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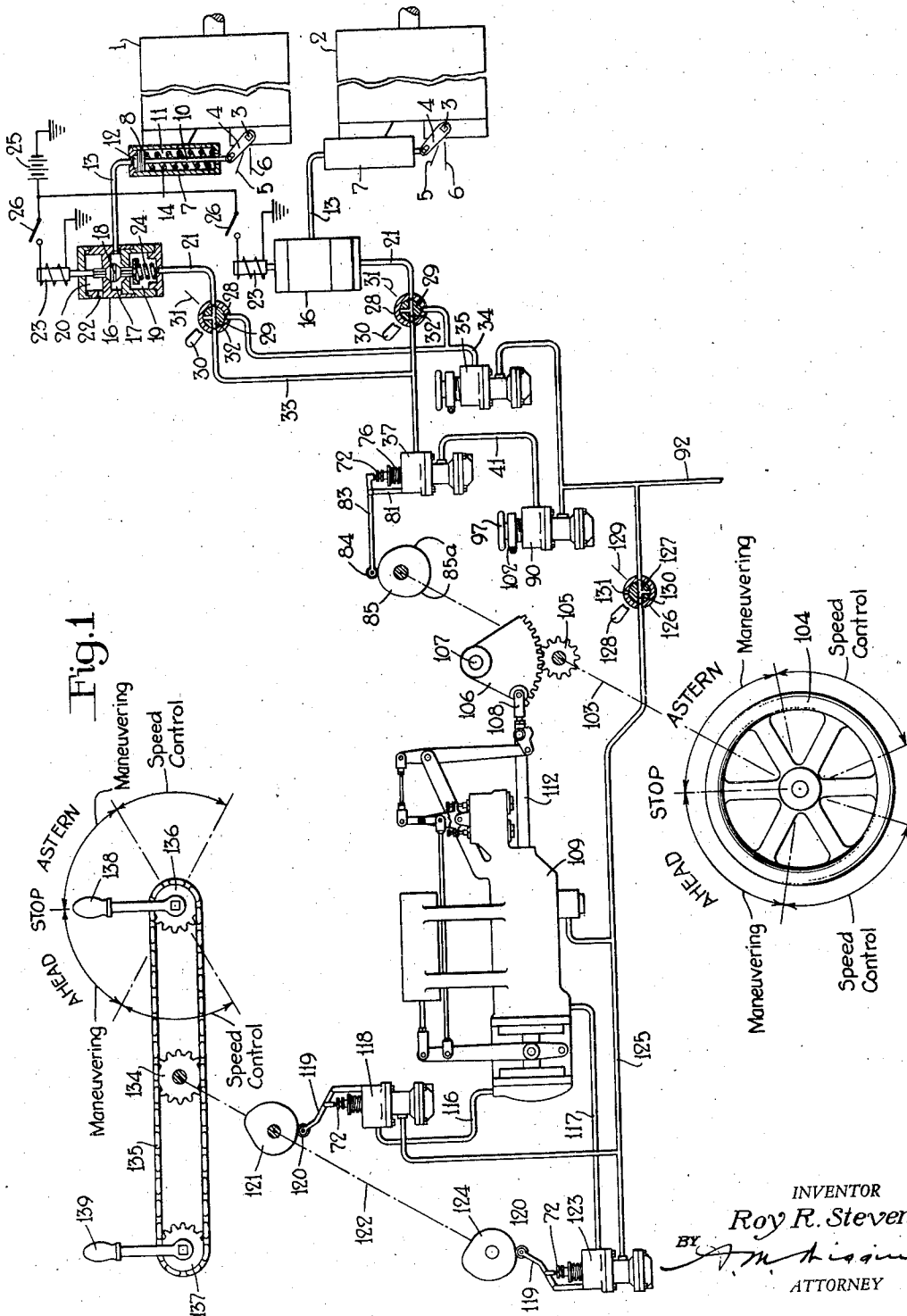
R. R. STEVENS

2,404,545

CONTROL APPARATUS

Original Filed April 28, 1944

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 3

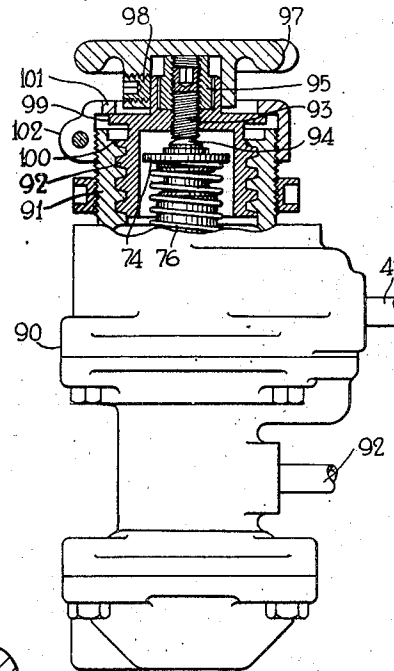
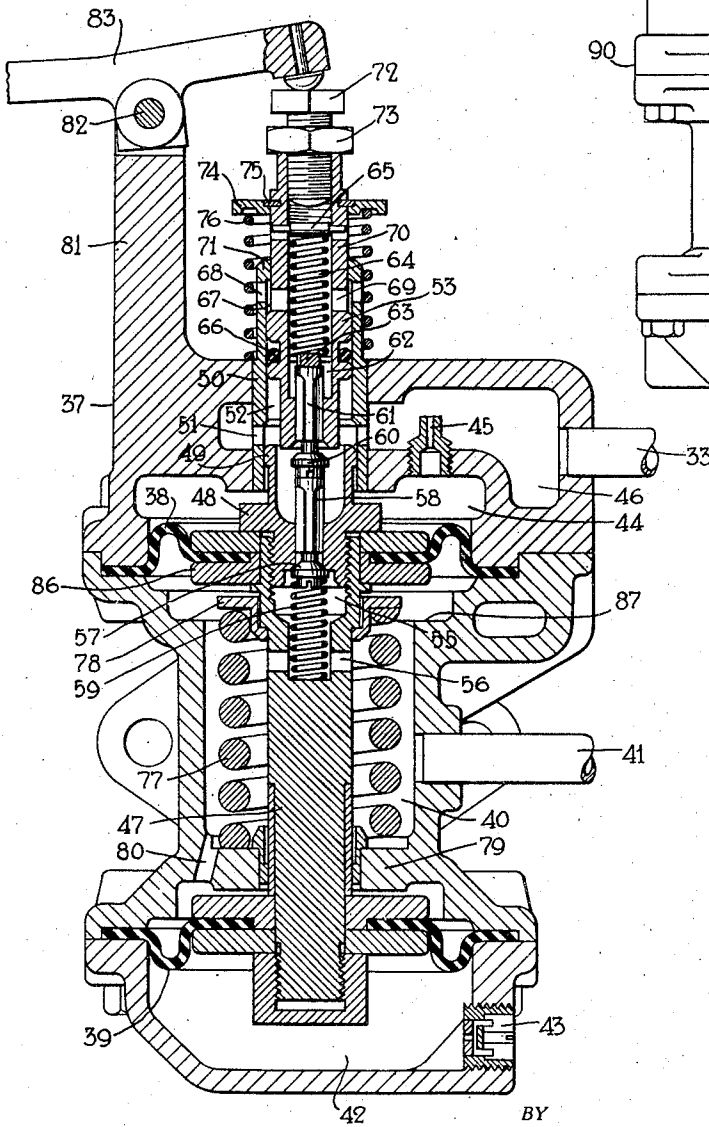


