

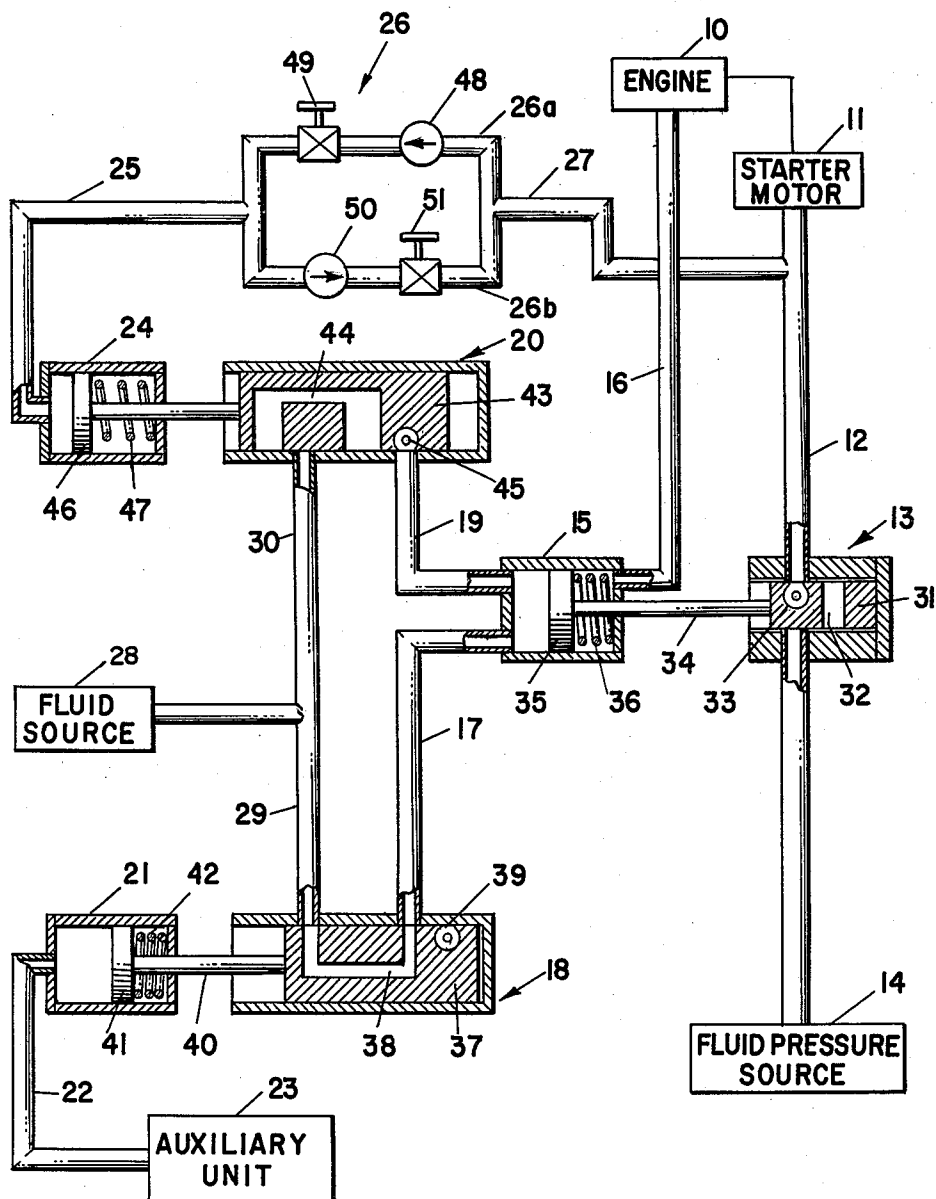
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ENGINE STARTING APPARATUS

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ENGINE STARTING APPARATUS

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This invention relates to an engine starting apparatus and more particularly to a hydraulically controlled apparatus for automatically starting internal combustion type engines.

