

Dec. 6, 1949

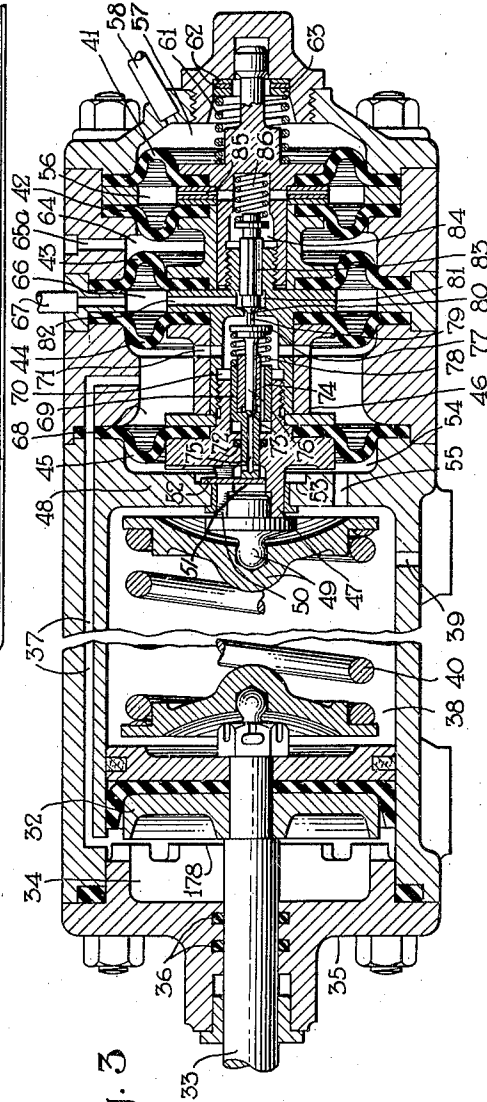
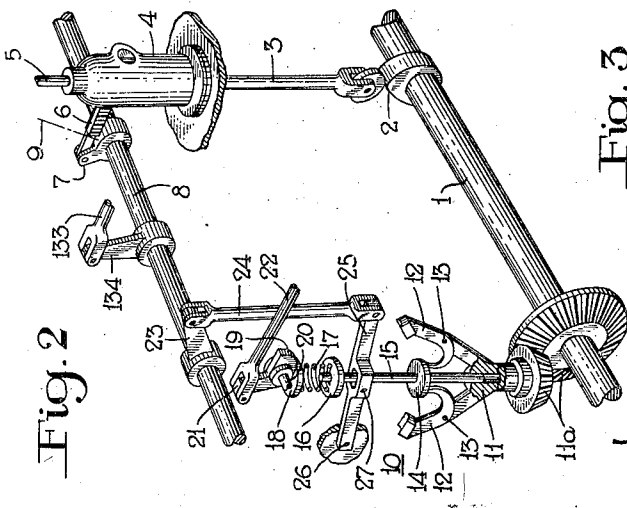
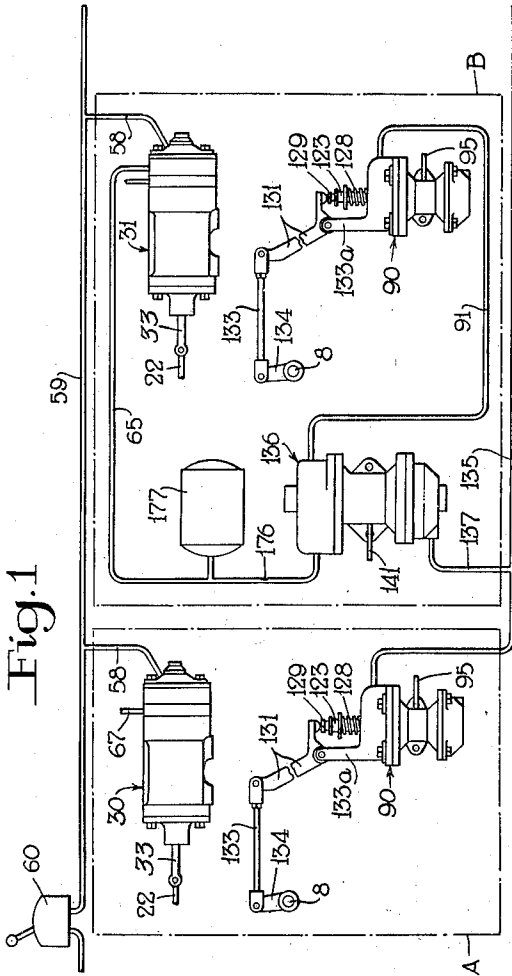
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2,490,113

ENGINE OUTPUT EQUALIZING APPARATUS

Filed March 16, 1946

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5

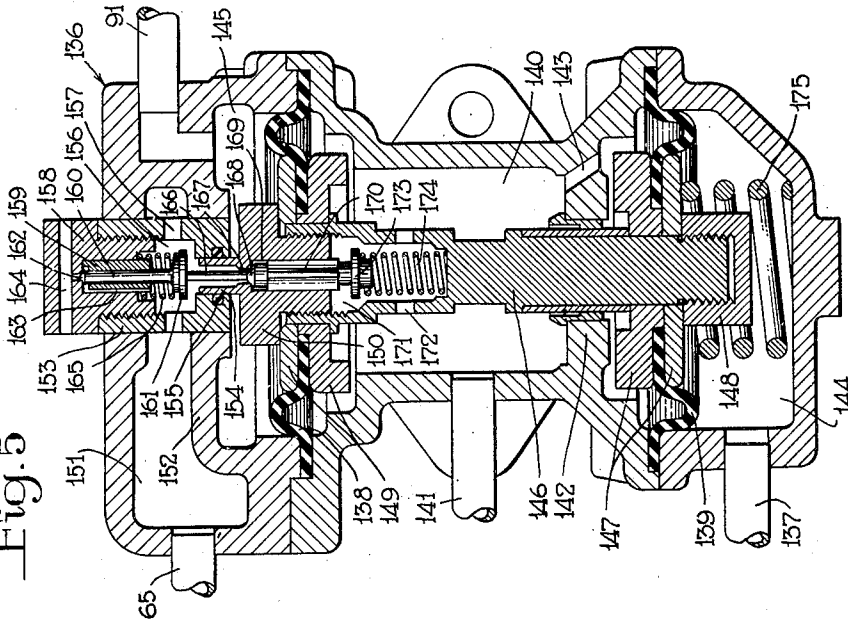
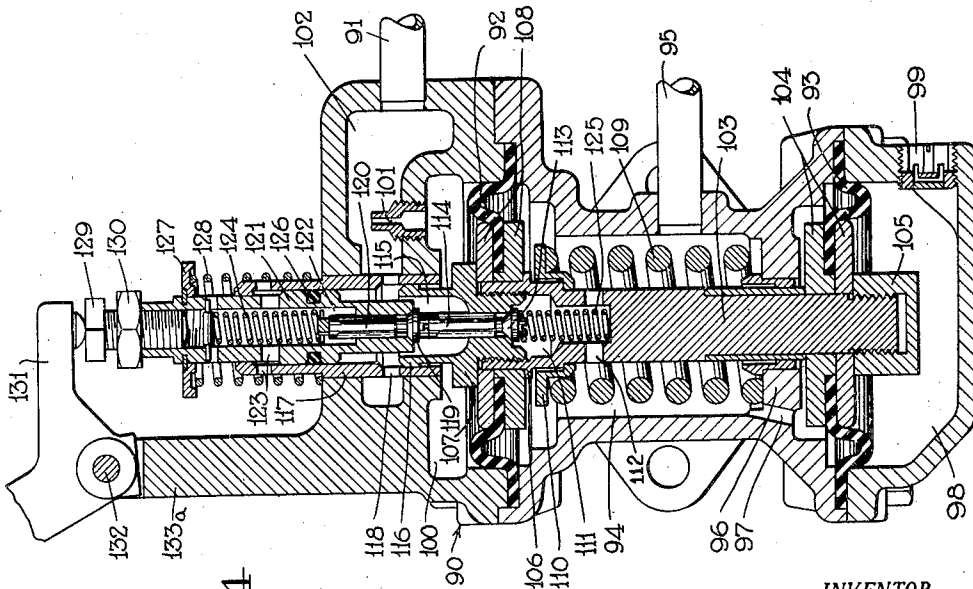


Fig. 4



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UNITED STATES PATENT OFFICE

2,490,113

ENGINE OUTPUT EQUALIZING APPARATUS

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Application March 16, 1946, Serial No. 654,931

10 Claims. (Cl. 60—97)

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This invention relates to control apparatus and more particularly to means for equalizing the power output of a plurality of prime movers such as internal combustion engines of the Diesel type.

