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ELECTRIC CONTROL CIRCUIT

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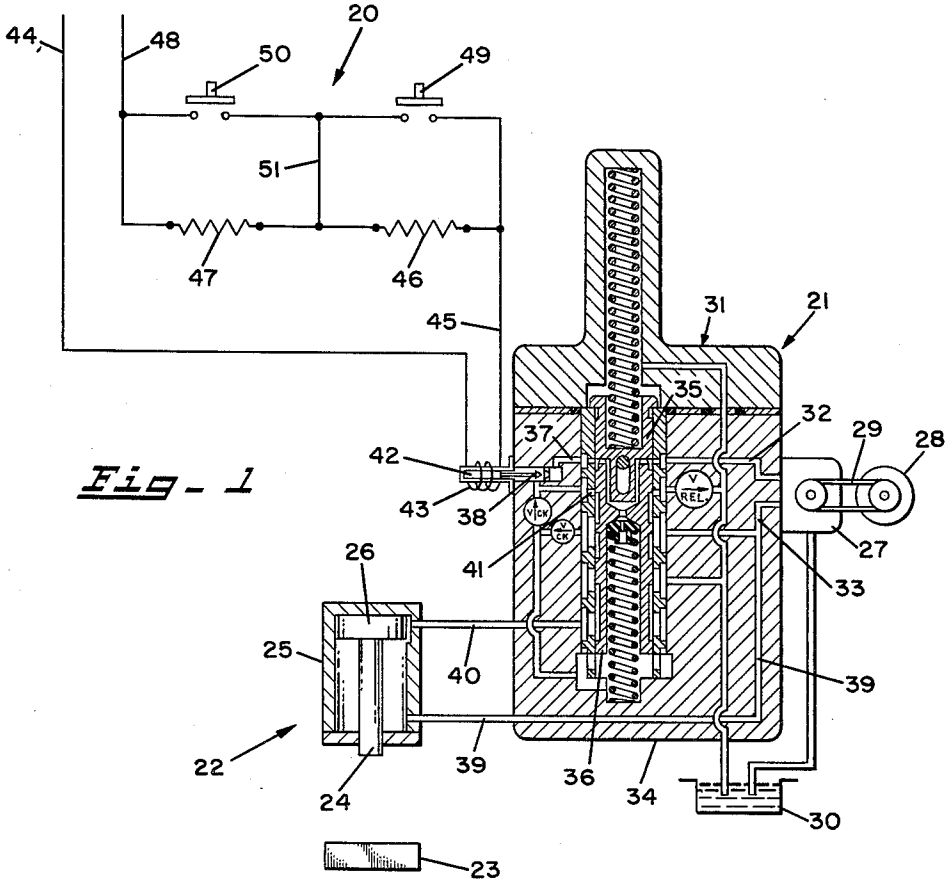


Fig - 1

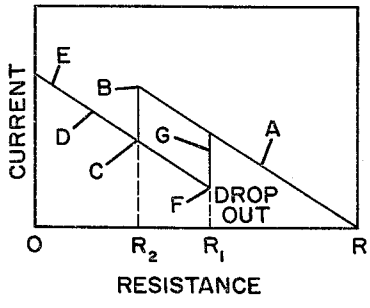


Fig - 2

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ELECTRIC CONTROL CIRCUIT

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Original application Feb. 23, 1956, Ser. No. 567,256, now Patent No. 2,945,990, dated July 19, 1960. Divided and this application Apr. 7, 1958, Ser. No. 726,985
5 Claims. (Cl. 317—135)

This invention relates to electric apparatus and more particularly to an electric circuit or system adapted to control any solenoid actuated or operated device and which circuit or system may be employed with particular advantage, for example, for controlling the operation of a hydraulic press.

The main object of this invention is to provide an improved electric circuit which includes two switches both of which must be closed to initiate the operation of an operating solenoid and in which, after said operation is initiated, only one of said switches need be maintained closed to maintain said solenoid in operation.