In starting internal combustion engines, it has been found most expedient to turn the engine over for a period of perhaps five to seven seconds and then wait for an approximately equal interval of time before turning the engine over again. By periodically turning the engine over in this manner, proper fuel feeding for initially starting the engine without either flooding or fuel starvation is achieved.

While the usual starting motor for an internal combustion engine may be operated by suitable personnel periodically in accordance with the above sequences until the engine starts, this operation is time consuming from a labor standpoint. It would be desirable, accordingly, to provide an automatic engine starting control apparatus which will effect the desired turning over of the internal combustion engine at periodic intervals until such time as the engine is started. After the engine started, the automatic control apparatus should be rendered inoperative. With such an arrangement, there would be no necessity of any human agency being present for starting the internal combustion engine. Further, by means of such an automatic engine starting apparatus, any particular internal combustion engine could be started automatically in response to the happening of some other event; for example, if, in a commercial plant, one engine or motor should stop, this stopping could be employed for automatically starting a second engine. In this way, failure of one engine would not interrupt any particular process which required continuous operation of the devices driven by the engines.

With all of the above in mind, it is accordingly a primary object of this invention to provide an automatic engine starting apparatus which will effect turning over of an internal combustion engine at periodic intervals until such time as the engine is started.

More particularly, it is an object to provide an engine starting apparatus which is a completely self-contained unit and does not require any outside source of power other than that normally provided for operating the motor used to turn the engine over.

Another important object is to provide an apparatus of the above type which may be automatically started in response to stopping of some other piece of equipment or in response to the occurrence of any particular physical condition such as attainment of given temperatures or pressures.

Another object is to provide an engine starting apparatus which may be adjusted to vary the intervals between turning over and non-turning over of the engine in accordance with the particular type of engine itself so that the starting apparatus is relatively versatile.

Still other objects are to provide an automatic engine starting apparatus meeting the foregoing objects which may be economically manufactured, is rugged in design, and which does not present any fire or explosion hazards.

Briefly, these and many other objects of this invention are attained by providing a valve means in the supply line between a source of hydraulic fluid pressure and a hydraulic motor connected to the engine for turning over of the same. When the valve means is moved to an open position, hydraulic fluid pressure is passed to the hydraulic motor to turn the engine over. When the

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valve means is moved to a closed position, the fluid flow is cut off to the hydraulic motor and turning over of the engine is stopped.

Cooperating with the valve means is a control means responsive to opening of the valve means for closing the valve means after a first given period of time. The control means also includes means responsive to closing of the valve means for opening the valve means after a second given period of time. By this arrangement, the motor is caused to be operated for a given period of time and thus will result in turning over of the engine for like periods of time until the engine starts.

The apparatus also includes means connected between the engine itself and the valve means for closing and holding closed the valve means only after the engine has started.

In accordance with a feature of the invention, auxiliary control means may be provided which is responsive to the happening of a given physical event such as the stopping of another engine for initiating operation of the automatic starting apparatus.

A better understanding of the invention will be had by now referring to one embodiment thereof as schematically illustrated in the single accompanying drawing.

Referring to the the upper righthand portion of the drawing, the box 10 represents an internal combustion engine connected to a starter motor 11 for turning over the engine. The starter motor 11 is preferably a hydraulic motor supplied by hydraulic fluid such as air or liquid through a high pressure line 12 and valve means 13 connected to a source of hydraulic pressure 14.

Operation of the starter motor 11 is controlled by the valve means 13 which includes a pressure control cylinder 15, one end of which is connected to the engine manifold through a pressure line 16. From the opposite end of the cylinder 15 there is provided a pressure line 17 connected to an auxiliary valve means 18 and a pressure line 19 connected to a pilot valve means 20.

The auxiliary valve means 18 is controlled by a pressure cylinder 21 which, in the example chosen for illustrative purposes, is connected through a pressure line 22 to an auxiliary power unit 23. The pilot valve means 20 in turn is operated by a control cylinder 24 connected by a pressure line 25 through a time delay structure, designated generally by the numeral 26, back to the high pressure line 12 through a branch line 27.