One object of the invention is the provision of means for automatically equalizing the power output of a plurality of engines.

Another object of the invention is the provision of apparatus embodying operator's control means for simultaneously adjusting the power output of a plurality of engines, and means automatically operative in accordance with a selected degree of power output of one of said engines to adjust the power output of the other engine or engines to substantially the same degree, in case the power output of said other engine or engines is materially different from that of said one engine.

In Diesel engines the position of the so-called fuel rack or shaft, which determines the amount of fuel supplied to the engine, is considered a most reliable and practicable index of engine output, and another object of the invention is therefore the provision of means which is automatically operative in accordance with the position of the fuel shaft on one engine to cause the fuel shaft on another engine or engines to assume substantially the same position.

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, elevational view of a system for controlling the speed or power output of a plurality of engines and embodying the invention; Fig. 2 is a diagrammatic view of a portion of a fuel control system for each of said engines; Fig. 3 is a sectional view of a fuel or speed control motor for each of said engines and shown in elevation in Fig. 1; Fig. 4 is a sectional view of a pressure regulating valve device associated with each of said engines and shown in elevation in Fig. 1; and Fig. 5 is a sectional view of an equalizing valve device shown in elevation in Fig. 1.

Description

As shown in Fig. 1 of the drawings, the dot-dash line enclosures designated A and B indicate two of a plurality of engines, the enclosure designated A constituting what may be called a master engine, while the enclosure designated B constitutes, one of any desired number of engines to be controlled from engine A. Engine B may be referred to as a slave engine.

Each of these engines may for the purpose of illustration be of the Diesel type comprising (Fig.

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2) a conventional cam shaft 1 for operating through a cam 2 and a push rod 3 an injector pump 4 for each engine cylinder, for supplying fuel to said cylinder through an injector pipe 5.

The amount of fuel supplied to the engine cylinder by pump 4 is adapted to be regulated by a pump adjusting rack 6 operatively connected to a lever 7 on a fuel control shaft 8. The fuel shaft 8 may have an engine idling position in which it is shown in the drawing for adjusting pump 4 to provide fuel to the engine cylinder in an amount sufficient to cause operation of the engine at an idling speed and may be turned in a clockwise direction, as viewed in Fig. 2, to adjust said pump to increase the fuel supply in proportion to the degree of such turning. A maximum amount of fuel will be provided to the engine in a position of the fuel shaft 8 such as indicated by a dot-dash line 9. It will be understood that the engine may have any desired number of cylinders and that a fuel pump 4, rod 3 and cam 2 will be provided for each cylinder, and that the fuel shaft 8 will be connected to all fuel pumps, in accordance with conventional practice.

Adjustment of the fuel control shaft 8 on each engine may be controlled by a speed governor 10 which may comprise a centrifuge 11 connected by gears 11a to the cam shaft 1. Two oppositely arranged centrifugally controlled bell cranks 12 are pivoted at their knees on pins 13 in centrifuge 11. One end of each of the bell cranks 12 engages a collar 14 secured to a vertically movable plunger or rod 15 which is provided with another collar 16 engaged by one end of a governor control spring 17. The opposite end of spring 17 is engaged by a movable follower 18 against which bears an adjusting cam 19 pivoted on a fixed pin 20 and connected by an arm 21 to a governor adjusting rod 22.

It will be apparent that when the engine is in operation turning the cam shaft 1, that centrifugal force of the governor bell cranks 12 will be opposed by the pressure of the control spring 17 and that the upper end of said cranks will move away from rod 15 to a position in which said centrifugal force will balance the pressure of said spring, and thereby position said rod in accordance with the pressure of said spring. If the cam is turned in a clockwise direction to increase the pressure of spring 17 on collar 16, the bell cranks 12 will be moved toward rod 15 to permit said rod to move down a proportional degree, while if the cam is returned toward the position in which it is shown in the drawing, the rod 15 will be elevated correspondingly. In other words, when the

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engine is operating the rod 15 will assume a position corresponding to the adjustment of cam 19.

An operating arm 23 for the fuel control shaft 8 is connected by a link 24 to one end of a lever 25. The opposite end of lever 25 is fulcrumed on a fixed pin 26, while intermediate its ends said lever is connected by a pin 27 to the governor rod 15, whereby the fuel control shaft 8 will be positioned in accordance with the position of said rod and of cam 19.

In the drawing the parts of the governor 10 including cam 19, and the fuel control shaft 8 are shown in the position which it may be assumed will provide for operation of the engine at an idling speed. With the engine operating, if the cam 19 is now turned in a clockwise direction the governor rod 15 and fuel control shaft 8 will move out of idling position to a new position, corresponding to the change in position of said cam, to cause a proportional increase in the amount of fuel supplied to the engine and thereby a corresponding increase of power output of the engine. The turning of cam 19 in the opposite direction will result in a corresponding reduction in the amount of fuel supplied to the engine. It will thus be seen that by suitable adjustment of cam 19 the supply of fuel to the engine may be adjusted to obtain any selected degree of power output from the engine.

On the master engine A, the governor control rod 22 is connected to a governor control motor 30, while on the slave engine B said rod is connected to a governor control motor 31.

With but one exception, which will be later brought out, the governor control motor 30 on the master engine A and the motor 31 on the slave engine B are identical in construction, each comprising (Fig. 3) a casing containing a power piston 32, and a rod 33 connected at one end to said piston while the opposite end is connected exteriorly of the casing to the governor control rod 22. The piston rod 33 extends through a pressure chamber 34 at one side of piston 32 and through a bore in a head 35 closing the open end of said chamber, said head being provided with a plurality of grooves encircling said rod and containing sealing rings 36 having sealing and sliding contact with said rod to prevent leakage of fluid under pressure from said chamber. The pressure chamber 34 is connected to a control passage 37 through which fluid under pressure is adapted to be supplied to and released from said chamber, in a manner and by means to be later described. At the opposite side of the power piston 32 is a non-pressure chamber 38 which is open to atmosphere through a passage 39 and which contains a regulating spring 40 acting on said piston in opposition to pressure of fluid in pressure of fluid in pressure chamber 34.

Each of the governor motors further comprises a plurality of spaced apart flexible diaphragms 41, 42, 43, 44 and 45 arranged in the order named in coaxial relation with each other and with the regulating spring 40 and the power piston 32, the diaphragm 41 being disposed most remote from said piston. The several diaphragms are clamped around their edges in the casing and are all connected together centrally for movement in unison by structure comprising followers, spacers, and securing means indicated generally in the drawing by reference numeral 46. This structure 46 includes a coaxially arranged sleeve-like member 47 projecting from the diaphragm 45 through a bore in a wall 48 into the non-pressure chamber 38 wherein it supports seat means

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49 carrying the end of regulating spring 40 opposite that acting on the power piston 32.

The sleeve-like member 47 is hollow and provided with spaced apart slots 50 extending longitudinally thereof. Disposed within the member 47 is an element 51 constituting a fixed part of a valve structure which will be presently described, said element having radial fingers 52 extending through the slots 50 and contacting a shoulder 53 on the partition wall 48. The slots 50 provides for longitudinal movement of member 47 relative to the element 51 and wall 48. Only one of the slots 50 and fingers 52 are shown in the drawing.

Between the diaphragm 45 and wall 48 is a non-pressure chamber 54 which is open through a passage 55 to the non-pressure chamber 38 and thence to atmosphere through passage 39.

The diaphragms 41 and 42 are of the same areas and cooperate to form an intermediate chamber 56. At the opposite side of diaphragm 41 is a control pressure chamber 57 which is open to a pipe 58. The pipe 58 at each engine is connected to a control pipe 59 extending to all the engines from an operator's control device 60 which is provided for regulating pressure of fluid in chamber 57 in all of the governor control motors 30 and 31 simultaneously. A pre-compressed bias spring 61 contained in chamber 57 in each of the motors 30 and 31 has one end bearing against the diaphragm connecting structure 46. The opposite end of the bias spring 61 is supported on one or more pressure adjusting shims 62, while in the motor 30 associated with the master engine A there is provided an additional shim 63 under spring 61 for reasons which will be later brought out. This additional shim 63 constitutes the only structural difference between the governor control motor 30 employed on the master engine A and the governor control motor 31 employed on the slave engine B.