Fig. 2



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2,404,545

CONTROL APPARATUS

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Original application April 28, 1944, Serial No. 533,145. Divided and this application April 21, 1945, Serial No. 589,640

4 Claims. (Cl. 60—97)

1

This invention relates to control apparatus and more particularly to means for controlling operation of a plurality of internal combustion engines; the present application being a division of my copending application Serial No. 533,145, filed April 28, 1944.

Certain ships are provided with a plurality of propulsion engines, such as of the Diesel type, and it is desirable at times to employ all of the engines for propulsion, while at other times less than all of the engines will provide adequate power for propulsion, under which latter condition it may be desirable to have the other engine or engines, not being used for driving the ship, operating at minimum or idling speed and instantly available to provide additional power for propulsion, if such is desirable.

Diesel engines are usually capable of continuous operation at a certain high speed which however is less than their maximum speed. The engines can be operated at their maximum speed only intermittently in order to avoid damage to the engines. In case of emergency, such for example as a ship answering a fire call, it is however desirable to be able to operate the engines at their maximum speed. It is also desirable to prevent indiscriminate operation of the engines at maximum speed. Further, as in case of a fire, it may be desirable to employ one of the engines for operating a fire pump while retaining the other engine or engines for propulsion purposes.

The principal object of the invention is therefore the provision of an engine control apparatus arranged to meet all of the above requirements or conditions.

According to this object the control apparatus is arranged to provide for control of the engines for propulsion purposes from either of two control stations, such as the engine room on a ship and from a remote control station such as the pilot house; the control station being selected by the engineer in the engine room. The engineer is provided with means whereby he may at will cut out any engine and, if he so desires, operate that engine independently of another engine or engines which may be still employed for propelling the ship. The engineer is also provided with means to limit the speed of the engines, that is, to allow the engine or engines to be operated at their top speed for continuous operation, or at their maximum speed for intermittent operation. The engineer being constantly aware of the operating condition of the engines may therefore limit the use of the maximum speed as required to protect the engine or engines against

2

damage, and thus completely relieve the pilot of concern for the engines.

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

In the accompanying drawings; Fig. 1 is a diagrammatic view, partly in section and partly in outline, of a control apparatus embodying the invention; Fig. 2 is a vertical sectional view of a self-lapping control valve device shown in side elevation in Fig. 1; and Fig. 3 is a view, partly in section and partly in outline, of another self-lapping control valve device shown in elevation in Fig. 1.

Description

In Fig. 1 of the drawings the reference numerals 1 and 2 indicate two internal combustion engines, for example of the Diesel type, which may be arranged to propel a ship directly, or the engines may operate generators for generating electric power to be used for operating electric propulsion motors. The manner in which the power of the two engines might be employed for propelling a ship is immaterial to the invention.

Each of the engines 1 and 2 is provided with a fuel control shaft 3 which is adjustable to different positions by a lever 4 for varying the amount of fuel supplied to and thereby the speed or power output of the individual engine. This control of the fuel supply to the engines may be direct, or the levers 4 may control the adjustment of a fuel control speed governor normally employed with engines of this type.

At each engine the fuel control lever 4 may have an idling position, in which it is shown in the drawing, to provide for operation of the engine at a minimum or idling speed. The fuel control lever 4 may be moved from this idling position to a position such as indicated by a line 5 for increasing the supply of fuel to the engine to an amount which will effect operation of the engine at its top speed for continuous operation, and said lever may be movable past line 5 to a position such as indicated by a line 6, for increasing the fuel supply to the engine to the amount to cause operation thereof at its maximum speed.

Adjustment of the lever 4 at each engine between its idling position and its continuous operation position indicated by line 5 will provide for operation of the engine at any desired speed from idling to the top speed for continuous speed, while adjustment between the continuous operation position indicated by line 5 and the maximum speed position indicated by line 6 will pro-

vide any degree of over speed in excess of the top continuous speed, as will be apparent.

Each engine is provided with fuel control device 7 for adjusting the position of the fuel control lever 4. Each of the fuel control devices 7 may, for the purpose of illustration, comprise a cylinder rigidly associated with the engine and containing a piston 8 connected by a rod 10 to the respective fuel control lever 4. The rod 10 extends through a non-pressure chamber 11 at one side of piston 8 while at the opposite side of said piston is a pressure chamber 12 open to a control pipe 13 through which fluid under pressure may be supplied to and released from said pressure chamber. A spring 14 in chamber 11 acts on piston 8 to yieldably oppose pressure of fluid effective in chamber 12. With all fluid under pressure released from the pressure chamber 12, spring 14 will move piston 8 to the position shown in the drawing by moving the fuel control lever 4 to its engine idling position. Upon supply of fluid to chamber 12 at a pressure which exceeds the opposing force of spring 14 the piston 8 will move to a position in which the pressure of fluid is counterbalanced by the increased pressure of said spring, for thereby moving the fuel control lever 4 out of idling position to a position corresponding to the pressure of such fluid. It will thus be seen that by providing fluid at different selected pressures in pressure chamber 12, the fuel control lever 4 may be adjusted to provide any selected amount of fuel to the engine to thereby obtain any desired degree of speed or output of power from the engine, while upon complete release of fluid from said chamber the speed or power output of the engine will be reduced to minimum.