The starting apparatus also includes an auxiliary source of fluid pressure 28 shown at the central left portion of the drawing for providing auxiliary fluid pressure through lines 29 and 30 to the auxiliary valve means 18 and pilot valve means 20, respectively. The pressure of the fluid source 28 is considerably less than the fluid pressure at the source 14 and may, if desired, be derived from the fluid pressure 14 through any suitable pressure dropping system.

Referring now in detail to the various components described above, the valve means 13 includes a valve body 31 including a transverse passage 32. Passage 32 will serve to provide communication between the fluid pressure source 14 and starter motor 11 when the valve body 31 is moved to the left as viewed in the drawing. Also included is an air bleeder port 33 in communication with the pressure line 12 when the valve body 31 is moved to the right as shown. Movement of the valve body 31 is controlled by piston rod 34 and piston 35 movable within the control cylinder 15. Normally, the piston 35 is biased by a compression spring 36 bearing against one side of the piston to urge it to its further leftmost position, thus tending to hold the valve body 31 in open position wherein the passage 32 registers with the high pressure line 12. The opposite side of the piston 35 is subject to var-

ious given pressures communicated through the line 17 and auxiliary valve means 18.

As shown in the drawing, this auxiliary valve means includes a valve body 37 provided with a passage 38 for connecting the lines 17 and 29 when in a first position as shown. The valve body 37 also includes a bleeder port 39. This bleeder port 39 is arranged to communicate with the pressure line 17 when the valve body 37 is moved to the left.

Control of movement of the valve body 37 is accomplished by a piston rod 40 connected to a piston 41 reciprocable within the control cylinder 21. Piston 41 is normally biased to a leftward position by a spring 42. The other side of piston 41 is subject to pressure through the line 22 from the auxiliary unit 23. When the piston 41 moves to the left as a consequence of a drop of pressure in the line 22, for example, the lines 29 and 17 will be disconnected and the bleeder port 39 will be placed in communication with the line 17 to open the left side of the piston 35 of the cylinder 15 to atmosphere.

The pilot valve 20 which also connects to the cylinder 15 through line 19 similarly includes a valve body 43 provided with a connecting passage 44 for connecting the lines 19 and 30 when the valve body 43 is moved to its righthandmost position. Line 30 is blocked when the valve body 43 is in its leftward position and line 19 is connected to bleeder port 45 as shown in the drawing. Movement of the valve body 43 is controlled by a piston 46 reciprocable within the control cylinder 24. A compression spring 47 normally biases the piston 46 to its leftwardmost position to hold the valve body 43 in the position shown in the drawing. The other side of the piston 46 is subject to pressure through the line 25 as controlled by the time delay structure 26.

This delay structure interposed between the line 25 and high pressure branch line 27 comprises first check valve 48 in series with a variable orifice control 49 disposed within a line 26a connecting the lines 27 and 25. Also included is a second line 26b in parallel with the line 26a and including a reverse check valve 50 and reverse variable orifice control 51. With this arrangement, the rate of pressure buildup on the left side of the piston head in the cylinder 24 may be controlled by the variable orifice control 49. Similarly, the rate of escape of fluid in a reverse direction from the cylinder 24 may be controlled by the variable orifice control 51.

With the above description in mind, the operation of the motor starting apparatus will now be described. Assume first that the engine 10 is not operating. Assume further that it is not desired to start the engine 10 unless some other physical event occurs such as failure of the auxiliary unit 23 shown at the lower lefthand portion of the drawing. In the particular example chosen, the auxiliary unit 23 may constitute a pump in which a relatively high pressure is maintained in line 22 connecting to the cylinder 21. This pressure will hold the piston 41 in its extreme right position against the bias of the spring 42. In this position, pressure from the auxiliary fluid source 28 will pass through the line 29 and passage 38 to line 17 and thus hold the piston 35 in the control cylinder 15 against the bias of spring 36. In this condition, the valve body 31 in the motor starter line 12 will be in the position shown so that high pressure fluid from the source 14 will not pass to the starter motor 11 and the engine 10 will remain shut off.