The diaphragms 43, 44 and 45 are all of the same area but of larger area than diaphragms 41 and 42. Between the diaphragms 42 and 43 is a chamber 54 which in the governor control motor 30 on the master engine A is open to atmosphere through a passage 55a, while on the slave engine B said chamber is open through said passage to a pipe 65 through which fluid under pressure is adapted to be varied in said chamber, in a manner which will be later brought out.

The diaphragms 43 and 44 cooperate to form a chamber 66 which is adapted to be constantly supplied through a pipe 67 with fluid under pressure from any suitable source. Between the diaphragms 44 and 45 is a chamber 68 to which passage 37 from the power piston pressure chamber 34 is open.

The element 51 supported on the casing wall 48 supports one end of a sleeve or valve seat member 69 which is slidably mounted in a suitable bore provided axially in the diaphragm connecting structure 46. The seat member 69 extends into a chamber 70 in structure 46 which chamber is in constant communication through a port 71 with chamber 68. A sealing ring 72 carried by structure 46 engages the peripheral surface of member 69 to prevent leakage of fluid under pressure from chamber 70 to chamber 54.

The valve seat member 69 has a valve seat arranged for engagement by a release valve 73 which is provided for controlling communication between a passage 74 open to chamber 70 and a passage 75 opening to the non-pressure chamber 38 by way of slots 50 in the element 47 and cham-

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ber 54. The release valve 73 is provided on one end of a stem 76 slidably mounted in a bore in the valve seat member 69 and extending into chamber 70 wherein said stem is provided with an enlarged head 77. Interposed between one side of head 77 and the adjacent end of member 69 is a coil bias spring 78 which is effective to urge the release valve 73 out of engagement with its seat.

The opposite side of head 77 on the release valve stem 76 engages a projection 79 of a coaxially arranged fluid pressure supply valve 80 which is contained in a chamber 81 provided in the structure 46. A seat is provided on structure 46 for the supply valve 80, and the projection 79 extends through an opening encircled by said seat, said opening being of greater area than said projection. Chamber 81 is in permanent communication through a port 82 in structure 46 with chamber 66 and thus with the fluid pressure supply pipe 67. The supply valve 80 is provided for controlling flow of fluid under pressure from the supply pipe 67 to chamber 70 and thence to chamber 68 and through passage 37 to chamber 34 at the outer face of the power piston 32.

The supply valve 80 is formed on one end of a fluted stem 83 which is slidably mounted in and extends through a bore in structure 46 into a chamber 84 which is open through one or more ports 85 to chamber 56 between diaphragms 41 and 42. A coil bias spring 86 contained in chamber 84 acts on the valve stem 83 for urging the supply valve 80 in the direction of its seat. Chamber 56 is adapted to be constantly supplied with fluid under pressure from the supply pipe 65 by way of the fluted valve stem 83.

In the governor control motor 31 on the slave engine B chamber 64 between diaphragms 42 and 43 is adapted to be charged through pipe 65 with fluid, by means to be later described, either at or above or below some chosen degree such as 25 pounds, and since diaphragm 43 is of greater area than diaphragm 41, this pressure will create a force acting in the direction of the left hand on structure 46. In the governor control motor 30 on the master engine A, in which diaphragm chamber 64 between the diaphragms 42 and 43 is opened to atmosphere, the additional shim 63 under spring 61 provides the same force on structure 46 acting in the direction of the left hand as obtained by the chosen pressure (25 pounds) provided in chamber 64 in the governor control motor 31 on the slave engine B. This additional shim 63 in the governor control motor 30 on the master engine A automatically conditions said engine to act as the master for controlling the output of the slave engine.

Associated with each of the engines is a pressure regulating valve device 90 arranged to be controlled by the respective fuel shaft 8 for providing in a pipe 91 fluid at a pressure proportional to the position of said shaft and hence proportional to the amount of fuel supplied to the engine.

Each of the pressure regulating valve devices 90 comprises a casing containing two spaced apart and coaxially arranged flexible diaphragms 92 and 93 of the same areas and clamped around their edges in the casing. Between the two diaphragms 92 and 93 is a chamber 94 open to a fluid pressure supply pipe 95 and thus adapted to be constantly supplied with fluid under pressure. The chamber 94 is formed in two parts separated by a wall 96 but in constant communication with each other through a passage

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97 in said wall. At the opposite side of diaphragm 93 is a non-pressure chamber 98 which is open to atmosphere through a breather port 99. At the opposite side of diaphragm 92 is a chamber 100 open through a stabilizing choke 101 to a chamber 102 to which pipe 91 is connected.

Disposed in chamber 94 is a stem 103 having one end connected to the center of diaphragm 93 by follower plates 104 and a clamping nut 105. The opposite end of stem 103 is in the form of an enlargement 106 extending centrally through the diaphragm 92 and cooperating with a nut 107 in chamber 100 to secure said stem to diaphragm 92 through the medium of follower plates 108. A coil regulating spring 109 encircling stem 103 within chamber 94 has one end engaging the casing wall 96, while the opposite end acts against the enlargement 106 through the medium of a spring follower 110. With spring 109 fully expanded, the diaphragm 92 and 93 and the stem 103 will assume a position such as shown in Fig. 4 of the drawing.

In the stem enlargement 106 is a chamber 111 open through a passage 112 to the fluid pressure supply chamber 94. A fluid pressure supply valve 113 contained in chamber 111 has a fluted stem 114 extending through an axial bore in nut 107 into a chamber 115 formed within an extension 116 of said nut. The extension 116 is mounted to slide in a sleeve 117 which extends from the exterior of the casing through chamber 102 and a wall separating said chamber from chamber 100. Chamber 115 within the nut extension 116 is open through one or more ports 118 in sleeve 117 to chamber 102.

The end of the supply valve stem 114 engages in chamber 115 a fluid pressure release valve 119 having a fluted stem 120 mounted to slide in a bore provided axially of a plunger 121 which is slidably mounted in sleeve 117 above the nut extension 116, said plunger being provided around the end of said bore open to chamber 115 with a seat for engagement by said release valve. The release valve stem 120 extends into a chamber 122 in plunger 121, said chamber being in constant communication with atmosphere through registering ports 123 in said plunger and the sleeve 117. Chamber 122 contains a bias spring 124 acting on the release valve 119 for urging it away from its seat, while in chamber 111 containing the supply valve 113 is a spring 125 for urging said valve into contact with its seat, the spring 125 exerting a greater force on the supply valve 113 than is exerted by spring 124 on the release valve 119. The plunger 121 has an annular groove carrying a sealing ring 126 having sliding contact with the interior surface of sleeve 117 for preventing leakage of fluid under pressure from chamber 115 past said plunger to atmosphere.

Outside of the casing and beyond the adjacent end of sleeve 117 is a spring seat 127 secured to plunger 121, and a coil spring 128 encircling said sleeve and supported on the casing bears against said seat for urging said plunger in a direction away from the release valve 119. Above the spring seat 127 an adjusting screw 129 is connected to plunger 121 by screw-threaded engagement and is locked in an adjusted position by a lock nut 130 mounted on said screw and engaging the adjacent end of said plunger. The adjusting screw 129 is engaged by one end of a bell crank 131 which at its knee is pivoted on a pin 132 carried in an arm 133a projecting from the casing. The opposite end of the bell crank 131 is operatively connected to one end of a link 133 the op-

posite end of which is connected to one end of an arm 134 which is mounted on the respective engine fuel control shaft 8 for movement therewith.

With the fuel control shaft 8 on each engine in its engine idling position, screw 129 in the respective regulating valve device 90 may be turned out of plunger 121 for urging said plunger in a downwardly direction against springs 123 and 124 to a position in which it is in contact with the release valve 119, with the supply valve 113 seated by spring 125 and with the spring 109 fully expanded. The screw 129 may then be locked to the plunger 121 by the lock nut 130.

If the fuel control shaft 8 on either engine is rocked out of its idling position in which it is shown in the drawing this movement will actuate arm 134 and link 133 to rock the bell crank 131 in a corresponding direction to move plunger 121 in the direction of the supply valve 113, and with the release valve 119 seated against the end of said plunger said supply valve will be opened to permit flow of fluid under pressure from chamber 94 and the supply pipe 95 to chamber 115 and thence through port 112 to chamber 102 and pipe 91. At the same time as fluid thus flows to pipe 91 it will equalize through the stabilizing choke 101 into chamber 100 and therein act on diaphragm 92 in opposition to pressure of the regulating spring 109. When the pressure of fluid in chamber 100 then becomes sufficient to overcome the force of regulating spring 109 the diaphragm 92 will deflect against said spring.