At each engine the pipe 13 leads to a magnet operated cut-out valve device 16 which comprises a casing having a chamber 17 open to said pipe and containing a double seating valve 18 arranged to control communication between said pipe and chambers 19 and 20 which are open, respectively, to an individual speed control pipe 21 and to atmosphere through a passage 22. The valve 18 is connected to a solenoid 23 which is operable upon energization to actuate said valve to close communication between pipe 13 and chamber 19 and for opening pipe 13 to the atmospheric passage 22 for releasing fluid under pressure from pressure chamber 12 in the respective speed control device 7. Upon deenergization of the solenoid 23 a spring 24 is operable to actuate valve 18 to close communication between pipe 13 and the atmospheric passage 22 and to open said pipe to the control pipe 21. The solenoid 23 is arranged in a circuit including a battery 25 and a switch 26 whereby closure of said switch will effect energization of the solenoid and opening of the switch deenergization. The switch 26 for each of the two engines is arranged for operation by the engineer.

At each engine, the speed control pipe 21 leads to an individual control valve device 28 which also is arranged for operation by the engineer. Each of the control valve devices 28 comprises, for the purpose of illustration, a plug valve 29 contained in a casing and rotatable therein by a handle 30 to two different control positions which may be called a multiple control position, and an individual control position, since, in the multiple control position, the speed of all engines is arranged to be controlled in unison, while in the individual control position the engines will be arranged for independent or individual control.

In the drawings the handle 30 for each control valve device 28 is shown in its multiple control position, while its individual control position is indicated by a line 31.

Each plug valve 29 is provided with a T-shaped passage 32 which, in the multiple control position of handle 30, connects the individual speed control pipe 21 to a master speed control pipe 33. In the individual speed control position of handle 30 communication is closed between pipe 33 and the respective pipe 21, and the latter pipe is connected by passage 32 to a pipe 34 leading to what may be called an engineer's independent control valve device 35. In the multiple control position of handle 30 pipe 34 is lapped by the respective plug valve 29.

The master speed control pipe 33 leads to a master speed control valve device 37 which may be of any suitable structure to provide any desired pressure of fluid in said pipe. By way of example the valve device 37 may be substantially the same as a self-lapping valve device fully disclosed in a copending application of Harry C. May, Serial No. 523,656, filed February 24, 1944, now Patent No. 2,381,222, and assigned to the assignee of the present application. Since reference may be had to this copending application this device will be described in the present application only in such detail as required for an understanding of the present invention.

Briefly, the speed control valve device 37 comprises (Fig. 2) a casing containing two spaced coaxially arranged flexible diaphragms 38 and 39 which are rigidly clamped in the casing around their peripheral edges. Between the two diaphragms is a chamber 40 arranged to be constantly supplied with fluid under pressure from a fluid pressure supply pipe 41. At the opposite face of diaphragm 39 is a chamber 42 open to atmosphere through a breather device 43, while at the opposite side of diaphragm 38 is a control chamber 44 open through a choke 45 to a chamber 46 which is connected to the master speed control pipe 33. A stem 47 extending through chamber 40 has one end rigidly clamped to the diaphragm 39 centrally thereof while its opposite end is rigidly clamped to diaphragm 38 centrally thereof by means including a nut 48 contained in chamber 44.

The nut 48 has a projection 49 slidably mounted in the adjacent end of a sleeve 50. The sleeve 50 is arranged in coaxial relation with diaphragms 38 and 39 and is pressed into aligned bores provided in opposite walls of chamber 46, and is provided with one or more radial ports 51 connecting said chamber to a chamber 52 formed between the end of projection 49 and one side of a plunger 53 which is mounted to slide in said sleeve.

The stem 47 has a chamber 55 formed below the nut 48, which chamber is in constant communication with chamber 40 through one or more passages 56. The chamber 55 contains a fluid pressure supply valve 57 having a fluted stem 58 extending through a suitable bore in nut 48 in the direction of plunger 53, said nut being provided with a seat for engagement by said valve. The valve 57 is thus arranged to control communication between chambers 55 and 40 and chamber 52, and a spring 59 in chamber 55 acts on said valve for urging it to its seated or closed position.

In chamber 52 the end of the supply valve stem

5

58 is engaged by a fluid pressure release valve 60 which has a fluted stem 61 slidably mounted in a bore provided axially in a depending portion of plunger 53 and extending through said bore into a bore 62 of larger diameter. A spring seat 63 in bore 62 engages the end of the release valve stem 61 and is engaged by one end of a coil spring 64, the opposite end of which spring engages a follower 65 mounted in the plunger 53. The plunger 53 is provided with an annular groove in which is disposed a sealing ring 66 having a sealing contact with said plunger and sleeve 50 for preventing leakage of fluid under pressure from chamber 52 past said plunger to a chamber 67 at the opposite side of said plunger. Chamber 67 is open through one or more ports 68 in bushing 50 to the atmosphere and is also connected by one or more ports 69 in plunger 53 to bore 62 within said plunger.

The sleeve 50, it will be noted, extends above the casing. The plunger 53 is provided with a part 70 having sliding contact with an intumed shoulder 71 provided at the upper end of said sleeve, which part extends beyond said shoulder and the end of said sleeve. An operating screw 72 is secured by screw-threaded engagement in the outer end of the part 70 of plunger 53 and a nut 73 on said screw is provided for engagement with the end of part 70 to secure said screw in an adjusted position. Below the lock nut 73 a spring seat 74 is secured to the part 70 of plunger 53 in any suitable manner as by a ring 75 and this seat is engaged by one end of a coil type bias spring 76. This spring encircles the portion of sleeve 50 projecting from the casing and its opposite end is supported on the casing. The spring 76 is pre-compressed and is constantly effective on seat 74 with a certain relatively small degree of force for urging said seat and thereby plunger 53 in a direction away from the release valve 60.

