control member having a fuel cut-off position and being movable out of said position to supply fuel to said prime mover in an amount proportional to the degree of such movement, a prime mover operated speed governor comprising pressure means operable to adjust said fuel control member out of said cut-off position to a degree proportional to the force of said pressure means, cut-off means operable to move said fuel control member to said cut-off position, an operator's control device operable to adjust the pressure of said pressure means, means adapted to respond to operation of said control device, to adjust said pressure means, to simultaneously render said cut-off means ineffective, reversing means selectively conditionable to render said prime mover operable in either one direction or in the opposite direction, and mechanism controlled by the direction of operation of said prime mover comprising means operable upon operation of said prime mover in a direction, corresponding to the condition of said reversing means, to render said cut-off means controllable by said operator's control device, and other means operable upon operation of said prime mover in a direction contrary to the condition of said reversing means to effect operation of said cut-off means to move said fuel control member to said cut-off position.

9. An apparatus for controlling the supply of fuel to a reversible prime mover comprising in combination, a fuel control member having a fuel cut-off position and being movable out of said cut-off position to supply fuel to said prime mover in an amount proportional to the degree of such movement, an operator's maneuvering control device having a stop position, an ahead position and an astern position, mechanism responsive to movement of said control device to said ahead position to start said prime mover in an ahead direction and responsive to movement of said control device to said astern position to

start said prime mover in an astern direction, means responsive to movement of said control device to said stop position to effect movement of said fuel control member to said cut-off position and being ineffective to control said fuel control member in said ahead and astern positions of said control device, fuel control means operable to adjust said fuel control member out of said cut-off position, fuel cut-off means operable to move said fuel control member to said cut-off position, an operator's fuel control device, means for rendering said fuel control device effective to simultaneously control operation of said fuel control means and to render said fuel cut-off means ineffective, and means including a device responsive to direction of operation of said prime mover operable upon movement of said maneuvering control device to a position contrary to the direction of operation of said prime mover to effect operation of said cut-off means to move said fuel control member to said cut-off position and operable upon starting of said prime mover in the direction corresponding to the position of said maneuvering control device to render said cut-off means responsive to operation of said operator's fuel control device.

10. An apparatus for controlling the supply of fuel to a prime mover comprising in combination, a movable fuel control member having a fuel cut-off position and being movable out of said cut-off position to increase the supply of fuel to said prime mover in an amount proportional to the degree of such movement, a prime mover operated speed governor comprising an adjustable control element and being operable to adjust said member out of said cut-off position to a degree corresponding to the adjustment of said element, an operator's control device operable to adjust said control element, stop means adjustable operation to limit movement of said fuel control member out of said cut-off position, means responsive to said operation of said control device to adjust said stop means, said stop means being also operable to effect movement of said control member to said cut-off position, and means operable to effect operation of said stop means to move said fuel control member to said cut-off position.

11. An apparatus for controlling the supply of fuel to a reversible prime mover comprising in combination, a movable fuel control member having a fuel cut-off position and being movable out of said position to supply fuel to said engine in an amount proportional to the degree of such movement, a speed governor operated by said prime mover and comprising an adjustable control element and being operable to adjust said member out of said fuel cut-off position to a position corresponding to the adjustment of said element, an operator's control device operable to adjust said element, stop means for said fuel control member, means controlled by operation of said control device, to adjust said element, to simultaneously adjust said stop means to limit movement of said fuel control member out of said cut-off position to a degree corresponding substantially to the adjustment of said control element by said control device, said stop means being also operable to effect movement of said fuel control member to said fuel cut-off position, mechanism operable to effect operation of said prime mover in either one direction or in the opposite direction, directional means responsive to direction of operation of said prime mover, and means controlled by said directional



means operable upon operation of said prime mover in the direction determined by said mechanism to render said stop means controllable by said operator's control device and operable upon operation of said prime mover in a direction contrary to that determined by said mechanism to effect operation of said stop means to move said fuel control member to said cut-off position.

12. An apparatus for controlling the supply of fuel to a reversible prime mover comprising in combination, a movable fuel control member having a fuel cut-off position and being movable out of said position to supply fuel to said engine in an amount proportional to the degree of such movement, a fluid motor operable by fluid under pressure to move said fuel control member in a direction away from said cut-off position to a degree proportional to the pressure of such fluid, stop means operable by fluid under pressure to limit movement of said fuel control member out of said cut-off position to a degree proportional to the pressure of the operating fluid and comprising means operable upon release of fluid under pressure to move said control member to said cut-off position, an operator's fluid pressure regulating device, means adapted to connect both said fluid motor and stop means to said regulating device for rendering said regulating device effective to vary simultaneously the pressure of controlling fluid in said motor and stop means, valve means controlling the fluid control communication between said operator's control device and stop means and operable to either open said communication or to close said communication and release fluid under pressure from said stop means, reversing means operable to condition said prime mover for operation in either one direction or in the opposite direction, and directional means responsive to direction of operation of said prime mover and operable upon operation thereof in a direction contrary to that determined by said mechanism to effect operation of said valve means to release fluid under pressure from said stop means and operable upon operation of said prime mover in a direction corresponding to the condition of said reversing means to effect operation of said valve means to open the communication control thereby.

13. An apparatus for controlling the supply of fuel to a reversible prime mover comprising in combination, a movable fuel control member having a fuel cut-off position and being movable out of said position to supply fuel to said engine in an amount proportional to the degree of such movement, a fluid motor operable by fluid under pressure to move said fuel control member in a direction away from said cut-off position to supply fuel to a degree proportional to the pressure of such fluid, an operator's control device arranged to control the pressure of fluid in said motor, adjustable stop means for said fuel control member, means adjustable by said control device in synchronism with operation of said fluid motor to adjust said stop means to limit movement of said fuel control member out of said cut-off position to a degree corresponding substantially to the pressure of fluid in said motor, structure for operating said stop means to move said control member to said cut-off position, reversing means operable to condition said prime mover for operation in either one direction or in the opposite direction, directional means responsive to direction of operation of said prime

mover, and means controlled by said directional means operable upon operation of said prime mover in a direction contrary to the condition of said reversing means to render said structure effective to move said fuel control member to said fuel cut-off position and operable upon operation of said prime mover in the direction determined by said reversing means to render said stop means controllable by said operator's control device.

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