Now assuming that movement of the fuel control shaft 8 has ceased in some position out of its idling position, movement of plunger 121 and thereby of the release valve 119 and supply valve 113 will also have stopped, as a result of which, deflection of diaphragm 92 by increasing pressure of fluid in chamber 100 will be relative to said supply valve until said supply valve becomes seated. Seating of the supply valve 113 will then prevent further flow of fluid under pressure to chambers 102 and 100 and pipe 91, whereupon deflection of diaphragm 92 will cease since the pressure of regulating spring 109 will have been increased sufficiently to counterbalance the pressure of fluid in chamber 100. The increase in pressure of fluid in pipe 91 will therefore be limited to a degree dependent upon the extent of movement of the fuel control shaft 8 out of its idling position.

If the fuel control shaft 8 is moved further out of its idling position the respective pressure regulating valve device 90 will again be operated to increase the pressure of fluid in the respective pipe 91 to a degree corresponding to the degree of such movement. A maximum pressure of fluid will be obtained in pipe 91 when the fuel control shaft 8 is moved to its full fuel position, indicated by the dot-dash line 9.

On the other hand, if the fuel control shaft 8 is moved in the direction of its idling position, assuming that it is out of said position, this movement will rock bell crank 131 to permit movement of plunger 121 by spring 123 plus pressure of fluid in chamber 115 acting on said plunger in a direction away from the supply valve 113. With the supply valve 113 seated, the release valve spring 124 will hold the release valve 119 against movement with plunger 121, so that this movement of plunger 121 will be away from said release valve to thereby open communication past said release valve for releasing fluid under pressure from chamber 102 and pipe 91, and also from chamber 100 above diaphragm 92. As the pressure of fluid

in chamber 100 is thus reduced spring 109 will deflect the diaphragm 92 in the direction of plunger 121, and during such movement spring 125 will move the supply valve 113 and the release valve 119 along with said diaphragm. Assuming that the fuel control shaft 8 is stopped in a position out of idling position, movement of plunger 121 will cease in a corresponding position, so that movement of the release valve 119 with diaphragm 92 will then be relative to said plunger until it engages its seat for preventing further release of fluid under pressure from chamber 102, pipe 91 and chamber 100. When the release valve 119 is thus closed preventing further release of fluid under pressure from chamber 100, diaphragm 92 will stop moving since the pressure of fluid in said chamber will just counterbalance the pressure of regulating spring 109. Thus the pressure of fluid in pipe 91 will only be reduced to a degree corresponding to the position of the fuel control shaft 8 out of idling position. If the fuel control shaft is moved further toward, but not completely to, its idling position the regulating valve device 90 will again operate as just described to effect a corresponding reduction in pressure of fluid in pipe 91, while if said shaft is returned to its idle position the parts of the regulating valve device will return to the position shown in Fig. 4 in which the release valve 119 will just contact its seat at the time the pressure of fluid in pipe 91 becomes reduced to substantially atmospheric pressure and spring 109 becomes fully expanded.

It will now be seen that the regulating valve device 90 on each engine will operate to provide in the respective pipe 91 a pressure proportional to the position of the respective fuel control shaft 8, and hence proportional to the amount of fuel supplied to the engine, and it is desired to further point out that the regulating valve devices 90 on both the master and slave engines are adjusted the same, so as to provide the same pressures in the respective pipes 91 for the same positions of the respective fuel control shafts 8.

The pipe 91 at the master engine A is connected to what may be called an equalizing pipe 135 adapted to extend to all slave engines, such as engine B. Associated with the slave engine B is what may be called an equalizing valve device 136 connected by a pipe 137 to the synchronizing pipe 135 and also connected to pipe 91 from the respective pressure regulating valve device 90.

The equalizing valve device 136 comprises a casing containing two coaxially arranged and spaced apart flexible diaphragms 138 and 139 of the same areas which are clamped around their edges in the casing. Between the two diaphragms is a chamber 140 adapted to be constantly supplied with fluid under pressure through a fluid pressure supply pipe 141. The chamber 140 is formed in two parts divided by a wall 142 having a passage 143 connecting the parts so that the adjacent faces of the two diaphragms 138 and 139 are constantly subject to fluid at supply pressure. At the opposite face of diaphragm 139 is a control chamber 144 which is open to pipe 137 leading to the equalizing pipe 135. At the opposite face of diaphragm 138 is a control chamber 145 which is connected to pipe 91 leading to the pressure regulating valve device 90 on the respective or slave engine.

Extending through the chamber 140 and the chamber dividing wall 142 is a stem 146 one end of which is clamped to the center of diaphragm 139 by follower plates 147 and a nut 148. The

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opposite end of stem 146 is connected to the center of diaphragm 138 by follower plates 149 engaging opposite faces of said diaphragm and a clamping nut 150 disposed in chamber 145. The casing of the device also has a chamber 151 to which pipe 65 from the governor control motor 31 on the respective engine is connected. Chamber 151 is separated from chamber 145 by a wall 152, and extending from the exterior of the casing through chamber 151 and wall 152 and having one end open to chamber 145 is a bushing 153 arranged in coaxial relation with the diaphragms 138 and 139 and with the nut 150. The nut 150 has a cylindrical extension 154 slidably mounted in an axial bore provided in the adjacent end of bushing 153, and encircling and having sealing and sliding contact with said extension is a ring 155 carried in a groove in said bushing. The interior of the extension 154 is open to a chamber 156 formed within the bushing and said chamber is open through one or more ports 157 to the casing chamber 151.

One end of chamber 156 within the bushing 153 is closed by a nut 158 secured in said bushing. Secured in the nut 158 is an element 159 having a bore arranged in coaxial relation to the flexible diaphragms 138 and 139, and in said bore is slidably mounted a pin 160. The pin 160 is provided in chamber 156 with an enlarged head 161 while on the opposite end of said pin is a fluid pressure release valve 162 arranged to co-operate with a seat on the nut 158 for controlling communication between a passage 163 extending through the element 159 to chamber 156, and a passage 164 which leads to atmosphere. Interposed between the nut 158 and the stem head 161 is a light spring 165 for moving the release valve 162 out of contact with its seat.

A pin 166 projects from the release valve stem head 161 centrally through the cylindrical extension 154 and an opening 167 in nut 150 to engage a fluid pressure supply valve 168 which is contained in a chamber 169 formed in the diaphragm clamping nut 150. The nut 150 has a seat for the supply valve 168 around the opening 167, which opening is of greater diameter than pin 166. The supply valve 168 is provided on one end of a fluted stem 170 which is mounted to slide in a bore extending through the nut 150 to a chamber 171 formed below said nut in the diaphragm connecting stem 146. Chamber 171 is connected through one or more ports 172 to the fluid pressure supply chamber 140 between the two diaphragms 138 and 139, and in chamber 171 the supply valve stem 171 is provided with a head 173 against which acts one end of a coil spring 174 the opposite end of which is supported by a wall in stem 146. A coil spring 175 contained in chamber 144 acts on the adjacent diaphragm follower plate 147 for opposing movement of the diaphragms 138 and 139 and of nut 150 in a direction against said spring.

In the equalizing valve device 136 it will now be noted that diaphragm 139 is subject in chamber 144 to pressure of fluid from the equalizing pipe 135 through pipe 137, that is, subject to pressure of fluid provided by the pressure regulating valve device 90 on the master engine A, while diaphragm 138 is subject in chamber 145 to pressure of fluid provided by the pressure regulating valve device 90 on the slave engine B. It will further be noted that pressure of spring 174 acting to seat the supply valve 168 will oppose movement of the diaphragms 138 and 139 and the connecting stem 146 by an increase in pressure of fluid

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in diaphragm chamber 144 over that effective in chamber 145, while spring 175 will oppose movement of said diaphragms and stem in the opposite direction by a preponderant pressure of fluid in chamber 145. The springs 174 and 175 are so proportioned as to require a definite or fixed differential, such as eight-tenths of a pound, between fluid pressures in chambers 144 and 145, acting in either one direction or in the opposite direction, to move the diaphragm and connecting stem 146, and this differential will remain substantially the same regardless of the pressure of fluid which may be effective in said chambers, in contrast to devices like the pressure regulating valve devices 90 wherein the force required through lever 31 to control the device will vary in proportion to variations in the opposing pressure of fluid effective in chambers 102 and 115 and acting on the plunger 121 plus the variable pressure of the bias spring 128.