In chamber 40 is a control spring 77 encircling the stem 47 and bearing at one end against the seat 78 secured to said stem, while the opposite end of said spring is supported on a shelf 79 in the casing. This shelf has one or more ports 80 providing communication between the adjacent face of diaphragm 39 and the fluid pressure supply chamber 40. With diaphragm 38 in the position shown in Fig. 2 the spring 77 is adapted to be fully expanded and said spring is adapted to oppose with increasing force, deflection of said diaphragm from this position in the direction of diaphragm 39.

The casing of the device is provided with a bracket 81 carrying a fulcrum pin 82 upon which is rockably mounted an intermediate portion of a control lever 83. One end of this lever engages the operating screw 72 while the opposite end is provided with a roller 84 as shown in Fig. 1, which roller contacts the peripheral surface of a cam 85 constituting a part of an engineer's maneuvering and speed control structure which will be later described.

With lever 83 in the position shown in Figs. 1 and 2 of the drawings, the adjusting screw 72 and plunger 53 will be maintained in the positions in which they are shown in Fig. 2 by spring 76, the diaphragm 38 will occupy its low pressure position as shown in the drawings, and spring 64 will hold a release valve 60 open with the supply valve 57 closed by spring 59.

Assuming now that fluid under pressure is supplied to chamber 40 through pipe 41, it will be noted that pressure of this fluid on diaphragm 38

6

will be counteracted by its pressure on the diaphragm 39.

If now the operator desires to supply fluid under pressure to the master speed control pipe 33 he will move the operating screw 72 in the direction of diaphragm 38 by rocking the lever 83 in a clockwise direction, as viewed in the drawings. This movement of screw 72 and thus of plunger 53 will be relative to the release valve 60 until the end of said plunger contacts said valve for closing communication between the speed control pipe 33 and bore 62 in the plunger, which bore is open to atmosphere. Further movement of screw 72 and plunger 53 will then act through the release valve 60 to open the supply valve 57, whereupon fluid under pressure supplied to chamber 40 will flow past said supply valve to chamber 52 and thence to chamber 46 and the speed control pipe 33. As fluid under pressure is thus supplied to chamber 46 it will also flow through choke 45 into chamber 44 above the diaphragm 38, said choke being effective to prevent the pressure of fluid increasing in chamber 44 substantially ahead of that in the device or devices 7 connected to the speed control pipe 33.

The pressure of fluid thus provided in chamber 44 will act to deflect diaphragm 38 against the opposing pressure of control spring 77 and, after movement of the regulating screw 72 and plunger 53 has ceased, this deflection of diaphragm 38 will be relative to the supply valve 57 and finally move nut 48 into seating contact with said valve to prevent further supply of fluid under pressure to chamber 46, pipe 33 and chamber 44. It will thus be seen that control spring 77 cooperating with the pressure of fluid in chamber 44 on diaphragm 38 will limit the pressure of fluid provided in the speed control pipe 33 according to the displacement of the regulating screw 72 and plunger 53 from their normal or low pressure positions in which they are shown in the drawings.

If the operator desires to increase the pressure of fluid effective in the speed control pipe 33 he will move the regulating screw 72 further in the direction of the flexible diaphragms for again unseating the supply valve 57. Fluid under pressure will again flow past the supply valve to the speed control pipe 33 and when the pressure in said pipe and in chamber 44 is increased to a degree sufficient for deflecting diaphragm 38 to a position for again seating the supply valve 57 further flow of fluid to said pipe will be prevented to again limit the pressure acting in said pipe in accordance with the adjustment of screw 72 inwardly of the device from its normal position. By suitable increments of adjustment of the screw 72 from its normal or low pressure position shown in the drawing in the direction of the flexible diaphragms, the pressure of fluid may thus be increased in the speed control pipe 33 in any desired increments.

Upon a certain maximum displacement of screw 72 from its normal position, the deflection of diaphragm 38 by pressure of fluid effective in the speed control pipe 33 and in chamber 44 will be limited to a degree to prevent seating of the supply valve 57, as for instance, by engagement between a follower 86 engaging the lower side of the diaphragm 48 and a shoulder 87 in the casing. With the supply valve 57 thus maintained opened whatever pressure of fluid is effective to the supply pipe 41 and in chamber 40 will become effective in the speed control pipe 33.

If the operator now desires to reduce the pressure of fluid in the speed control pipe 33 he will

7

actuate lever 83 in a counterclockwise direction to permit movement of the adjusting screw 72 by spring 76 in a direction away from the diaphragms. Since, at this time, the pressure of fluid effective in chamber 44 will be counter-balancing the pressure of control spring 77, this movement of the adjusting screw 72 and thereby of plunger 53 will be relative to diaphragm 38 and thus relative to the release valve 60 due to the action of spring 64 on the stem of said valve. The plunger 53 will thus be moved out of seating contact with the release valve 60 whereupon fluid under pressure will flow from the speed control pipe 33 and chambers 46 and 44 past the release valve to atmosphere and as fluid pressure is thus released from chamber 44 the control spring 77 will deflect the diaphragm 38 in the direction of plunger 53. If the operator limits movement of plunger 53 to a position short of its normal position, then the deflection of diaphragm 38 will move the release valve 60 toward and finally into seating engagement with its seat on the end of said plunger so as to limit the release of fluid under pressure from pipe 33 and chamber 44 and thus hold in said pipe and chamber a pressure corresponding to the position of the adjusting screw 72. Further movement of the adjusting screw 72 by spring 76 will permit plunger 53 to again move out of contact with the release valve 60, whereupon a further release of fluid from pipe 33 and chamber 44 will occur. The control spring 77 will then again deflect diaphragm 38 in the direction of plunger 53 and in case said plunger is stopped still short of its normal position, the diaphragm 38 will again seat the release valve 60 in a new position of the diaphragm corresponding to that of plunger 72 for again limiting the reduction in pressure of fluid in said pipe in accordance with said position. Further movements of adjusting screw 72 by spring 76 will allow further reductions in pressure in pipe 33, while upon return of said adjusting screw to its normal position a complete release of fluid from said pipe will occur due to the fact that the control spring 77 will become fully expanded without moving the release valve 60 into contact with its seat.

