Nov. 2, 1965 M. E. IVERSON 3,214,901

HYDRAULIC CONTROL SYSTEM

Filed May 22, 1963 2 Sheets-Sheet 1

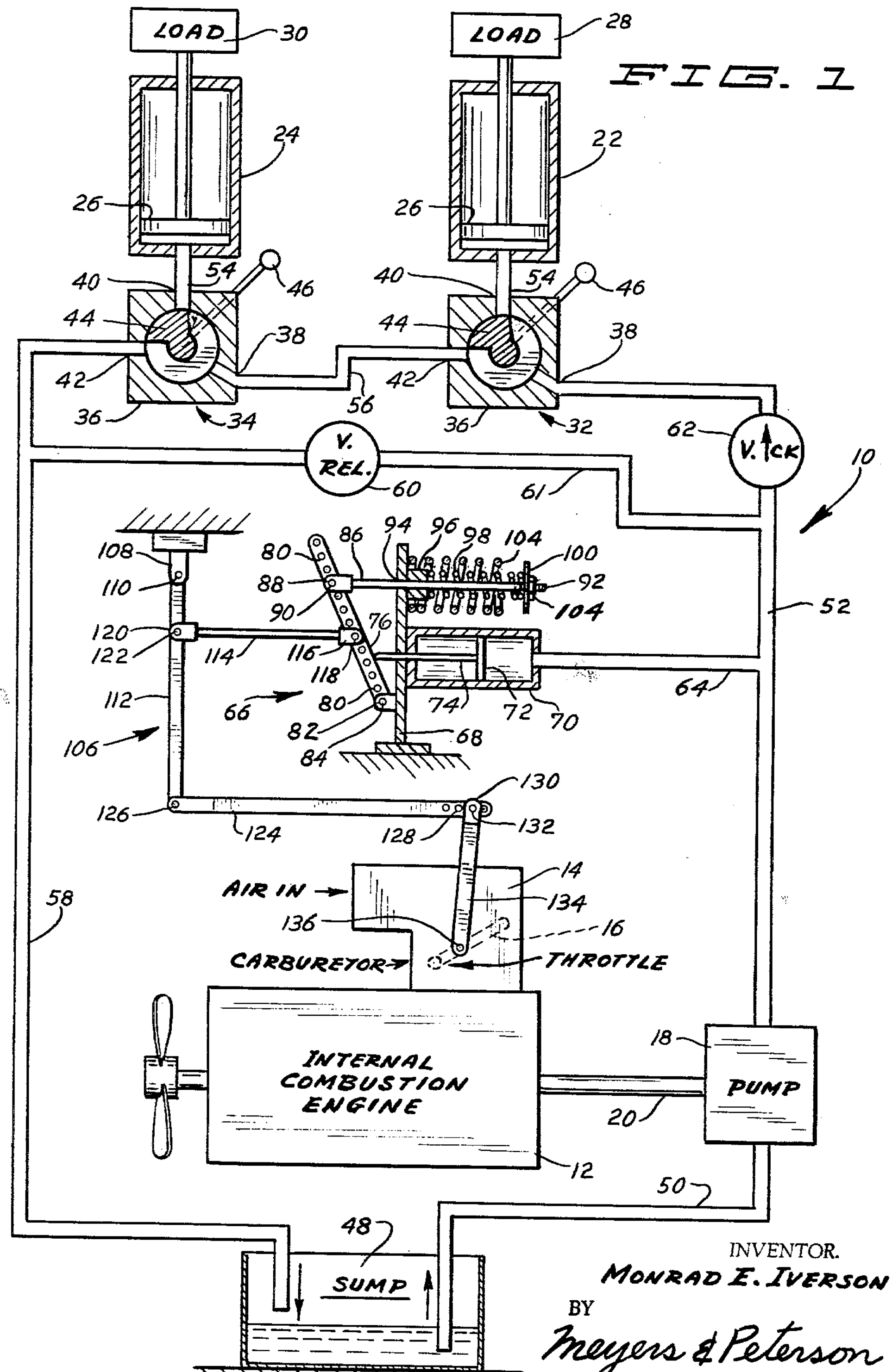

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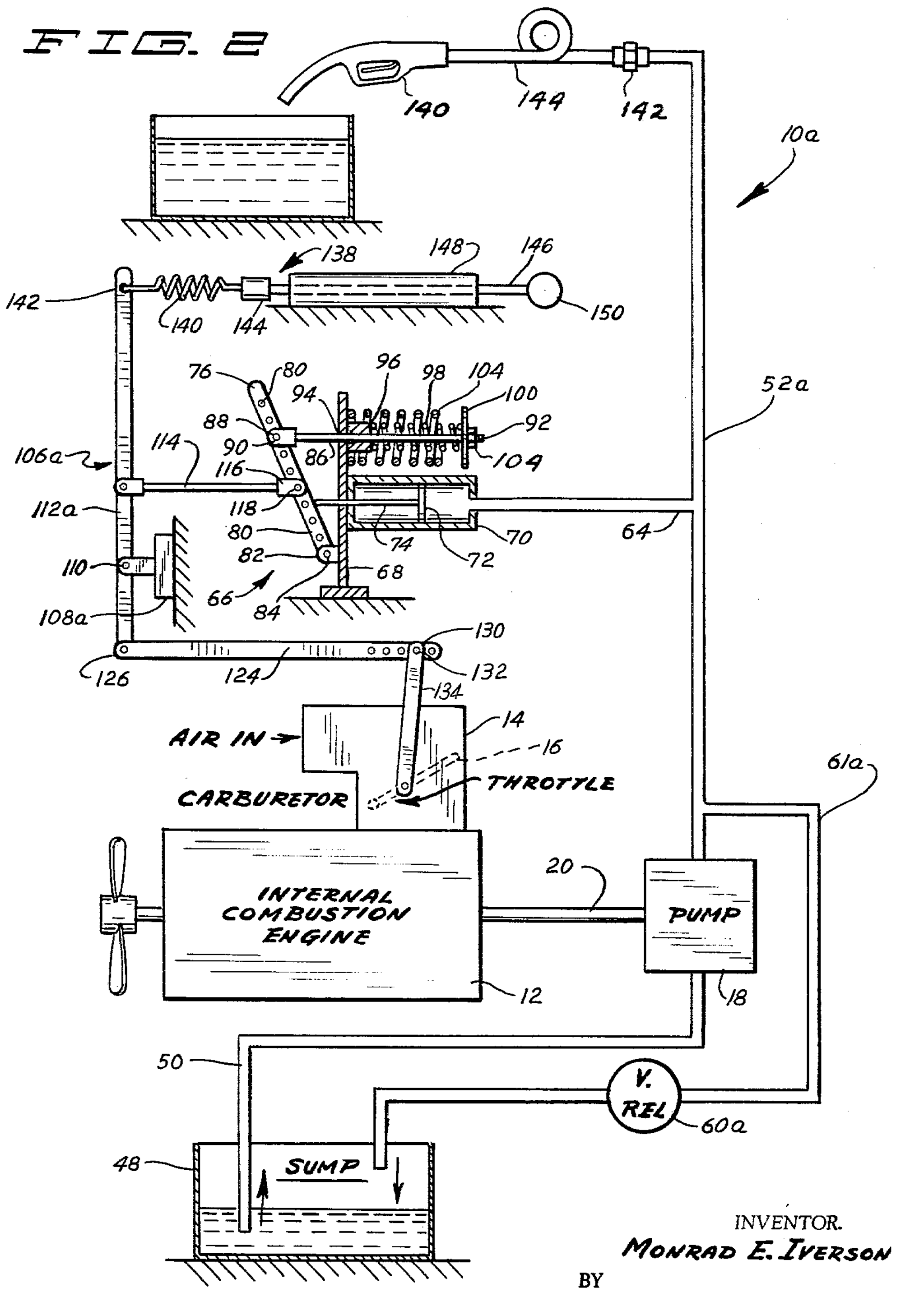
FIG. 2



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HYDRAULIC CONTROL SYSTEM

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This invention relates generally to hydraulic control systems, and pertains more particularly to a system for controlling the speed of an internal combustion engine that is drivingly connected to a pump that supplies the system's hydraulic pressure.

One object of the invention is to provide a hydraulic control system for an engine-driven pump that normally permits the engine to idle but which causes an increase in engine speed when load conditions so require.

Another object is to provide a hydraulic control system that will act rapidly to bring the internal combustion engine to the proper speed for the particular hydraulic load to which the system is subjected, even though such hydraulic load might vary over a relatively wide range.