The opposing forces of springs 174 and 175 on the diaphragms 138 and 139 and the connecting stem 146 is also adapted to insure movement of these parts to a neutral or lap position in which both the supply valve 168 and release valve 162 are seated, as shown in the drawing, when the differential between the pressures of fluid in chambers 145 and 144 is less than the chosen differential above mentioned.

When a speed governor controlled engine is in operation, the speed governor is usually constantly operating within a limited range to match the fuel supply to slight variations in engine load or speed, and as a consequence, the pressure regulating valve devices 90 on both the master and slave engines A and B, respectively, will cause corresponding slight variations in the pressure of fluid in the respective chambers 144 and 145 of the equalizing valve device 136, and another purpose of springs 174 and 175 is to prevent the parts of said device from moving out of their neutral position in response to such variations in fluid pressure.

In pipe 65 is a choke 176, and connected to said pipe between said choke and the governor control motor 31 on slave engine B is a volume or reservoir 177.

Operation

In operation, let it be initially assumed that the engines A and B are stopped, that the operator's control device 60 is opening the control pipe 59 and diaphragm chambers 57 in the motors 30, 31 to atmosphere, and that the whole system is void of fluid under pressure. On each engine, the upper ends of the governor bell cranks 12 will then be moved by the governor control spring 17 into substantial contact with plunger 15 and said plunger will be effective through lever 25, link 24 and arm 23 to move the respective fuel control shaft 8 to its maximum fuel position, indicated by the dot-dash line 9 in Fig. 2. With the fuel control shaft 8 at each engine thus positioned, the arm 134 thereon and link 133 will hold lever 131 of the respective fluid pressure regulating device 90 to its maximum pressure position in which plunger 121 will be seated against the release valve 119 and said valve will be unseating the supply valve 113 from the nut 107.

Further, with the system void of fluid pressure the power piston 32 in the governor control motors 30 and 31 will be in contact with a stop 178 under the pressure of spring 40. In the governor motor 31 on slave engine B the pressure of spring 40 on one end of the dia-

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phragm connecting structure 46 will thereby be reduced to a degree which will permit control spring 61, as precompressed only by the shims 62, to hold said structure in the position for seating the release valve 73 and in which position the supply valve 80 will also be seated by spring 86. In the governor motor 30 on master engine A the pressure of the additional shim 63 under the control spring 61 will however increase the force of said spring to a degree which will move the structure 46 against the regulating spring 40 and relative to the seated release valve 73 to permit opening of the supply valve 80 by said release valve.

Now let it be assumed that pipes 95 of the pressure regulating valve devices 90 and pipes 67 of the governor motors 30 and 31 are opened to the source of fluid under pressure. On the master engine A fluid under pressure thus supplied to pipe 95 will flow to chamber 94 in the respective pressure regulating valve devices 90 and thence past the open supply valve 113 to chambers 115 and 102 and from the latter chamber through pipe 91 to the equalizing pipe 135 and thence through pipe 137 to diaphragm chamber 144 in the equalizing valve device 136. At the same time as fluid is thus supplied to chamber 144 in the equalizing valve device 136 fluid will also flow from chamber 102 through the stabilizing choke 101 to diaphragm chamber 100 in the pressure regulating valve device 90 on the master engine. When the pressure of fluid in chamber 100 then becomes increased sufficient to overcome the opposing force of regulating spring 109 the diaphragms 92 and 93 will be deflected in unison against said spring and relative to the supply valve 113 until said supply valve becomes seated to prevent further flow of fluid under pressure to chambers 102 and 100 in the pressure regulating valve device and to chamber 144 in the equalizing valve device 136, so as to thereby limit the pressure of fluid obtained in said chambers to a maximum degree corresponding to the maximum fuel position of the fuel control shaft 8 on engine A.

On slave engine B the pressure regulating valve device 90 will also operate to supply fluid at a maximum degree of pressure, corresponding to a maximum fuel position of the respective fuel control shaft 8 through pipe 91 to diaphragm chamber 145 in the equalizing valve device 136. Assuming that the supply of fluid to the two pressure regulating valve devices 90 is cut in at the same time the pressures of fluid in diaphragm chambers 144 and 145 in the equalizing valve device 136 will be increased substantially in unison and to the same maximum degree, as a result of which the parts of the equalizing valve device 136 will remain in the position in which they are shown in Fig. 5 of the drawings.

When fluid under pressure is initially supplied to pipe 67 leading to the governor control motor 31 on slave engine B it will merely flow into chamber 66 between the diaphragms 43 and 44, it being remembered that the supply valve 80 in said motor at this time is seated. Hence the power piston 32 in motor 31 will remain in contact with the casing stop 178. However, in the fluid motor 30 on master engine A, when fluid is initially supplied through pipe 67 to chamber 66, fluid will flow past the open supply valve 80 into chamber 70 and thence through passage

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71 to chamber 68 between diaphragms 44 and 45 and from the latter chamber through passage 37 to the power piston chamber 34. Fluid under pressure will thus continue to flow to chamber 34 until it becomes sufficient to move piston 32 against spring 40 for increasing the pressure of said spring on the diaphragm connecting structure 46 to a degree sufficient to move said structure against the control spring 61 relative to the supply valve 80 and until said structure seats against said supply valve. When the supply valve 80 in the governor motor 30 is thus closed the supply of fluid pressure to the power piston chamber 34 will cease so that movement of the power piston 32 will also cease in a position in which it is shown in Fig. 3 of the drawing and in which the fuel control shaft 8 will be in its engine idling position. It will thus be seen that on the master engine A, the power piston 32 will be moved away from stop 178 slightly upon initially cutting in the air supply to motor 30 and 31, while on slave engine B the motor piston 32 will still be in contact with stop 178; hence the pressure of spring 17 in the governor on the master engine A will be increased to a degree slightly in excess of that on slave engine B.

Now let it be assumed that, with the operator's control valve device 60 still opening the control pipe 59 and thereby diaphragm chambers 57 in the two governor control motors 30 and 31 to atmosphere, the two engines are started in any conventional manner.

As soon as the engines are started, rotation of centrifuge 31 by the respective cam shaft 1 will cause the upper ends of the governor bell cranks 12 to rock in a direction away from plungers 15, due to the action of centrifugal force thereon, and to a position in which said force will counterbalance the adjusted pressure of the respective control spring 17. On each engine this action of the governor arms 12 will rock the fuel control shaft 8 out of its full fuel position, indicated by the dot-dash line 9, in the direction of its idling position in which it is shown in Fig. 2, but since the pressure of the governor control spring 17 on slave engine B is less than that on the master engine A, the governor control arms 12 on the slave engine B will move out to a slightly greater degree and thereby operate the respective fuel control shaft 8 to reduce the fuel supplied to the slave engine B to a degree slightly less than on master engine A, but still of a sufficient degree to ensure that the slave engine B will continue to operate.

When the two engines are started as just described operation of the fuel control shafts 8 to reduce the amount of fuel supplied to the engines will cause operation of the respective pressure regulating valve devices 90 to proportionately reduce the pressure of fluid in chambers 144 and 145 in the equalizing valve device 136, it being noted that the pressure of fluid in chamber 145 will reduce to a degree below that in chamber 144 since the fuel control shaft 8 on slave engine B occupies a position for supplying less fuel to said slave engine than is being supplied to the master engine A. As a result, a sufficient differential will be obtained between the pressures of fluid in chambers 144 and 145 to deflect the diaphragms 138 and 139 against the supply valve seating spring 174 to thereby move the nut 153 relative to the supply valve 168 so as to open said

supply valve. Upon opening of the supply valve 168 fluid under pressure supplied through pipe 141 to chamber 140 will flow past said valve to chamber 156 and thence through passage 157 to chamber 151 and from the latter chamber through pipe 65 to diaphragm chamber 64 in the governor control motor 31 on slave engine B, the increase in pressure in said chamber 64 being limited in rate by the restricting effect of choke 176 and the volume of reservoir 175.