It will now be seen that suitable adjustments of regulating screw 72 either in opposition to or by spring 76, will provide corresponding pressures of fluid in the speed control pipe 33, and that upon a maximum degree of displacement of plunger 72 from its normal position, the supply valve 57 will be held open to permit equalization of the pressure of fluid in the supply pipe 41 into the speed control pipe 33.

The supply of fluid to the supply pipe 41 is arranged to be controlled and limited in degree of pressure by an engineer's overspeed control valve device 90. The device 90 may be identical to the speed control valve device 37 except that chamber 46 is connected to pipe 41 while chamber 40 is connected to a fluid pressure supply pipe 92 which in use will be constantly supplied with fluid at any desired pressure, such as seventy-five pounds. Moreover, the casing is provided, around the bias spring 76, with a cylindrical portion 91 having internal, relatively coarse screw-threads, and meshing with these threads is an adjusting nut 92. An adjusting screw 93 is screw-threaded centrally through the outer closed end of nut 92 and its inner end contacts a button 94 provided in the end of plunger 53 in place of the regulating screw 72 of the structure shown in Fig. 2. A lock nut 95 provided on the adjust-

8

ing screw 93 is arranged for contact with the nut 92 to secure the screw 93 in an adjusted position. Mounted over the lock nut 95 and an extension 96 of the adjusting nut 92 is an adjusting member or hand wheel 97 which is secured by a lock screw 98 to said nut so that said nut may be turned by said member or wheel. The adjusting nut 92 is provided around its closed end with a collar 99 arranged to contact a shoulder 100 in the cylindrical portion 91 of the casing to limit inward movement of said nut, while outward movement of said nut is arranged to be limited by contact between said collar and a flange 101 provided on a split ring 102 having screw-threaded engagement with the cylindrical portion 91 externally thereof.

With the flange 99 on the adjusting nut 92 in contact with shoulder 100 the screw 93 is so adjusted as to cause operation of the overspeed control valve device 90 to supply fluid to pipe 41 at a certain maximum pressure, such for example as seventy-five pounds and which may be the same as that provided in pipe 92. The split ring 102 is then adjusted on the cylindrical portion 91 of the device so that with collar 99 in contact with flange 101 the device 90 will provide in pipe 41 fluid at a pressure such as sixty-five pounds. For normal control of the speed of the two engines, i. e., when it is desired to limit the speed of said engines to the top speed for continuous operation, the hand wheel 97 will be adjusted to the position defined by contact between flange 99 and flange 101.

The engineer's independent control valve device 35 may be identical to the overspeed control valve device 90 except that it will be so adjusted as to permit the engineer to supply fluid from pipe 92 to pipe 34 at any desired degree from atmospheric pressure to the maximum such as seventy-five pounds.

For controlling operation of the master speed control valve device 37 an engineer's maneuvering and speed control device is provided which comprises a shaft 103 that is rotatable manually by a hand wheel 104. This wheel has a neutral or "Stop" position in which it is shown in the drawing and is rotatable therefrom in either one or an "Ahead" direction or in the opposite or an "Astern" direction, as indicated by appropriate legends in Fig. 1 of the drawings. Immediately adjacent and at each of the opposite sides of "Stop" position is a zone of movement of wheel 104 designated by the legend "Maneuvering" for controlling the starting, stopping and reversing of the engines by apparatus not shown in the drawing and not pertinent to the invention, and beyond each of these "Maneuvering" zones there is a zone of movement designated by the legend "Speed control" for controlling the speed of the engines. Since the invention is limited to apparatus for controlling the speed or power output of the engines, the means shown in the drawing as operable by the shaft 103 is limited to such control, said means comprising the cam 85 which is arranged for rotation with said shaft by the hand wheel 104.

The cam 85 is provided with a peripheral surface for contact with roller 84 on the end of lever 83. This surface comprises a portion of constant radius of a length permitting movement of the hand wheel 104 from "Stop" position in either direction through the "Maneuvering" zones without moving the regulating screw 72 of the master speed control device 37 out of its normal position. Beyond each end of this portion

of the cam 85 there is a surface 85a of increasing radius for operating lever 83 to displace the screw 72 into the device 37 a distance proportional to the extent of movement of the hand wheel 104 into the respective "Speed control" zone in a direction away from "Stop" position. Maximum displacement of the regulating screw 72 will be obtained upon rotation of hand wheel 104 in either direction to the end of the respective "Speed control" zone most remote from "Stop" position. It will be apparent that by suitable adjustment of hand wheel 104 by the engineer in either "Speed control" zone, the speed regulating device 37 may be operated to provide any desired pressure of fluid in the master speed control pipe 33, between atmospheric pressure and the maximum degree.

A gear 105 is mounted on and secured to shaft 103 for turning same. The teeth on this gear are in mesh with teeth on a gear sector 106 mounted to turn on a pin 107 which is fixed with respect to the shaft 103. The gear sector 11 is connected by a link 108 to a power motor 109 of any suitable fluid pressure controlled type which is arranged to be controlled from a remote control station for adjusting shaft 3 without manual operation of the engineer's hand wheel 104.

For the purpose of illustration the motor 109 may be substantially like that disclosed in my copending application Serial No. 488,041, filed May 22, 1943, assigned to the assignee of the present application and which comprises means including a power piston rod 112 connected to link 108 for actuating same to adjust the gear sector 106.