Another object of the invention is to provide a hydraulic system of the foregoing character that is more sensitive to lower pressures so that the internal combustion engine will begin to change its speed as soon as there is an indication that a greater hydraulic pressure will be needed, even though such indication is at first quite small.

A further object of the invention is to provide a control system that lends itself readily to various hydraulic valve arrangements that are apt to be encountered in actual practice. In this regard, it is to be appreciated that some valve arrangements operate in decidedly different ways and the hydraulic system in accordance with the teachings of the present invention is easily adapted to the different valve schemes that are in fairly common usage.

Somewhat in connection with the above object, the invention has for an additional feature the use of the control system with internal combustion engines either with or without governors, and also it is within the purview of the invention to utilize the system where a manually actuated throttle setting mechanism is employed.

Yet another object of the invention is to allow the control device forming the basic portion of my hydraulic control system to be employed for the purpose of limiting the maximum pump pressure and the maximum engine speed when the pump is operating under no load conditions. On the other hand, the control device can be connected into the system so as to act as a warning in case there is a leak in the hydraulic circuit.

Still another object of the invention is to provide a hydraulic system that will minimize wear and tear on the internal combustion engine, the pump and the valves incorporated into the system.

These and other objects and advantages of my invention will more fully appear from the following description, made in connection with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is a schematic representation of one form my hydraulic system may assume, and

FIGURE 2 is a modified system in accordance with the teachings of the invention.

Referring now in detail to FIGURE 1, the hydraulic control system there depicted has been designated in its entirety by the reference numeral **10**. The internal combustion engine has been labeled **12** and it will be discerned that it is equipped with a conventional carburetor **14** which has therein a throttle identified by the reference numeral **16**.

The internal combustion engine **12** is drivingly coupled to a pump **18** via a shaft **20**. While in some instances it will be desirable to employ an intermediate set of gears between the engine **12** and the pump **18**, nonetheless it is to be understood that the pump speed is directly proportional to the speed of the engine **12**.

While it is comtemplated that the system will find utility in conjunction with the operation of various hydraulic devices, for the sake of simplicity only two operating cylinders **22, 24** have been schematically portrayed in the drawing. These operating cylinders **22, 24** contain reciprocable pistons **26** that lift loads **28** and **30**, respectively. In actual practice, the cylinders **22, 24** will be of the double acting variety, but as already indicated an effort is herein being made to present the system in as simple a form as is possible. Whereas operating cylinders **22, 24** have been depicted, it will also be appreciated that other hydraulic devices, such as winches and the like can be substituted therefor.

In the illustrated system, there are two valves **32** and **34**, there being only one such valve associated with each of the operating cylinders **22, 24** inasmuch as these cylinders are shown with single acting pistons. Each of the valves **32, 34** include a casing **36** having an inlet port **38**, an outlet port **40** and a by-pass port **42**. Within the casing **36** in each instance is a segmental valve head **44** which is rotated about a central axis by means of a lever **46**. Valves of this general type are in common usage, and therefore the pictured valves are to be considered only exemplary as the specific construction thereof may vary quite widely. Basically, though, it is to be observed that the valve heads **44** can be moved into an annular position in which they block their respective outlet ports **40**, thereby allowing fluid flow to occur directly from the inlet ports **38** to the by-pass ports **42**. However, when the levers **46** are moved in a counterclockwise direction the outlet ports **40** will be gradually opened and the by-pass ports **42** will be gradually closed.

At this time, attention is called to a sump **48** which serves as a reservoir for the liquid to be pumped through the system **10**. Extending into the sump **48** in a suction line or conduit **50**. The discharge from the pump **18** is delivered directly into a line or conduit **52** that has direct communication with the inlet port **38** of the valve **32**. A short line or conduit **54** extends from the outlet **40** of the valve **32** to the lower end of the operating cylinder **22**, and an identical line **54** extends from the outlet port **40** of the valve **34** to the other operating cylinder **24**. A line or conduit **56** extends from the outlet port **42** of the valve **32** to the inlet port **38** of the valve **34**. Hence, when the valve **32** is by-passing fluid from the line **52** to the line **56**, then the valve **34** will be receiving fluid at its inlet port **38**. The by-pass port **42** of the valve **34**, however, is connected to a line or conduit **58** that returns the fluid to the sump **48**. Obviously, in actual practice there will be a much larger number of valves **32, 34** that are employed, but the two that have been depicted should provide an adequate basis for the piping arrangement that is contemplated in conjunction with the system **10**.