When fluid under pressure is thus supplied to chamber 64 in the governor control motor 31 on slave engine B as just mentioned, its effect on the differential areas of diaphragms 42 and 43 will create a force which, acting in conjunction with the respective control spring 61, will move the diaphragm connecting structure 46 in the direction of the left-hand against the force of regulating spring 40 and thus out of seating engagement with the supply valve 80 which is held against movement at this time by the seated release valve 73. When the supply valve 80 in the governor control motor 31 on the slave engine B is thus opened, fluid under pressure will flow from the supply pipe 67 past said valve to chamber 70 and thence to chamber 68 between the diaphragms 44 and 45 and from the latter chamber through passage 37 to the power piston chamber 34. When the pressure of fluid in chamber 34 is thus increased sufficiently the power piston 32 will move against the regulating spring 40 and increase the force of said spring against the diaphragm structure 46, and when the force of said spring is consequently increased to a sufficient degree said structure will move against the pressure of fluid in diaphragm chamber 64 and the pressure of the respective regulating spring 61, relative to and finally into contact with the supply valve 80 for preventing further flow of fluid under pressure to the power piston chamber 34. This movement of the power piston 32 in the governor motor 31 on slave engine B will in turn actuate cam 19 to increase the pressure of the governor control spring 17 on said engine for thereby causing operation of the fuel control shaft 8 to increase the supply of fuel to said engine to a degree determined by the increased pressure of said spring and the centrifugal action of the governor control arm 12.

As the fuel control shaft 8 on slave engine B is thus operated to increase the supply of fuel to said engine the respective pressure regulating valve device 90 will be operated to correspondingly increase the pressure of fluid in diaphragm chamber 145 of the equalizing valve device 136 and when this pressure, acting in conjunction with spring 174, becomes increased to substantially the same pressure as is effective in chamber 144, the diaphragms 138 and 139 will be moved against spring 175 and thus relative to the supply valve 168 until said valve becomes seated against the nut 150. When the supply valve 168 is thus seated further flow of fluid under pressure to chamber 64 in the governor control motor 31 on slave engine B will be prevented to thereby limit operation of said motor and of the respective fuel control shaft 8 for increasing the supply of fuel to said engine relative to that provided on master engine A, to a degree in which the respective pressure regulating valve device 90 is supplying fluid to chamber 145 in the equalizing valve device at substantially the same pressure as is provided in chamber 144 by the pressure regulating valve device 90 on master engine A. Hence the fuel control shaft 8 on slave engine B will now

be occupying substantially the same position as the fuel control shaft 8 on master engine A, and the power output of the former engine will therefore be substantially the same as that of the latter engine.

It will now be seen that the pressure of fluid provided in chamber 64 of motor 31 on slave engine B equalizes the power output of said engine with that of master engine A. It should however be noted that the force produced by such pressure on the differential areas of diaphragms 42 and 43 may not equal that produced by spring 61 incident to the use of shim 63, since to obtain the equalization a greater force might be required or even a less force would be sufficient, dependent upon the condition of the apparatus being controlled, such as slight variations in adjustments, resistances to movement, etc. Thus to obtain equalization of the output of slave engine B to that of master engine A, the pressure of fluid required in chamber 64 on the slave engine may be either greater or less than the chosen degree, such as 25 pounds which would provide equalization if the apparatus on the two engines were identical in operation. The effect of shim 63 on spring 61 with respect to operation of motor 30 on the master engine H is the same as would be provided by this chosen pressure of fluid in chamber 64 in motor 31 on slave engine B. The shim 63 thus constitutes a means on the master engine for causing automatic operation of the apparatus to equalize the output of slave engine B to that of said master engine.

Now let it be assumed that it is desired to increase the amount of fuel supplied to and thereby the power output of the two engines. To accomplish this the operator's control device 59 will be operated to increase the pressure of fluid in pipe 59 to a degree corresponding to the desired increase in power output. At each of the engines this increase in pressure in pipe 59 will be effective through branch pipe 58 in control chamber 57 of the respective governor control motor 30 or 31 and therein act on diaphragm 41 to move the diaphragm connecting structure 46 in the direction of the left hand against the opposing force of regulating spring 40. This movement of structure 46 will be relative to the supply valve 80 since said valve is at this time held against movement by the seated release valve 73 and, as a result fluid under pressure from the supply pipe 67 will flow past said supply valve to the power piston chamber 34.

When the pressure of fluid thus provided in chamber 34 in each of the governor control motors is then increased to a degree sufficient to overcome the opposing force of spring 40 on the power piston 32, said piston will move against and increase the pressure of said spring against the diaphragm connecting structure 46. Fluid under pressure will continue to be supplied past the supply valve 80 to the power piston chamber 34 until the power piston is moved to a position in which the increased pressure of spring 40 is sufficient to counterbalance the increased pressure of fluid in chamber 57 and to then move the diaphragm structure 46 back into seating engagement with the supply valve 80 for thereby preventing further flow of fluid under pressure to the power piston chamber 34. The power piston 32 will then stop in a position, it will be noted, corresponding to the increased pressure of fluid in the control chamber 57, and the corresponding increase in pressure of the respective governor control spring 17 should cause a corresponding

change in position of the respective fuel control shaft 8 and thus a like increase in the amount of fuel supplied to the respective engine.

As the fuel control shafts 8 on the two engines are thus operated for increasing the supply of fuel to the engines, the respective pressure regulating valve devices 90 will be operated to correspondingly increase the pressure of fluid in diaphragm chambers 144 and 145 of the equalizing valve device 136, and in case the fuel shafts 8 on all of the engines assume substantially the same position the pressure of fluid provided in said chambers will be substantially the same so that the parts of the equalizing valve device 136 will remain in the position in which they are shown in Fig. 5 of the drawings.

However, if when the output of the engines is increased, as just described, the fuel rack 8 on the master engine A should be operated to increase the supply of fuel to said engine to an amount exceeding that supplied to slave engine B, the pressure regulating valve device 90 on master engine A will increase the pressure of fluid in diaphragm chamber 144 to a degree sufficiently in excess of that in chamber 145 to cause operation of the equalizing valve device 136 to increase the pressure of fluid in diaphragm chamber 64 of the governor control motor 31 on slave engine B. This increase in pressure of fluid in chamber 64 in motor 31 will then cause operation of said motor to increase the pressure of the governor control spring 17 on slave engine B for in turn causing operation of the fuel control shaft 8 on said engine to increase the amount of fuel supplied to said engine. The fuel control shaft 8 on slave engine B as it is thus operated to increase the supply of fuel to the engine, will also operate the respective pressure regulating valve device 90 to increase the pressure of fluid in diaphragm chamber 145 in the equalizing device 136 until it substantially equals that in chamber 144 whereupon spring 174 will move the diaphragms 139 and 139 back to neutral position for closing the supply valve 168. When the supply valve 168 is thus closed further flow of fluid to diaphragm chamber 64 in the governor control motor 31 will be prevented, whereupon operation of said motor will cease, as will also movement of the respective fuel control shaft 8, in a position in which the pressure of fluid provided in diaphragm chamber 145 of the equalizing valve device will be substantially the same as that provided in chamber 144 by operation of the pressure regulating device 90 on engine A. Thus with the regulating valve device 90 on slave engine B adjusted to provide substantially the same pressure of fluid as provided by regulating valve device 90 on master engine A, the fuel control shaft 8 on the slave engine will be in substantially the same position as that on the master engine, so that the output of power from the slave engine will be substantially the same as from the master engine.

On the other hand, let it be assumed that in response to an increase in pressure of fluid in pipe 59 for increasing the power output of the two engines, the fuel control shaft 8 on slave engine B is operated by the governor control motor 31 and the respective governor 10 to increase the supply of fuel to said engine to a degree exceeding that obtained on master engine A by operation of the governor control motor 30.

Under such a circumstance the pressure regulating valve device 90 on slave engine B will increase the pressure of fluid in diaphragm cham-

ber 145 in the equalizing valve device 136 to a degree exceeding that which will be obtained in chamber 144 by operation of the pressure regulating valve device 90 on master engine A. As a result, the diaphragms 139 and 139 and the connecting stem 146 will be moved by the pressure of fluid in diaphragm chamber 145 against the lower pressure of fluid in chamber 144 and the pressure of spring 175 and thereby act through the supply valve 168, which will be seated by spring 174, to draw stem 166 in the direction away from the release valve stem 160. Spring 165 will however maintain the head 161 on the release valve stem 160 in contact with the stem 160, and as a result, will pull the release valve 162 out of contact with its seat. When the release valve 162 is thus opened fluid under pressure will be vented past said valve from diaphragm chamber 64 in the governor control motor 31 on slave engine B.