Operation of the power motor 109 to adjust the shaft 103 is arranged to be controlled by pressure of fluid in two control pipes 116, 117. With both of these control pipes open to atmosphere the piston rod 112 will assume a neutral position for positioning shaft 103 in "Stop" position. Upon supply of fluid at a certain pressure to pipe 116 while maintaining pipe 117 open to atmosphere, the motor 109 will act to turn shaft 103 from "Stop" position in the "Ahead" direction to the opposite end of the respective "Maneuvering" zone, while a further increase in pressure of fluid in said pipe will cause operation of the motor to turn the shaft into the adjacent "Speed control" zone an amount in proportion to the degree of pressure increase. A certain maximum pressure of fluid in pipe 116 will cause operation of motor 109 to turn shaft 103 in the "Ahead" direction to the end of the "Speed control" zone most remote from "Stop" position. Positioning of shaft 103 at the "Astern" side of "Stop" position may be obtained by operation of motor 109 in a similar manner upon providing fluid at proper pressures in pipe 117 while maintaining pipe 116 open to atmosphere.

Pipe 116 leads to a control valve device 118 which may be identical to the master speed control valve device 47 except for the type of operating lever 119. In contrast to the master speed control device, one end of lever 119 is fulcrumed to the casing of the device while an intermediate portion engages the regulating screw 72. In the opposite end of lever 119 is a roller 120 which engages the peripheral surface of a cam 121 which is mounted on a shaft 122 for rotation therewith.

The control pipe 117 is connected to a control valve device 123 which is identical to the control valve device 118 and thus provided with a

lever 119 in the end of which is a roller 120 engaging the peripheral surface of a cam 124 also secured to shaft 122 for rotation therewith. The cam 124 is identical to the cam 121 but reversely arranged on shaft 122.

A fluid pressure supply pipe 125 connected to the two control valve devices 118 and 123 is supplied with fluid under pressure from the supply pipe 92 through a cut-out valve device 126. This device may comprise a plug valve 127 and an operating handle 128 for turning said valve to a pilot-house control position in which it is shown in the drawing, or to an engine-room control position indicated by a line 129. A T-shaped passage 130 in the plug valve 127 establishes communication between pipes 92 and 125 in the pilot-house control position of said valve and handle 128, while in the engine-room control position indicated by line 129 this communication is closed and passage 130 connects pipe 125 to an atmospheric vent port 131 for thereby releasing all fluid pressure from the control valve device 118 and 123 and from the power motor 109.

The shaft 122 is arranged to be operated by a gear 134 which is operatively connected by an endless chain 135 to two gears 136 and 137 which are rotatably mounted on a fixed portion not shown. A hand operated lever 138 is connected to gear 136 for operating same to turn gear 134 and shaft 122, while a hand operated lever 139 is connected to gear 137 for operating same to turn gear 134 and shaft 122. It will be noted that the two levers 138 and 139 will operate in unison upon operation of either. These two levers constitute pilot's control means for controlling maneuvering the speed of the engines and are intended for location in the pilot-house of a ship, one at either side thereof.

Each of the manually operated levers 138 and 139 has a neutral or "Stop" position in which it is shown in Fig. 1 of the drawings, and at either side of this position there is a "Maneuvering" zone and beyond each "Maneuvering" zone is a "Speed control" zone, as indicated by lines and legends in Fig. 1, it being noted that said levers have the same control positions and zones of movement as the engineer's hand wheel 104.

The cam 124 is so designed as to effect operation of the control valve device 123 to gradually increase the pressure of fluid in pipe 117 for controlling operation of the power motor 109, as the pilot's control levers 138 and 139 are moved from "Stop" position in the "Ahead" direction, while, under this condition, the cam 121 will permit operation of the control valve device 118 to maintain pipe 116 open to atmosphere. The power motor 109 is adapted to respond to pressure of fluid thus provided in pipe 117 by the time the pilot's control levers 138 and 139 are moved to the end of the "Maneuvering" zone in the "Ahead" direction to turn shaft 103 and cam 85 to the same position as said shaft would obtain upon movement of the engineer's control wheel 104 to the corresponding position. Upon further movement of the pilot's control lever 138 and 139 in the "Ahead" direction, i. e., out of the "Maneuvering" zone into the adjacent "Speed control" zone, the control valve device 123 will increase the pressure of fluid in pipe 117 proportionately, to cause operation of motor 109 to correspondingly change the position of control shaft 103 and cam 85. The maximum speed position of the control shaft 103 will be obtained upon movement of the pilot's control levers 138 and 139 in the "Ahead" direction to the end of the "Speed

11

control" zone most remote from "Stop" position. It will thus be seen that by adjustment of the pilot's control lever 138 and 139 in the "Speed control" zone at the "Ahead" side of "Stop" corresponding adjustment of shaft 103 and cam 85 on the engineer's maneuvering and speed control shaft 103 will be obtained.

On the other hand, if the pilot moves the levers 138 and 139 in the opposite or "Astern" direction from "Stop" position the valve device 118 will act to supply fluid to pipe 116 at a pressure corresponding to the position of said lever, while the valve device 123 will open pipe 117 to the atmosphere, whereby shaft 103 of the engineer's maneuvering and speed control device will be correspondingly positioned.

In operation, let it be assumed that the cut-out valve device 126 is in the pilot-house control position shown in the drawing supplying fluid under pressure from pipe 92 to pipe 125 and thence to the power motor 109 and control valve devices 118 and 123. Let it further be assumed that the pilot's control levers 138 and 139 are in their "Stop" positions as shown in Fig. 1 under which condition both of the valve devices 118 and 123 will be conditioned to open pipes 116 and 117 to the atmosphere so that the power motor 109 will cause the gear sector 106, gear 105, shaft 103 and thereby the engineer's control wheel 104 to assume their corresponding or "Stop" position.

With the control wheel 104 and shaft 103 in "Stop" position, the master speed control valve device 37 will open pipe 33 to atmosphere, so that with the engineer's control valves 28 in their multiple control positions as shown in Fig. 1, and with the solenoids 23 deenergized, pressure chambers 12 in the two fuel control devices 7 will be open to atmosphere. The fuel control arm 4 at each engine will then occupy the minimum speed or idle position shown in Fig. 1.

Let it also be assumed that the engineer's overspeed control valve device 90 is adjusted as shown in Fig. 3 in order to supply fluid from pipe 92 to pipe 41 at the reduced pressure of sixty-five pounds above-mentioned.