Inasmuch as it is contemplated that the pump **18** will be of a positive displacement type and that there be no by-pass in the pump itself, it is essential in practice to employ a relief valve **60** which is contained in the transverse line or conduit **61** leading from the line **52** and connecting with the line **58**. The relief valve **60** will be set for the maximum safe pressure that the system can withstand, say, on the order of 3,000 p.s.i., although other pressures might be selected. It is also to be noted that a check valve **62** has been incorporated into the line **52** to prevent any reverse flow from occurring should the pump 18 fail to deliver an adequate pressure due either to some failure within the pump or to an inadvertent shutdown of the internal combustion engine 12. While the valves 60, 62 have been illustrated as separate and distinct components, valves are available that perform a combined relieving and checking operation.

In order to provide the actual control of the throttle 16 belonging to the engine 12, a takeoff line 64 has communication with the line 52 at its right end and leads to a control device generally denoted by the reference numeral 66. The control device 66 plays a very important role in the practicing of the invention and will now be described in detail. In order to provide a unitary structure, the device 66 includes a vertical plate 68 that is fixedly mounted so as to maintain a cylinder 70 fixedly coupled to the take-off line 66. Within the cylinder 70 is a reciprocable piston 72 having a piston rod 74 projecting from the left end of said cylinder. The projecting end of the piston rod 74 abuts an arm 76 having a series of holes or apertures 80 formed therein. The lowermost of said apertures 80 is aligned with a fixed clevis 82 that is attached to the plate 68, there being a pin 84 that functions as a pivot point for said arm 76.

The control device 66 further includes a bias rod 86 carrying a clevis 88 at one end which has a pin 90 connecting the clevis 88 to a selected aperture 80 in the arm. The opposite end of the rod 86 from the clevis 88 is threaded and has been identified by the reference numeral 92. The rod 86 is slidably received in an aperture 94 formed in the plate 68.

Attached to the plate 68 circumjacent the aperture 94 is a bushing or collar 96 further serving as a bearing for the reciprocable mounting of the rod 86. A relatively lightweight coil spring 98, that is a spring having a relatively low spring constant, abuts at one end against the collar 96 and abuts at the other end against a washer 100 carried on the bias rod 86. The amount of compression introduced into the lightweight coil spring 98 can be adjusted initially by a nut 102 threadedly carried on the end 92. A relatively heavy coil spring 104 is mounted concentrically with the spring 98. The relatively high spring constant spring 104 bears at one end against the plate 68 and circumscribes the collar 96. The opposite end of the relatively heavy coil spring 104 is capable of bearing against the washer 100 when the piston 72 has urged the arm 76 sufficiently in a counterclockwise direction.

A linkage mechanism designated generally by the reference numeral 106 is utilized for the purpose of moving the throttle 16. This mechanism 106 includes a fixed clevis at 108 having a pin 110 extending through the upper end of a vertical arm 112. The mechanism further includes a connecting rod 114 having a clevis 116 at the right end thereof through which a pivot pin 118 extends, the pin 118 passing through one of the apertures 80 in the arm 76. At the left end of the connecting rod 114 is a second clevis 120 having a pivot pin 122 extending through the vertical arm 112.

Still describing the mechanism 106, it is to be noted that a horizontal arm or link 124 has a pin 126 pivotally connecting the left end thereof to the lower end of the vertical arm 112. The right end of the link 124 is provided with a plurality of holes 128, for the purpose of attaching this end to a clevis 130 through the agency of a pivot pin 132. The clevis 130 is carried at the upper end of rocker arm 134 and the lower end of the arm 134 is attached to a shaft 136 which carries the throttle 16 located within the confines of the carburetor 14.