This reduction in pressure in chamber 64 on the differential areas of diaphragms 42 and 43 in motor 31 on slave engine B will reduce the force resulting therefrom and acting in the direction of the left hand, and as a result, the pressure of the regulating spring 40 on structure 46 will move said structure in the direction of the right hand against the control pressure of fluid in chamber 57 and the control spring 51. With the supply valve 80 seated against structure 45, this movement of said structure will be relative to the element 51 and the release valve seat member 53, so as to permit spring 78 to move the release valve 73 along with said supply valve and thus out of engagement with its seat. When the release valve 73 is thus opened fluid under pressure will be released from the power piston chamber 34 through passage 37, chamber 58, chamber 70, and thence past said release valve to chamber 34 and from the latter chamber through passage 55, chamber 38 and passage 39 to atmosphere.

As the pressure of fluid in the power piston chamber 34 in governor control motor 31 on slave engine B is thus reduced, the pressure of regulating spring 40 will move the piston 32 in the direction of the left hand, as viewed in Fig. 3, for thereby actuating cam 19 to reduce the pressure of the respective governor spring 17. The governor 10 on slave engine B will then operate to turn the respective fuel control shaft 8 in a direction to correspondingly reduce the supply of fuel to the engine, and as a result, the pressure regulating valve device 90 on said engine will be operated to correspondingly reduce the pressure of fluid in diaphragm chamber 145 of the equalizing valve device 136.

When the fuel control shaft 8 on slave engine B is thus turned to a position in which the respective pressure regulating valve device 90 reduces the pressure of fluid in diaphragm chamber 145 to substantially the same degree as effective in diaphragm chamber 144, the pressure of fluid in the latter chamber plus the pressure of spring 175 will deflect the diaphragms 139 and 139 and the connecting stem 146 in the direction of chamber 145, and with supply valve 168 held seated by spring 174, the supply valve 162 will be moved with said diaphragms and finally into contact with its seat to prevent further release of fluid under pressure from chamber 64 in the governor control motor 31.

As soon as the reduction in pressure in chamber 64 in the governor control motor 31 is terminated as just described, the reduction in pressure of regulating spring 40 on the diaphragm connecting structure 46, upon slight further movement

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of the power piston 32 in the direction to reduce the pressure of said spring, will result in movement of said structure by the remaining fluid pressure in chamber 64 plus that in chamber 57 to the position in which the release valve 73 is seated for preventing further release of fluid under pressure from the power piston chamber 34. The power piston 32 will then stop in a position corresponding substantially to the reduced pressure of fluid in chamber 64 in the governor control motor 31, and as a result, the respective speed governor 10 will operate to stop movement of the fuel control shaft 8 on slave engine B in a corresponding position for thereby preventing further reduction in the fuel supply to said engine; thus limiting the degree of such supply to substantially that provided for master engine A.

From the above description it will now be seen that regardless of the pressure of fluid provided in pipe 59 for obtaining different desired degrees of power output from the engines, the power output of slave engine B will, if it is different from that on master engine A, be either increased or decreased automatically as required to obtain substantially the same output as on said master engine.

It will be further noted that engine A is automatically rendered effective as the master engine for regulating or limiting the supply of fuel to slave engine B to substantially the same degree as obtained on the master engine A, by the shim 63 provided in the governor control motor 30. The provision of fluid pressure in chamber 64 in the governor control motor 31 on slave engine B, and of means for varying said pressure in accordance with the relative fuel supply positions of the fuel control shafts 8 on the two engines enables operation of said motor to equalize the power output of slave engine B with that of master engine A as predetermined by the shim 63 and pressure of controlling fluid in pipe 59.

In the equalizing valve device 136 the springs 174 and 175 not only insure movement of the diaphragms 138 and 139 and of the stem 146 to neutral position in which both the supply valve 168 and the release valve 162 are seated, but also prevent said parts overtraveling neutral position, since said springs insure that said neutral position will be obtained without increasing pressure of fluid in chamber 145 above that in chamber 144, on the one hand, or reducing the pressure of fluid in chamber 145 below that in chamber 144, on the other hand. Due to this, movement of the fuel shaft 8 on slave engine B in a direction to increase the supply of fuel to said engine will be positively stopped in a position in which the pressure of fluid delivered by the respective pressure regulating valve device 90 may equal but does not exceed that delivered by the pressure regulating valve device 90 on master engine A, so that there will be no oversupply of fuel to slave engine B with respect to that supplied to master engine A. Further, when the fuel shaft 8 on slave engine B is operated to reduce the supply of fuel to said engine, the supply will not be reduced to below that on master engine A since the equalizing valve device 136 when it obtains neutral position will stop movement of the fuel control shaft 8 on slave engine B when the pressure of fluid in diaphragm chamber 145 becomes reduced by operation of the respective pressure regulating valve device 90 to substantially, but not below, that provided by the regulating valve device 90 on master engine A. The springs 174 and 175 in thus preventing operation of the equalizing valve

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device 136 to cause an oversupply, or an undersupply, as the case may be, of fuel to slave engine B with respect to that being supplied to master engine A renders the whole apparatus stable and positive in operation.

In order to still further stabilize operation of the apparatus, the rate of either increase or decrease in pressure in diaphragm chamber 64 of the governor control motor 31 on slave engine B retarded to such a degree, as by the use of choke 176 and the reservoir 177, that the governor 10 on said engine will operate to change the position of the respective fuel control shaft 8 and thereby cause operation of the respective pressure regulating valve device 90 to vary the pressure of fluid in diaphragm chamber 145 in the equalizing valve device 136, at least as rapidly as said motor operates to change adjustment of said governor, so as to ensure that operation of said motor will cease substantially at the instant the equalizing valve device 136 obtains its neutral position, and for in turning insuring that the fuel control shaft 8 on slave engine B will positively stop in a position corresponding substantially to that of the fuel control shaft 8 on master engine A for limiting the amount of fuel supplied to slave engine B to substantially the same degree as being supplied to engine A.

Stability of the apparatus is further insured by springs 174 and 175 in the equalizing valve device 136 which will maintain the parts of said device in neutral position upon slight changes in pressure of fluid in either diaphragm chamber 144 or chamber 145 incident to slight variations in position of the fuel shaft 8 on either engine by operation of the respective speed governor 10 to maintain the engine speed or power output substantially constant against minor variations in load or the like on the engines.

It is desired to further point out that the sensitivity of the equalizing valve device remains the same through out the full fuel control range of the fuel control shafts 8, i. e., regardless of the opposing pressure of fluid which may be acting in chambers 144 and 145, since operation of said device depends only upon a chosen differential between said pressures, and this is very desirable in that it will ensure prompt equalization of the power output of the slave engine to that of the master engine when the engines are operated under maximum load, just as readily as when operating at idling speed and possibly under no load.

Summary

It will now be noted that the improved control apparatus provides positive automatic equalization of the amount of fuel supplied to each of any desired number of slave engines with the amount of fuel supplied to a preselected master engine, so as to substantially equalize the power output of the several engines, which is particularly desirable where several engines are connected to a common load, in order to substantially equally divide the load between the engines.

Only one engine can be the master engine and it is conditioned automatically to so function by the use of shim 63 in the governor control motor 30 on that engine while on the slave engine or engines the governor control motor 31 is automatically adjustable in accordance with the position of the respective fuel control shaft relative to that on the master engine, to match the fuel supply to and thereby the power output of the slave engine to that of the master engine.

While only one slave engine B is shown in the

drawings, any desired number can be controlled from the master engine A through the equalizing pipe 135 as will be obvious.

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

1. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, an adjustable power control element for each prime mover for varying the power output thereof, equalizing means having a first position, a second position and a neutral position intermediate said first and second positions, means operable by said equalizing means in said first position to effect adjustment of said power control element on said one prime mover to increase the power output of said one prime mover, in said second position to effect operation of said power control element on said one prime mover to reduce the power output of said one prime mover and operable in said neutral position to maintain said power control element on said one prime mover against change in adjustment, means adjustable in accordance with the relative power output of said prime mover for effecting movement of said equalizing means to said first position upon a preponderance in output of said other prime mover over that of said one prime mover, to said second position upon a preponderance in output of said one prime mover over that of said other prime mover, and to said neutral position upon equalization of the power output of said one prime mover with that of said other prime mover.

2. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, an adjustable power control element for each prime mover for varying the power output thereof, control means for adjusting said power control elements, equalizing means having a first position, a second position and a neutral position intermediate said first and second positions, means operable by said equalizing means in said first position to effect operation of said control means on said other prime mover to effect adjustment of the respective power control element to increase the power output of said other prime mover, and in said second position to effect operation of said control means on said other prime mover and thereby of the respective power control element to reduce the power output of said other prime mover, and in said neutral position to maintain said control means on said other prime mover against change in adjustment, means adjustable in accordance with the relative power output of said prime movers for effecting movement of said equalizing means to said first position upon a preponderance in output of said one prime mover, and to said second position upon a preponderance in output of said other prime mover, and means operable to move said equalizing means to said neutral position upon substantial equalization of the power output of both prime movers.

3. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, an adjustable power control element for each prime mover having an idling position and operable to increase the power output of the respective prime mover in proportion to movement of said element out of said idling position, equalizing means having a first position, a second position and a neutral position intermediate said first and second positions, means operable by said equalizing means

in said first position to effect operation of said power control element on said one prime mover to increase the power output of said one prime mover, and in said second position to effect operation of said power control element on said one prime mover to reduce the power output of said one prime mover and operable in said neutral position to maintain said power control element on said one prime mover against change in adjustment, means adjustable in accordance with the relative positions of said power control elements for effecting movement of said equalizing means to said first position upon a preponderance in output of said one prime mover and to said second position upon a preponderance in output of said other prime mover, and means for effecting movement of said equalizing means to said neutral position upon substantial equalization of the output of both prime movers.

4. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, first and second control pipes for said one and other prime movers, an adjustable power control element for each prime mover for varying the power output thereof, first and second pressure regulating means associated respectively with said one and other prime movers and adjustable by the respective prime mover power control element to provide in the respective one of said control pipes fluid at a pressure proportional to the power output of the respective prime mover, equalizing means subject to pressure of fluid provided in said first pipe acting in opposition to pressure of fluid provided in said second pipe and movable to a first position by the pressure of fluid provided in said first pipe when it exceeds that provided in said second pipe, and movable to a second position by the pressure of fluid provided in said second pipe when it exceeds that provided in said first pipe, means for moving said equalizing means to said neutral position upon substantial equalization of pressures of fluid in both of said pipes, and means operable in said first position of said equalizing means to effect operation of said power control means on said other prime mover to increase the power output thereof, in said second position to effect operation of said power control means on said other prime mover to reduce the power output thereof, and in said neutral position to maintain said power control means on said other prime mover against change in adjustment.

5. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, first and second control pipes for said one and other prime movers, an adjustable power control element for each prime mover for varying the power output thereof, first and second pressure regulating means associated respectively with said one and other prime movers and adjustable by the respective prime mover power control member to provide in the respective one of said control pipes fluid at a pressure proportional to the power output of the respective prime mover, equalizing means subject to pressure of fluid provided in said first pipe acting in opposition to pressure of fluid provided in said second pipe and movable to a first position by the pressure of fluid provided in said first pipe when it exceeds that provided in said second pipe, and movable to a second position by pressure of fluid provided in said second pipe when it exceeds that in said first pipe, spring means acting on said equalizing means opposing movement thereof to either said first or second positions by

fluid under pressure and operable to move same to a neutral position between said first and second positions upon substantial equalization of the pressures of fluid in said first and second pipes, and means operable in said first position of said equalizing means to effect operation of said power control means on said other prime mover to increase the power output thereof, in said second position to effect operation of said power control means on said other prime mover to reduce the power output thereof, and in said neutral position to maintain said power control means on said other prime mover against change in adjustment.

6. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising an adjustable power control element for each prime mover, means for adjusting the power control elements on both prime movers to regulate the power output thereof including fluid motor means on said one prime mover and means operable by said motor means to adjust the power control element and thereby the power output of said one prime mover relative to that of the other prime mover, valve means having a first position for supplying fluid under pressure to said fluid motor means and a second position for releasing fluid under pressure from said fluid motor means for operating same to adjust the respective power control element to either increase or decrease the power output of said one prime mover relative to that of said other prime mover, said valve means also having a neutral position intermediate said first and second positions for bottling up the fluid pressure in said motor means, spring means for moving said valve means to said neutral position, and means adjustable in accordance with the power output of said prime movers for effecting movement of said valve means against said spring means to said first position upon a preponderance in output of said other prime mover over that of said one prime mover, and to said second position upon a preponderance in output of said one prime mover over that of said other prime mover, and operable upon equalization of the output of said one prime mover with that of said other prime mover to render said spring means effective to move said valve means to said neutral position.

7. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising an adjustable power control element for each prime mover, means for adjusting the power control elements on both prime movers to regulate the power output thereof including fluid motor means on said one prime mover and means operable by said motor means to adjust the power control element and thereby the power output of said one prime mover relative to that of the other prime mover, valve means having a first position for supplying fluid under pressure to said fluid motor means and a second position for releasing fluid under pressure from said fluid motor means for operating same to adjust the respective power control element to either increase or decrease the power output of said one prime mover relative to that of said other prime mover, and also having a neutral position intermediate said first and second positions for bottling up the fluid pressure in said motor means, equalizing means subject to opposing pressures of fluid in a first chamber and in a second chamber and operable upon a preponderance in pressure in said first chamber over that in said second chamber to move said valve means to said

first position and upon a preponderance in pressure in said second chamber over that in said first chamber to move said valve means to said second position, spring means for moving said valve means to said neutral position upon substantial equalization of pressures of fluid in said first and second chambers, and first and second pressure regulating means operable by said power control elements on said one and other prime movers to vary the pressure of fluid in respectively said first and second chambers in proportion to the power output of the respective prime movers.

8. A control apparatus for equalizing the power output of one prime mover with that of another prime mover comprising an adjustable power control element for each prime mover, first and second fluid motors for adjusting respectively the power control elements on said one and other prime movers, operator's control means for varying pressure of fluid in said motors, power means subject to pressure of fluid in a first chamber and opposing pressure of fluid in a second chamber and movable to a first position upon a preponderance in pressure in said first chamber over that in said second chamber, and movable to a second position upon a preponderance in pressure in said second chamber over that in said first chamber, spring means for moving said power means to a neutral position intermediate said first and second positions upon substantial equalization of the fluid pressures in said first and second chambers, a valve operable by said power means in said first position to supply fluid under pressure to said first motor, another valve operable by said power means in said second position to release fluid under pressure from said first motor, means for closing both of said valves in said neutral position of said power means, and means operable by said power control elements on said one and other prime movers to vary the pressure of fluid in respectively said first and second chambers in proportion to the power output of the respective prime movers.

9. A control apparatus for equalizing the power output of two prime movers comprising, a power control element for each prime mover adjustable to vary the power output thereof, first and second fluid motors for said prime movers for adjusting the respective power control elements, operator's control means connected to both of said motors for simultaneously controlling operation thereof, said second motor comprising fluid pressure controlled bias means for adjusting the respective power control element relative to that on said one prime mover in accordance with variations in pressure either above or below a chosen pressure of fluid on said bias means, means associated with said first motor for automatically effecting an adjustment of the respective power control element corresponding to the adjustment of said power control element on said other prime mover effected by said chosen pressure of fluid acting on said bias means, valve means for increasing and decreasing the pressure of fluid on said bias means and for bottling up the fluid pressure on said bias means, power means movable to a first position upon the preponderance in pressure of fluid in a first chamber over that in a second chamber and movable to a second position upon a preponderance in pressure of fluid in said second chamber over that in said first chamber and having a neutral position, for controlling said valve

means, spring means for moving said power means to said neutral position upon substantial equalization of the fluid pressures in said first and second chambers, and first and second pressure regulating devices associated with said one and other prime movers operable by the respective power control elements to vary the pressure of fluid in said first and second chambers in proportion to the adjusted power output of the respective prime movers.

10. An apparatus for equalizing the power output of one prime mover with that of another prime mover comprising, a power control element for each prime mover adjustable to vary the power output thereof, an equalizing pipe, a regulating device adjustable by said power control element on said other prime mover to vary pressure of fluid in said equalizing pipe in proportion to the adjusted power output of said other prime mover, a second pipe, a second pressure regulating device adjustable by said power control element on said one prime mover to vary pressure of fluid in said second pipe in proportion to the adjusted power output of said one prime mover, an equalizing device controlled by pressure of fluid in said equalizing pipe acting in opposition to pressure of fluid in said second pipe and movable to a first position upon a preponderance in pressure in said equalizing pipe over that in said second pipe, and movable to a second

position upon a preponderance in pressure of fluid in said second pipe over that in said equalizing pipe, spring means for moving said equalizing device to a neutral position between said first and second positions upon substantial equalization of pressures in said equalizing pipe and second pipe, and means operable in said first and second positions of said equalizing means to effect adjustment of said power control element on said one prime mover to increase and decrease, respectively, the power output of said one prime mover with respect to that of said other prime mover and operable in said neutral position to prevent change in adjustment of said power control element on said one prime mover.

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