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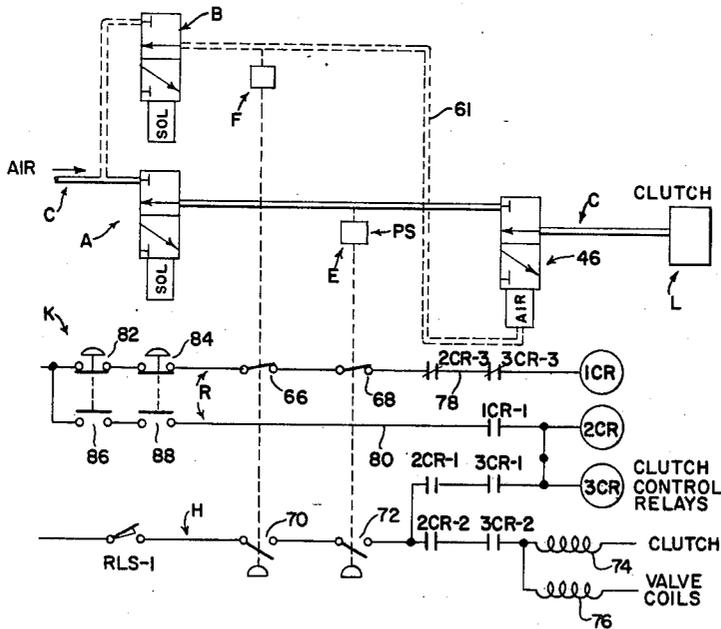
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[54] **DUAL CLUTCH VALVE INTERLOCKING**
11 Claims, 7 Drawing Figs.

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100/53
 [51] Int. Cl. **F16p 3/18**
 [50] Field of Search **192/129,**
(.2), (.3), 131; 100/53

ABSTRACT: An improved pneumatic-electrical interlocking arrangement for presses comprising an electrical run circuit; a pair of contacts in series in said run circuit; a pneumatic clutch circuit including dual solenoid actuated poppet valves arranged so that if one of said valves should fail the other valve prevents the inadvertent flow of air in said pneumatic circuit; the solenoids of said poppet valves being connected in said run circuit; and switch means responsive to the positions of said poppet valves actuating said contacts, said switch means being of the class consisting of pressure switches and proximity switches.