OPERATION, FIGURE 1 MODIFICATION

Having presented the foregoing description, the manner in which the system 10 operates will now be given. When the internal combustion engine is started, it will quickly come up to its normal idling speed. The pump

18 will therefore be driven at a relatively low speed and the pressure developed by the pump will be correspondingly low. The inactive or normal position of the valves 32, 34 is that shown in FIGURE 1 and under these circumstances the fluid under pressure from the pump 18 will flow via the line or conduit 52 into the inlet port 38 of the valve 32 and will continue on through the by-pass port 42 to the inlet port 38 of the valve 34. The valve 34 being in the same position as the valve 32 will permit the fluid to continue on to the by-pass port 42 and it will return to the sump 48 via the line or conduit 58. While only two valves 32, 34 have been pictured, it has already been indicated that a larger number of such valves will be employed in actual practice. Depending upon the number of such valves, the frictional losses will be in accordance with such number and may amount to 70 p.s.i. Even so, this pressure is a relatively low pressure compared to the pressure needed to move the pistons 26 in either of the cylinders 22 and 24.

As a consequence of the above happening, there will be only a small pressure sensed via the line or conduit 64 and the piston 72 will not be moved appreciably so as to overcome the biasing action of the relatively lightweight coil spring 98. Hence, the linkage 106 will remain in a position such that the throttle 16 will be almost closed. Stated somewhat differently, there is no demand for an increased hydraulic pressure from the pump 18 and the internal combustion engine 12 is maintained at its relatively low idling speed.

Assuming now that the lever 46 of the valve 32 is moved gradually in a counterclockwise direction, it follows that the segmental head 44 will start to close off the by-pass port 42 and will begin to open the outlet port 40, thereby admitting fluid under pressure to the lower end of the operating cylinder 22. Whereas the pressure caused by friction was of the order of 70 p.s.i., the closing of the by-pass port 42 will cause an increase in this pressure. In this regard, an increase in pressure is desired because the outlet port 40 is being gradually opened and depending upon the amount of load 28 a particular pressure will be needed in order to raise this load.

The increase in pressure within the line 52 is sensed by the device 66 and the piston 72 will be urged to the left and the piston rod 74 will bear with increased amount of force against the arm 76. This causes the connecting rod 114 to be moved toward the left and the arm 112 is thereby pivoted in a clockwise direction about the pin 110. This, in turn, moves the link 124 to the left with the consequence that the rocker arm 134 is moved in a counterclockwise direction to open the throttle 16 to a greater degree.

If, for instance, the lever 46 of the valve 32 is moved far enough to cause the head 44 to block completely the by-pass port 42, then it will be appreciated that if the load 28 is quite heavy, the pump 18 is working against the piston 26 and a pressure will continue to be built up in the line 52 and this pressure will continue to be sensed by the control device 66. The greater the pressure that is sensed, the farther the arm 76 will be moved and the farther the throttle 16 will be opened, the linkage 106 transmitting the movement to said throttle 16. As a result, the internal combustion engine 12 will be speeded up to whatever extent is necessary to cause the pump 18 to develop a sufficient pressure for the actuation of the piston 26 contained within the operating cylinder 22.

From what has been described, it will be evident that the system 10 takes into account any load requirements with respect to the operating cylinder 22 and its load 28. Considering now the possibility that the operating cylinder 24 will be the one requiring sufficient fluid pressure, then the lever 46 of the valve 32 will be moved back into the position in which it appears in the drawing, thereby preventing reverse flow from the cylinder 22 via the outlet port 40. Under these conditions, the by-pass port 42 will be opened and fluid is permitted to flow via the line **56** to the inlet port **38** of the valve **34**. Movement of the lever **46** of the valve **34** will then cause the by-pass port **42** of this valve **34** to be gradually closed while the outlet port **40** is being gradually opened. The same action then takes place that occurred when the lever **46** of the valve **32** was moved to cause the head **44** of the valve **32** to admit liquid under pressure to the cylinder **22**. The control device **66** functions in the same fashion so that there will always be enough pressure supplied via the line **52** to the valve **34** so that the piston **26** of the operating cylinder **34** will lift the load **30** to the desired extent.

When the loads **28** and **30** are to be lowered, the lever **46** of the valve **32** is moved sufficiently in a clockwise direction so as to open all three ports **38**, **40** and **42**, thereby permitting fluid to flow directly from the inlet port **38** to the by-pass port **42**, as well as from the cylinder **22**, downwardly through the outlet port **40** to said by-pass port **42**. The lever **46** of the valve **34** will, of course, be moved so as to assure continued flow from the inlet port **38** of the valve **34** to the by-pass port **42**. If the load **30** is to be lowered, then the lever **46** of the valve **34** will be moved into a clockwise position so as to open the outlet port **40** and provide communication with the by-pass port **42**. The angular span of the valve heads **44** is such as to permit fluid to flow downwardly from the cylinder **24** through the outlet port **40** and into the by-pass port **42** with inlet port **38** still open. On the other hand, if the load **28** has already been lowered, then the inlet port **38** of the valve **34** can be blocked by the head **44** of said valve **34** so as to permit ready communication between the outlet port **40** and the by-pass port **42**.