Without any high pressure in the line 12, there will not be any pressure against the piston 46 in the control cylinder 24 for the pilot valve 20. Therefore, the spring 47 will hold the piston 46 in its leftward position as shown, any trapped air being bled off through the one-way check valve 50, orifice control 51, line 27, and high pressure line 12 to the bleeder port 33 in the valve means 13.

If the auxiliary pump unit 23 should fail, the resulting

drop in pressure in line 22 will then permit the spring 42 to move the piston 41 to the left, thereby sliding the valve body 37 to the left and placing the line 17 in communication with the bleeder port 39. Also, the source of auxiliary pressure 28 will be cut off from the left side of the piston 35 in the control cylinder 15. As a consequence, the spring 36 may now move the piston 35 to the left and thus slide the valve body 31 to the left to cause the passage 32 to register with the high pressure line 12. High pressure fluid will then pass from the source 14 through the valve means 13 to the starter motor 11 and turn over the engine 10.

When high pressure is applied to the starter motor 11, it will also be communicated from the line 12 through the branch line 27, check valve 48, and variable orifice control 49 through the line 25 to the left side of the piston 46. This pressure will gradually move the piston 46 to the right to compress the spring 47. The rate of movement of the piston 46 to the right will depend upon the rate of pressure buildup behind the piston. This rate, in turn, may be controlled by the rate of flow permitted by the control 49 and thus the piston 46 will not be moved all the way to the right until a first given period of time has elapsed.

As the piston 46 moves to the right, the pilot valve body 43 will be moved to the right. After the referred to period of time, the passage 44 will connect the line 30 to the line 19, thereby resulting in pressure from the fluid source 28 passing through the line 30, passage 44, and line 19 to the control cylinder 15. This pressure will then act against the piston 35 and move the valve body 31 in the valve means 13 to the right, thereby cutting off or closing this valve and thus stopping the starter motor 11. Simultaneously, the bleeder port 33 in the valve body 31 will be placed in communication with the high pressure line 12 so that the pressure behind the piston 46 of the cylinder 24 may bleed off in a reverse direction through the line 25, check valve 50, variable orifice control 51, line 27, and line 12 through the outlet orifice 33. The rate of pressure bleed off is controlled by the variable orifice 51 and may be adjusted such as to permit a second given period of time to pass before the auxiliary source 28 is disconnected thereby permitting the spring 36 to return the piston 35 in the control cylinder 15 to its extreme leftward position.

When the passage 44 is moved out of registration with the line 19, the spring 36 will then return the piston 35 to its leftward position thus opening up the line 12 to the fluid pressure source to start the motor 11. Pressure in the cylinder 15 can bleed off through both bleeder ports 39 and 45. The valve means 13 will be opened and the engine 10 again turned over and the complete cycle repeated. It should be noted that both bleeder ports 39 and 45 are relatively small and their connection to cylinder 15 will not permit the spring 36 to move the piston to the left unless the auxiliary pressure from source 28 is also removed.

From the foregoing, it will be evident that the engine 10 will be periodically turned over for a given length of time dependent upon the setting of the control orifice 49 and caused to rest for intervals between the turning over periods which latter intervals may be controlled by the variable orifice control 51.

If at any time the engine 10 should start, the resulting drop in manifold pressure will be immediately communicated through the line 16 to the righthand side of the piston 35 causing a reduced pressure sufficient to move the piston 35 to the right, thus closing off the control valve 13.