Another object of the invention is to provide an improved electric circuit as set forth in the foregoing object which may be used with particular advantage in controlling the hydraulic apparatus, and consequently the operation, of a hydraulic press in which the press operator must use both of his hands to operate the mentioned switches to initiate operation of the press and after said operation is initiated the operator may release one of said switches and the pressing operation of the press will continue.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the accompanying drawings:

FIG. 1 is a diagrammatic showing of an electric control circuit including features of the invention, said circuit being shown associated with the hydraulic system of a hydraulic press which it controls, and

FIG. 2 is a graph showing current characteristics of a solenoid operating on alternating current and connected in series with a resistance.

This application is a division of my copending application Serial No. 567,256, filed February 23, 1956, for an "Electric Control Circuit," now Patent No. 2,945,990.

FIG. 1 of the drawings illustrates an electric control circuit or system 20 associated with the hydraulic apparatus or system 21 of a hydraulic press which is indicated generally at 22. The hydraulic system 21 per se is the invention of Robert Smilges and is fully described and claimed in his copending application Serial No. 559,438, filed January 16, 1956, for "Hydraulic Press and Control Means," now Patent No. 2,927,558. This system is made a part of this application for illustrating the operation and purpose of the present invention and it is described herein only in sufficient detail to set forth the operation of the apparatus herein claimed. For an understanding of the details and operation of the hydraulic system, reference should be had to the above identified application to Robert Smilges.

Referring more particularly to FIG. 1 of the drawings, the hydraulic press 22 is shown as being comprised of a bed 23 and ram 24. Ram 24 is shown as forming the piston rod of a double-acting reciprocating hydraulic motor which includes a cylinder 25 and a piston 26. The hydraulic system 21, in addition to the press motor, also includes a pump 27 which is driven by an electric motor 28 through sheaves and a belt 29, a reservoir or tank 30 for hydraulic liquid used in the system, a hydraulic control valve 31 and suitable conductors or pipes which are

fully indicated in the drawing. The parts of the above described structure are shown in the drawings in the positions in which they occupy when the ram is held in its "up" position. Before describing the operation of the hydraulic system further, it should be pointed out that the pump 27 has two separate high pressure outlet or output ports which are connected respectively to conduits or lines 32 and 33 formed in the body 34 of valve 31 and that the volume of liquid delivered to the lines 32 and 33 are preferably, but not necessarily, different.

When the parts of the control valve 31 are in the positions shown in the drawings and the ram 34 is held in its "up" position, hydraulic liquid flows from the tank 30 to the inlet port of pump 27 in which it is divided and caused to flow to lines 32 and 33 as aforesaid. Liquid from the low volume output port of pump 27 flows through line 32 to a groove in a sleeve 35 in valve body 34 and from this groove 34 it passes to the interior of the sleeve 35 and to the upper end of a spool 36 and also to a conduit 37 in valve body 34 which is adapted to be closed by a solenoid operated valve 38. The construction of the control valve 31 is such that until the valve 38 is closed the spool 36 will remain in the position shown and the combined output volumes of the pump 27 will be directed through a conduit 39 to the bottom of the cylinder 25 and piston 26 to urge the latter to its "up" position. This liquid will be returned from the top of cylinder 25 through a conduit 40 to valve 31 and tank 30. Upon the closing of the valve 38, hydraulic pressure will increase above the spool 36 and shift it downwardly to close a valve 41 which is connected in series with the valve 38. After valve 41 is closed, if valve 38 is opened, the valve 31 will cause liquid to be delivered to the press motor to complete automatically one cycle of operation of the press, and all of the parts, after the completion of said one cycle, will return to the positions shown in the drawing. If the valve 38 is not open, the ram 24 will travel toward the bed 23, or work thereon, and will remain in an extended position until valve 38 is opened.