Turning now to the modified system shown in FIGURE 2, this system having been labeled **10***a*, it can be pointed out that the two systems are basically quite similar but do differ in certain respects. Accordingly, it will be helpful to understand at the outset that those parts that do function in a different way or that are somewhat structurally different have been distinguished by the suffix "*a*." Also, as the description progresses, it will be seen that some additional parts or members are utilized in the system labeled **10***a*.

Instead of leading to the valves **32** and **34**, the slightly modified line **52***a* from the pump **18** conveys liquid under pressure to a nozzle valve **140** via a pipe coupling **142** and a flexible hose **144**. The nozzle valve **140**, for the sake of illustration, discharges into a storage tank **146** when open.

The control device **66** remains unchanged as far as its specific structure is concerned with respect to both the systems **10** and **10***a*. However, the linkage mechanism **106***a* differs in certain aspects and these will now be dealt with. For instance, it will be observed that there is a fixed clevis **108***a* that is located between the connecting rod **114** and the horizontal link **124**. It will be recalled that the clevis **108** of FIGURE 1 was located at the other side of the connecting rod **114**. Consequently, the vertical arm **112***a* is somewhat different inasmuch as it is contemplated that a throttle setting mechanism **138** be attached to the upper end thereof. The attachment is effected by reason of a coil spring **140** having one end hooked into a hole or aperture **142** at the upper end of the arm **112***a*. The throttle setting mechanism additionally includes a connector member **144** for attaching a cable **146** to the other end of the coil spring **140**. The cable **146** extends through a tube **148** and has at the end thereof remote from the spring **140** a knob **150** which permits the cable **146** to be pulled or moved into any desired position in order to adjust the throttle **16** via the modified linkage **106***a*.

OPERATION, FIGURE 2 MODIFICATION

With the foregoing modified details in mind, it is believed that the operation of the system **10***a* will be readily understood. Assuming for the moment that the nozzle valve **140** is closed, it can readily be understood that even though the internal combustion engine **12** is operating at a fairly low speed, such as an idling speed, the pump **18** will be acting against a blocked path. Hence, very little speed is necessary to cause the pump **18** to build up a sufficient pressure to operate the relief valve **60***a*. This is the no load condition, for it will be recognized that no fluid is being transferred to the storage tank **146**. Consequently, there is no need for the internal combustion engine **12** to operate at a relatively high rate of speed, so it is within the purview of the invention to cause the engine **12** to operate at a relatively low speed, more specifically, its idling speed.

With a fairly high pressure exerted on the piston **72** of the control device **66** via the line **52***a* and take-off line **64**, the piston rod **74** will be moved to the left and bears against the arm **76** to cause the connecting rod **114** to move to the left. Due to the fact that the clevis **108***a* has been placed in a different position from that in FIGURE 1, it follows that the vertical arm **112***a* will be rotated in a counterclockwise direction about the pivot pin **110** of the clevis **108***a*. This causes the horizontal link **124** to move toward the right with the result that the throttle **16** is moved toward closed position. This is exactly the goal that is desired, for there is no need to operate the engine **12** at a high rate of speed when there is no hydraulic load being applied to the system **10***a*.

However, when the nozzle valve **140** is opened, this tends to lower the pressure in the line **52***a*. Concomitantly with the lowering of the pressure in the line **52***a*, the pressure is naturally lowered in the cylinder **70** with the result that the piston **72** moves to the right, it being recalled that two coil springs **98** and **104** are compressed when the piston **72** moves sufficiently to the left. In other words, the coil springs **98** and **104** are exerting their biasing force to return the piston **72** to the right inasmuch as the biasing rod **86** is being moved to the right and is pulling the arm **76** against the projecting end of the piston rod **74**. This, in turn, causes the linkage **106***a* to be moved in an opposite direction, which results in the arm **112***a* being rotated in a clockwise direction about the pivot pin **110** of the clevis **108***a*. The horizontal link **124** is in this way moved to the left and the rocker arm **134** is, of course, rotated in a counterclockwise direction to open the throttle **16**.