Rather than have the initiation of the above cycle dependent upon a pressure as supplied by the auxiliary unit 23, the entire control cylinder 21, associated piston 41, and compression spring 42 may be eliminated and the rod 40 simply manually operated to move the slide valve

body 37 between its right and lefthand positions. To commence automatic operation of the starter, it would then only be necessary for an operator to move the valve slide 37 to the left.

It will be appreciated from the above description that the entire starting operation constitutes a completely self-contained unit, the only source of energy being derived from the readily available source of high pressure fluid. No electrical motors or batteries are required, and thus fire and explosion hazards and the like are reduced. The starter of this invention will thus find its preferred applications in chemical processing industries in which explosive atmospheres may be generated.

While only one embodiment of the starter has been set forth, various changes and modifications falling clearly within the scope and spirit of the invention will occur to those skilled in the art. The engine starting apparatus is therefore not to be thought of as limited to the one embodiment set forth merely for illustrative purposes.

What is claimed is:

1. An engine starting apparatus comprising, in combination: a fluid operated motor starter; a source of fluid; a conduit connecting said source of fluid to said motor starter; valve means in said conduit for passing fluid from said source to said starter when in an open position and for terminating flow of fluid to said starter when in a closed position; means for initially opening said valve means; control means connected to said valve means and responsive to an increase in fluid pressure in said conduit resulting from opening of said valve means for closing said valve means after a first given period of time and responsive to a decrease in fluid pressure in said conduit resulting from closing of said valve means to enable said valve means to open after a second given period of time; and engine responsive means for closing said valve means when said engine starts whereby said engine is automatically periodically turned over by said starter at given time intervals until said engine starts.

2. An apparatus according to claim 1, in which said control means includes: an auxiliary source of fluid pressure; a pilot valve operatively connected between said auxiliary source and said control means for closing said valve means when said pilot valve is opened and for enabling said valve means to open when said pilot valve is closed; and time delay means connected between said conduit and said pilot valve and responsive to the presence and absence of fluid pressure in said conduit portion connecting to said starter for respectively opening said pilot valve after said first given period of time and for enabling said pilot valve to close after said second given period of time.

3. An apparatus according to claim 2, in which said means for initially opening said valve means includes an auxiliary valve operatively connected between said aux-

iliary source and said control means and adapted upon actuation to enable said valve means to open.

4. An engine starting apparatus comprising, in combination: a hydraulic motor starter connected to turn over said engine; a source of hydraulic fluid; valve means operatively connected to said source; a fluid pressure line operatively connecting said valve means to said motor, said valve means including actuating means for opening said valve means in response to a change in an auxiliary fluid pressure to pass said hydraulic fluid through said line to said hydraulic motor starter; an auxiliary source of said auxiliary pressure; a pilot valve operatively connected between said auxiliary source and said actuating means so that opening of said pilot valve subjects said actuating means to said auxiliary pressure to close said valve means and closing of said pilot valve removes said auxiliary pressure from said actuating means to enable said valve means to open; a first time delay means connected between said pilot valve and said line and responsive to hydraulic fluid pressure in said line applied to said motor starter for opening said pilot valve after a first given period of time; a second time delay means connected between said pilot valve and said line and responsive to the absence of hydraulic fluid pressure in said line to enable said pilot valve to close after a second given time delay; and means responsive to starting of said engine and connected to said actuating means to hold said valve means closed.

5. An engine starting apparatus according to claim 4, in which said valve means includes a valve body movable between closed and opened positions, said actuating means comprising a cylinder, a piston in said cylinder connected to move said valve body, and spring means biasing one side of said piston in a direction to open said valve body, said pilot valve applying said auxiliary pressure to the opposite side of said piston to close said valve body; and said means responsive to starting of said engine comprising a line for communicating the manifold pressure of said engine to said one side of said piston whereby starting of said engine reduces said manifold pressure sufficiently to move said piston in a direction to close said valve body.

6. An engine starting apparatus according to claim 5, in which said first and second time delay means comprise pressure control orifices for varying the rate of movement of said pilot valve between open and closed positions.

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