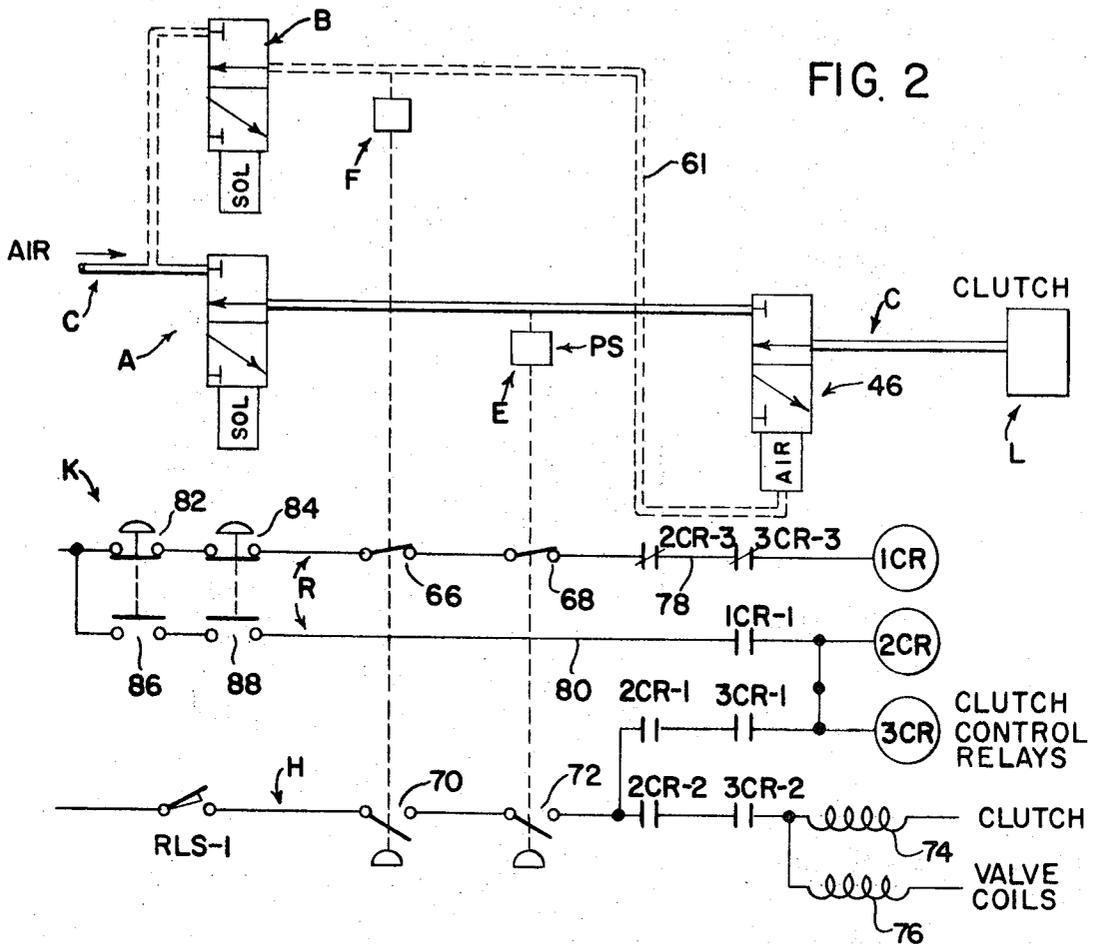


FIG. 2

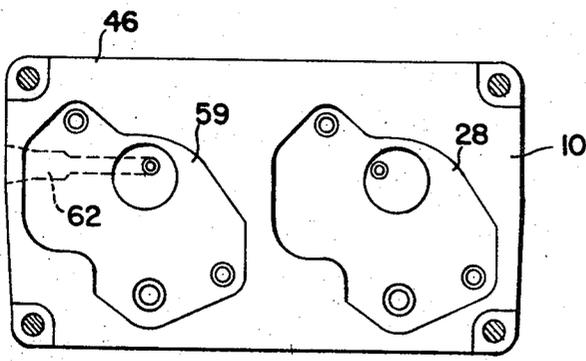
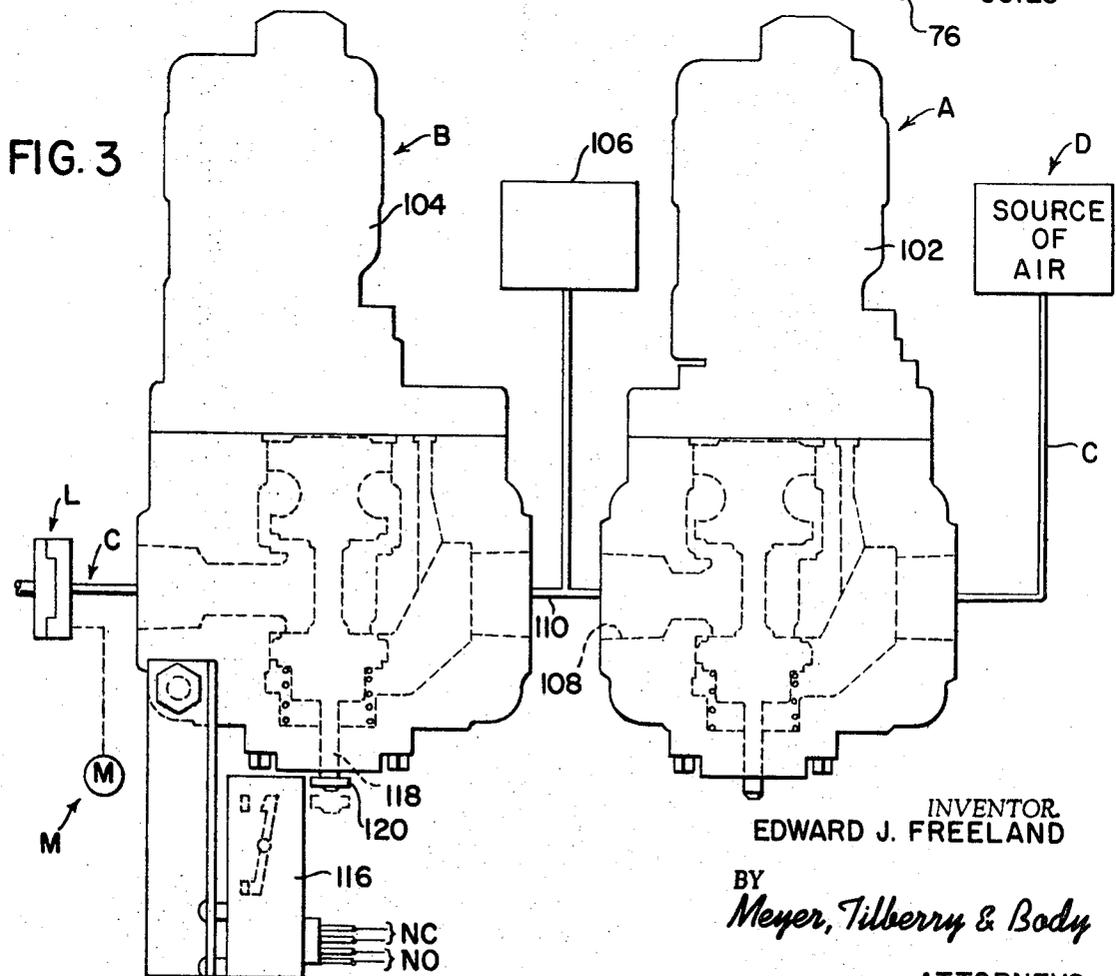
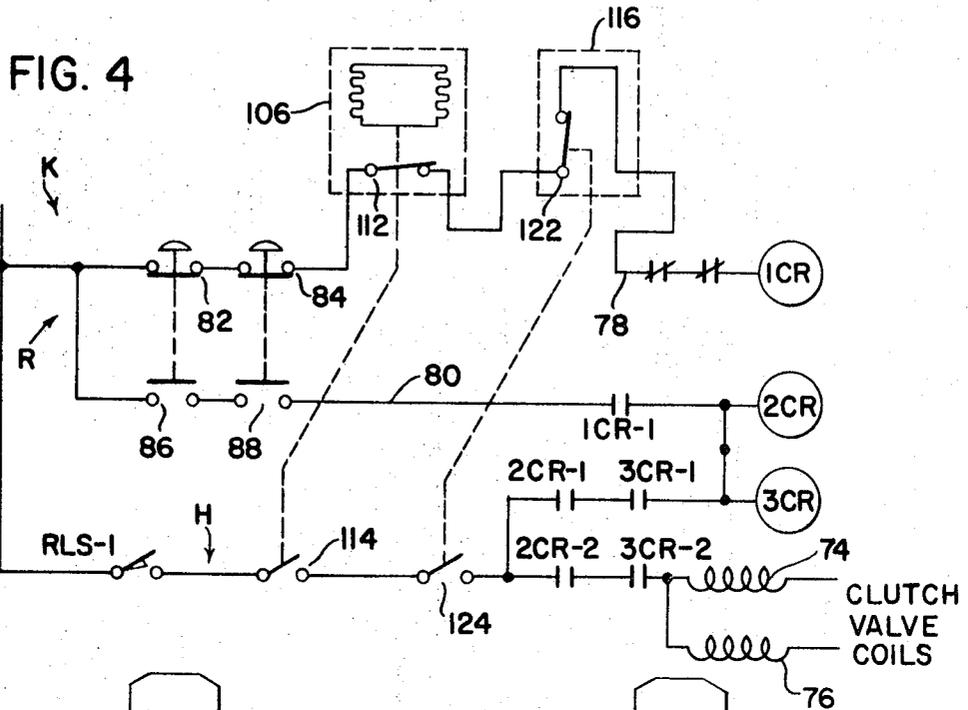