With the apparatus conditioned as just described, if the pilot desires to move the ship forwardly he will move levers 138 and 139 from "Stop" position in the direction indicated by the legend "Ahead" through the "Maneuvering" zone to the "Speed control" zone and this operation will cause starting of both of the engines by means not shown in the drawing and which are immaterial to the invention. It is merely desired to point out however that when the levers 138 and 139 reach the end of the "Maneuvering" zone adjacent the "Speed control" zone the engines will be started and the cam 85 will be so positioned that the master speed control valve device 37 will still be opening pipe 33 and thereby pressure chambers 12 in the fuel control devices 7 to atmosphere. The two fuel control devices 7 will therefore function to cause adjustment of the fuel control levers 4 to supply fuel to the engine in a quantity to permit operation of the engines at the minimum or idling speed.

If the pilot now desires to accelerate the two engines, he will move levers 138 and 139 further in the "Ahead" direction into the "Speed control" zone and this will cause operation of cam 124 and valve device 123 to effect operation of the power motor 109 to correspondingly operate cam 85. This operation of cam 85 will in turn cause operation of the master speed control device 37 to

12

provide fluid in pipe 33 at a pressure corresponding to the position of the pilot's control levers 138 and 139 and this pressure, being effective in pressure chambers 12 of the two fuel control devices 7 on the two engines, will cause adjustment of the fuel control levers 4 out of their idling position in the direction of lines 5 to positions corresponding to the position of the pilot's control lever. The engines will thus accelerate in unison to a speed determined by the position of the pilot's control lever.

Further movement of the pilot's control lever, into the "Speed control" zone will effect a correspondingly greater movement of the fuel control levers 4 on the two engines away from their idling positions and thus a corresponding increase in speed or power output of the two engines. Movement of the pilot's control levers 138 and 139 in the "Ahead" direction to the extreme end of the "Speed control" zone will condition the master speed control valve device 37 so that the supply valve 57 therein will remain open, whereupon the maximum pressure of fluid effective in pipe 41 will become effective through pipe 33 in pressure chambers 12 of the two fuel control devices 7, and this pressure of fluid will actuate the pistons 8 to move the fuel control arms 4 on the engines to the positions indicated by lines 5 in order that both engines will operate at their top speed or output for continuous operation.

If the operator now desires to reduce the speed or output of the engines, he will move levers 138 and 139 back in the direction of the "Stop" position and the master speed control device 37 will operate to correspondingly reduce the pressure of fluid in pressure chambers 12 of the fuel control devices 7, so that the speed of the two engines will be proportionately reduced. Turning of the pilot's control levers 138 and 139 to the end of the "Speed control" zone adjacent "Stop" position will cause reduction in speed or output of the engines to minimum or idling, as will be apparent.

If the pilot now desires that the ship move in the opposite or astern direction, he will move the levers 138 and 139 in the direction indicated by the legend "Astern" and with said levers at the end of the "Maneuvering" zone adjacent the respective "Speed control" zone, the engines will be started in the reverse direction and will operate at minimum idling speed. Further movement of levers 138 and 139 into the "Speed control" zone will then accelerate the engines in accordance with the position of said levers in said zone. Movement of levers 138 and 139 to the extreme end of the "Speed control" zone at the "Astern" side of "Stop" position will allow fluid, at the pressure in pipe 41, to become effective in the speed control pipe 33, in order that both engines will operate at their top speed or output for continuous operation, while return of said lever through the "Speed control" zone in the direction of "Stop" position will reduce the speed of the engines according to the position of said levers in said zone. Turning of levers 138 and 139 to the end of the "Speed control" zone adjacent the respective "Maneuvering" zone will cause the speed of the engines to reduce to idling, as will be apparent.

In the operation just described, the over-speed control valve device 90 was assumed to be in the condition shown in Fig. 3 to limit the pressure of fluid in pipe 41 to the lower degree of 65 pounds, and this pressure effective in the fuel control devices 7, in the maximum speed positions of the pilot's control levers 138 and 139, will

move the fuel control levers 4 only to the positions indicated by levers 5 to obtain the top speed of the engines for continuous operation as above mentioned. It is desired to point out, however, that by suitable adjustment of the pilot's control levers 138 and 139, any desired speed of the engines from idling to the top speed for continuous operation can be obtained, but the pilot cannot increase the engine speed above this top speed since it is limited by the pressure of fluid provided in pipe 41.

Now if it should be desired to operate the engines at an even greater speed than the top speed for continuous operation, the engineer may operate the over-speed valve device 90 to increase the pressure of fluid supplied to pipe 41, and since the supply valve 57 of the master speed control valve device 37 will be open under this condition, this increased pressure of fluid will become effective in pipe 33 and thus in the two fuel control devices 7 at engines 1 and 2. This increased pressure of fluid provided in the fuel control devices 7 will then act to move the fuel control levers 4 past the lines 5 in the direction of lines 6 to positions corresponding to the increase in pressure of fluid.

Should the engineer adjust the overspeed valve device 90 to provide the maximum permissible pressure of fluid in pipe 41, as might be obtained by an adjustment of said device to maintain pipe 92 open to pipe 41, this pressure effective through the master speed control device 37 in the fuel control device 7 will move the fuel control levers 4 to the positions indicated by lines 6 to thereby provide for operation of both engines at their maximum speed or output. By proper adjustment of the overspeed control valve device 90, it will be seen that the engineer can increase the pressure of fluid in pipe 41 in any desired number of increments from that normally provided up to the maximum, and can also reduce this pressure in any desired number of increments, in order that any desired degree of overspeed of the engines 1 and 2 may be obtained, or the degree of overspeed may be limited, in case of necessity, or the overspeed can be completely cut out, if desired.

This over-speed control of the engines is under the control of the engineer who will be constantly aware of the operating condition of the engine, so that the degree and use of overspeed may be limited as required to protect the engines against damage, and further, it relieves the pilot of the ship of any concern over the engine condition.