The electric circuit or system 20 controls the operation of the hydraulic system 21 and it includes a solenoid 42 having a winding 43 for operating the valve 38 of said hydraulic system 21. One side of the solenoid coil or winding 43 receives electric current directly from a main lead line 44 and the other side 45 of coil or winding 43 is connected through a pair of resistors 46 and 47 in series to the other main lead line 48. Resistors 46 and 47 are such that when they are connected in series, as above described, insufficient current will flow through them to energize the solenoid coil 43 sufficiently to move the solenoid armature or core to its operated position, that is, insufficient current will flow through the coil 43 to operate solenoid 42. The end 45 of coil or winding 43 may also be connected directly to lead line 48 through a pair of normally open push type switches 49 and 50 connected in series or through either of resistors 46 and 47 and one of switches 49 and 50 and a bypass conductor or line 51 connected from between the switches 49 and 50 to between the resistors 46 and 47.

In the operation of the circuit or system, in order to energize the solenoid 43 to operate it initially, it is necessary to close both push type switches 49 and 50 at the same time, but not necessarily simultaneously, in order to bypass both of the resistors 46 and 47 and to permit the full line current from lines 44 and 48 to flow to the coil or winding 43. After the solenoid 42 has been energized initially by said flow of current either of the push type switches 49 or 50 may be opened and the solenoid 42 will remain in operation. Stated another way, when the circuit is employed in connection with the hydraulic system 21 it is necessary to close both push type switches 49 and 50 to close valve 38 and after said valve 38 is closed

only one of said switches 49 or 50 need be maintained closed to hold the valve 38 closed.

It will be seen that after the initial operation of solenoid 42 that if switch 49 is permitted to open that the flow of current to coil 43 from lead line 48 will be through closed switch 50 bypass connector 51 and resistor 46 to side 45 of the coil 43. It will also be seen that if switch 50 is opened that the flow of current to coil 43 from lead line 48 will be through resistor 47, bypass connector 51 and switch 49 to side 45 of coil 43. Thus when both switches 49 and 50 are closed, both resistors 46 and 47 will be bypassed. When switch 49 is opened and switch 50 is closed, resistor 47 will be bypassed and when switch 50 is opened and switch 49 is closed resistor 46 will be bypassed.

FIG. 2 is a graph showing current characteristics of a solenoid operating on alternating current which are taken advantage of in the circuit seen in the drawings. In this graph, current flowing through the coil or winding of the solenoid is represented as a function of a resistance connected in series with the solenoid.

Referring more particularly to the graph shown in FIG. 2, R represents a resistance which will permit no current to flow through a solenoid coil and as R is decreased progressively (moved toward point 0) the current which flows through the solenoid coil will increase, as indicated by the line A, up to the point B where the solenoid "picks up" and operates by shifting its core. When the current flowing in the solenoid coil increases to the "pick up" point B and the solenoid operates, the current flowing through the solenoid coil drops immediately to the point C due to the increase in impedance of the solenoid and as the resistance R is further decreased the current flowing through the solenoid coil will increase along line D up to the point E of maximum current applied to it.

When the resistance R is increased from the point 0 of no resistance, the current flowing through the solenoid coil decreases along line D to a "drop out" point F at which the magnetic field crested by the coil of the solenoid is insufficient to maintain the solenoid in operation. Upon shifting of the solenoid core at the "drop out" point F, current flowing through the coil will rise immediately along the line G to line A due to the decrease in impedance of the solenoid and will then continue to decrease along line A as the resistance is increased.

As indicated by the graph, less resistance is required to cause the solenoid to "pick up" or operate to shift its core than is required to permit the solenoid to "drop out." Stated another way, it requires more current flowing through the solenoid coil to energize the solenoid sufficiently to cause it to operate than it requires to keep it in operation once it has been initially energized and operated.

In the electric circuit or system, each of the resistances 46 and 47 is such as to offer resistance to current (which could be shown on the graph as lying at a point between R–1 and R–2) so that when either of the resistances is connected in series with the coil or winding 43 of solenoid 42 sufficient current will be applied to the coil 43 to maintain the solenoid 42 in operation once it has been initially energized by closing both push type switches 49 and 50 and so that when the resistors 46 or 47 are connected in series, as when both switches 49 and 50 are opened, the combined resistance of the resistors 46 and 47 will be such as to cause the current applied to the coil 43 to be insufficient to maintain the solenoid in operation (the combined resistances of resistors 46 and 47 would fall upon the graph somewhere between the point R–1 and R).