The above action continues as long as the pressure is pulled down by having the nozzle valve **140** open so as to discharge fluid to the tank **146**. If the nozzle valve **140** is opened to its full extent, then the pressure will be lowered correspondingly and the control device **66** through the intermediary of the linkage **106***a* will cause the internal combustion engine **12** to speed up to the extent necessary to maintain the discharge pressure of the pump **18** at an appropriate value for maintaining the desired rate of flow.

As soon as the nozzle valve **140** has been closed, it follows that the throttle **16** will again be moved toward its closed position so as to reduce the speed of the internal combustion engine **12**. In other words, the pressure in the line **52***a* will build up and the increase in pressure will act upon the piston **72** to actuate the linkage **106***a* in a direction to move the throttle **16** toward its closed position, as outlined in the early part of the operational sequence pertaining to system **10***a*.

Having mentioned the throttle setting mechanism **138**, it can be explained that this mechanism **138** permits the throttle **16** to be initially set or adjusted for a given desired speed. Because the spring **140** introduces a yielding action into the system **10***a*, the control device **16** and the linkage **106***a* can function in accordance with the intended plan, the spring **140** readily permitting the desired operation to occur. The spring **140**, it will be recognized, does contribute somewhat to the biasing action afforded by the coil springs **98** and **104**. Consequently, in some refined instances allowance will be made for the additional use of the spring **140** and the springs **98**, **104** can be made slightly weaker than they would be if the throttle setting mechanism **138** were not utilized.

With respect to both of the systems **10** and **10***a*, it should be readily appreciated that when the internal combustion engine **12** is equipped with a governor mechanism, tractors and the like usually having such governors, although trucks normally do not, then the systems **10** and **10***a* still continue to function in the same manner that has been described. Stated somewhat differently, the governors only attempt to maintain a desired operating speed, but this speed is modified by reason of the throttle control that has been provided via the control device **66** in each system.

It will, of course, by understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of my invention as set forth in the appended claims.

What is claimed:

1. In a hydraulic control system:
(a) an internal combustion engine having a throttle associated therewith;
(b) a pump driven by said engine;
(c) a fluid motor operable by said pump; and
(d) means responsive to the pressure supplied said fluid motor for actuating said throttle in accordance with said pressure to increase the speed of said engine to cause said pump to provide a sufficient discharge pressure to operate said fluid motor, said pressure responsive means including:
(1) a cylinder;
(2) a piston reciprocable in said cylinder movable in a direction to actuate said throttle to increase the speed of said engine; and
(3) spring means biasing said piston in an opposite direction to close said throttle, the spring means including a first relatively light coil spring, and a second relatively heavy coil spring.

2. In a hydraulic control system:
(a) an internal combustion engine having a throttle associated therewith;
(b) a pump driven by said engine;
(c) a fluid motor operable by said pump; and
(d) means responsive to the pressure supplied said fluid motor for actuating said throttle in accordance with said pressure to increase the speed of said engine to cause said pump to provide a sufficient discharge pressure to operate said fluid motor, said pressure responsive means including:
(1) a cylinder;

(2) a piston reciprocable in said cylinder movable in a direction to actuate said throttle to increase the speed of said engine; and
(3) spring means biasing said piston in an opposite direction to close said throttle, said spring means including a first coil spring having a relatively low spring constant, a second coil spring having a relatively high spring constant, and said first coil spring having a length so as to be acted upon before said second coil spring becomes effective.

3. In the hydraulic control system of claim **1** in which:
(a) said coil springs are arranged so that said piston acts to compress first said first spring and then said second spring while still compressing said first spring.

4. In a hydraulic control system:
(a) an internal combustion engine;
(b) a throttle for controlling the speed of said engine;
(c) an articulate linkage mechanism for operating said throttle;
(d) means for manually adjusting said linkage mechanism including a coil spring attached at one end to said linkage mechanism and a cable connected to the other end of said coil spring whereby said throttle may be set to a desired partially open position;
(e) a pump driven by said engine;
(f) load means connected to said pump; and
(g) means for automatically adjusting said linkage mechanism in response to pressure supplied said load means so as to move said throttle toward closed position to decrease the speed of said engine when said pressure increases sufficiently and to move said throttle toward open position to increase the speed of said engine when said pressure decreases sufficiently.

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