In case the power of both engines is not required for propelling the ship, either engine may be disconnected from the master speed control device 37 and allowed to operate at idling speed by closing of the respective engineer's switch 26 whereupon pressure chamber 12 in the respective fuel control device 7 will be opened to atmosphere to allow movement of the respective fuel control lever 4 to its idling position. Subsequent closure of the switch 26 will again connect the respective fuel control valve device 7 to the master speed control device 27, so that the engine will accelerate to the speed corresponding to the adjustment of the master control device 37 and thus to the speed of the other engine.

If desired, the engineer may remove either engine from control by the pilot and control it independently for operating auxiliary apparatus, such as a fire pump. In case the engineer should thus desire to cut out the control of engine 2 by the pilot, he will turn the plug valve 29 from the

position shown in Fig. 1 to that in which handle 30 will be in the position indicated by line 31. This will close communication between the master speed control pipe 33 and the respective pipe 21 to render the fuel control device 7 of engine 2 nonresponsive to the master speed control device 37, which device however remains connected to control operation of engine 1. In this position of plug valve 29 for engine 2 the respective pipe 21 is connected to pipe 34 and the engineer's control valve device 35. The engineer by operation of the control valve device 35 may then vary the pressure of fluid in the fuel control device 7 on engine 2 independently of engine 1 and thus operate engine 2 at whatever speed he may desired. Return of the plug valve 29 for engine 2 to the position shown in Fig. 1, will render the engineer's control device 35 ineffective to control engine 2, and engine 2 will then be reconnected for control to the master speed control device 37. Likewise, engine 1 by suitable manipulation of the respective plug valve 29 may be disconnected from the master speed control device 37 and connected to the engineer's speed control device 35 for control by the engineer independently of engine 2 as controlled by the pilot, while return of this plug valve to the position shown in the drawings will restore control of engine 1 to the pilot, as will be evident.

Both of the plug valves 29 may be operated if desired or necessary to remove the control of both engines from the pilot and place both under control of the engineer's control device 35, while return of the plug valves 29 to the positions shown in Fig. 1 will restore the control of both engines to the pilot.

In case of necessity or desire the engineer may take over all control of the engines, that is, control of starting, and speed as above described in connection with pilot's control. To take over this control the engineer will turn the plug valve 127 from its pilot-house control position shown in the drawing to its engineer's control position in which the lever 128 will occupy the position indicated by the line 129. In this latter position of plug valve 127 the supply of fluid to pipe 125 will be cut off and said pipe opened to atmosphere. With pipe 125 open to atmosphere, all fluid pressure will be released from the control valve devices 118 and 123 and from the power motor 109 whereby piston rod 112 of said motor may be reciprocated by operation of the engineer's hand wheel 104. The engineer by suitable operation of the hand wheel 104 may then control the starting of the engines in either direction and subsequently the speed of the engines, in a manner which will be apparent from the above description of pilot's control.

Summary

It will now be seen that I have provided a control system for a plurality of engines embodying means for controlling the engines either from a local station or a remote station in unison, or from said local station individually. While the engines are under the control of the remote station either may be removed from such control, and, if desired, operated individually and independently under control from the local station. The system provides at the remote station for control of engine speed from minimum speed up to a top speed for continuous operation. Overspeed of the engines may be obtained, but the control of overspeed is at all times under the control of the engineer who is constantly aware

15

of the condition of the engines and thus in a position to limit the use and degree of overspeed to safeguard the engines.

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

1. An apparatus for controlling the speed or power output of a plurality of internal combustion engines each of which is provided with fuel governing means having an engine idling position, a second position for effecting operation of the engine at a top speed for continuous operation and a third or over-speed position, said apparatus comprising in combination, a fluid pressure controlled means for each engine operable when void of fluid under pressure to adjust said fuel governing means to said idling position and when subject to fluid at a certain pressure to adjust said fuel governing means to said second position and when subject to fluid at a still higher pressure to adjust said fuel governing means to said overspeed position, a source of fluid under pressure, manually adjustable overspeed control means for controlling supply of fluid under pressure from said source to a supply pipe, said overspeed control means having two adjustments one for limiting pressure of fluid in said supply pipe to the said certain pressure and another for limiting the pressure of fluid in said supply pipe to said greater pressure, master self-lapping control means operable to supply fluid under pressure from said supply pipe for operating both of said fluid pressure controlled means and having a maximum pressure condition for maintaining open communication between said supply pipe and said fluid pressure controlled means and being also operable to close said communication and to release fluid under pressure from said fluid pressure controlled means, independent control means for each of said fluid pressure controlled means, and selector means controlling communication between said fluid pressure controlled means and said master and independent control means and selectively operable to open communication between said fluid pressure controlled means and either said master or independent control means and to close communication between said fluid pressure controlled means and the other control means.

2. In combination, a plurality of internal combustion engines, individual fluid pressure controlled speed control means for each engine adjustable to vary the speed or power output of the engine in accordance with pressure of such fluid, master control means comprising an operating

16

member and means controlled by said member and operable to supply fluid at pressures which vary according to operation of said member for controlling said speed control means, an independent control means for each of said speed control means comprising an operating member operable to supply fluid at pressures in accordance with the operation of said member for controlling operation of the respective speed control means, and an individual selector valve for each speed control means operable to connect same for control by fluid under pressure provided by either said master control means or the respective independent control means and at the same time to disconnect the respective speed control means from the other control means.

3. In combination, a plurality of internal combustion engines, individual speed control means for each engine adjustable to vary the speed or power output of the engine, master control means operable to control the individual speed control means for all of said engines in unison, manually operable means at one station operable to control said master control means, power control means operable to control said master control means, manually operable means at another station operable to control operation of said power control means, and selector means at said one station selectively operable to render said master control means controllable by either said power control means or by said manually operable means at said one station.

4. In combination, a plurality of internal combustion engines, individual speed control means for each engine adjustable to vary the speed or power output of the engine, master control means operable to control the individual speed control means for all of said engines in unison, manually operable means at one station operable to control said master control means, power control means operable to control said master control means, manually operable means at another station operable to control operation of said power control means, selector means at said one station selectively operable to render said master control means controllable by either said manually operable means at said one station or by said power control means, independent control means at said one station operable to control said speed control means, and selector means selectively operable to render said speed control means controllable by either said master control means or said independent control means and non-controllable by the other control means.

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