The hydraulic press 22 including the hydraulic apparatus or system 21 performs each cycle of operation very rapidly, that is, when valve 38 is closed the ram 24 travels toward the bed, or work on the bed, or returns to its "up" position rapidly and at such a rate of speed that an operator has not time to release either of the push type switches 49 or 50 and get either of his hands caught under the ram. He may, however, release or permit either or both of these switches to open while the ram is traveling toward the press bed 23 or work thereon and should he permit only one of said switches to open the ram will travel only to its extended position and "dwell" at a maximum pressing pressure upon work on the bed 23.

For the reasons set forth, it will be seen that the operator can not "cheat" the system in operating the press as by blocking one of the push type switches in a closed position since both of said switches 49 and 50 must be opened to cause the ram to return from its "dwell" position to its "up" position.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. In a control circuit for a hydraulic press having a valve for controlling the operation of said press, solenoid means including winding means for controlling the operation of said valve, conductor means for conducting electric current to said winding means, a pair of resistor means in said conductor means, a pair of switches, and means connecting said switches each to by-pass one of said resistor means whereby closing of both of said switches will by-pass both of said resistor means to pass electric current to said winding means sufficient to initiate operation of said solenoid and thereafter only one of said switches need be maintained closed to pass sufficient current to said winding means to maintain said solenoid in operation.

2. A safety control circuit for a cyclically operable device including a solenoid which must initially be pulled in, then dropped out and subsequently pulled in to cause a recycling of said device, said solenoid having solenoid winding means, conductor means for conducting electric current to said winding means, a pair of resistor means in said conductor means, a pair of switches, and means connecting one of said switches across one of said resistor means and the other of said switches across the other of said resistor means, whereby when both of said switches are closed current flowing in said conductor means by-passes both of said resistor means and whereby when only one of said switches is closed current flowing in said conductor means by-passes only one of said resistor means, said resistor means being related to said solenoid winding means whereby said solenoid is pulled in only when both switches are closed and said solenoid is dropped out only when both switches are opened.

3. A safety control circuit for a cyclically operable device including a solenoid which must initially be pulled in, then dropped out and subsequently pulled in to cause a recycling of said device, said solenoid having solenoid winding means, conductor means for conducting electric current to said winding means, a pair of resistor means in said conductor means, a pair of manually operated switches, and means connecting one of said switches across one of said resistor means and the other of said switches across the other of said resistor means, whereby when both of said switches are closed current flowing in said conductor means by-passes both of said resistor means and whereby when only one of said switches is closed current flowing in said conductor means by-passes only one of said resistor means, said resistor means being related to said solenoid winding means whereby said solenoid is pulled in only when both switches are closed and said solenoid is dropped out only when both switches are opened.

4. A safety control circuit for a cyclically operable device including a solenoid which must initially be pulled in, then dropped out and subsequently pulled in to cause a recycling of said device, said solenoid having solenoid winding means, conductor means for conducting electric current to said winding means, a pair of resistor means in said conductor means, a pair of switches, and means connecting said switches each to by-pass one of said resistor

means whereby closing of both of said switches will by-pass both of said resistor means to pass electric current to said winding means sufficient to initiate operation of said solenoid and thereafter only one of said switches need be maintained closed to pass sufficient current to said winding means to maintain said solenoid in operation.

5. A safety control circuit for a cyclically operable device including a solenoid which must initially be pulled in, then dropped out and subsequently pulled in to cause a recycling of said device, said solenoid having solenoid winding means, conductor means for conducting electric current to said winding, a pair of series connected resistor means in said conductor means, a pair of normally open manually operated switches, means connecting said switches in series relation across said pair of resistor means, and means connecting each of said switches across one of said resistor means whereby when both of said switches are closed current flowing in said conductor

means by-passes said resistor means and whereby when one only of said switches is closed current flowing in said conductor means by-passes only one of said resistor means, said resistor means being related to said solenoid winding means whereby said solenoid is pulled in only when both switches are closed and said solenoid is dropped out only when both switches are opened.

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