FIG. 2A

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DUAL CLUTCH VALVE INTERLOCKING

The present invention pertains to the art of controls for machines, and more particularly to a novel control arrangement for the presses of the reciprocating type.

The invention is particularly applicable to controls which utilize both an electrical control circuit and a pneumatic actuating circuit, and to a novel safety interlock arrangement between the two circuits by which the electrical control circuit is opened on failure of components of the pneumatic actuating circuit.

Although the invention will be described with reference to a press, it will be apparent that principals of the invention are applicable to other types of machinery utilizing electrical and pneumatic control circuits, where a safety interlock arrangement is of paramount importance.

In a reciprocating press, there usually is provided a motor for driving the press, associated with a clutch mechanism which connects the motor to the press crankshaft, and a pneumatic circuit which actuates the clutch mechanism. The pneumatic circuit, in addition to an air supply, comprises usually two solenoid actuated air clutch valves referred to as dual clutch valves, which when opened allow the flow of air from the air supply to the clutch mechanism.

The reason for dual clutch valves is one of safety.

It is known for solenoid actuated valves to stick, both in the closed and open positions, sticking in the open position obviously being the most serious. If a valve sticks closed, the press simply fails to operate, but if it sticks in the open position, the press could inadvertently reciprocate without action on the part of the operator. The use of two valves insures that if one sticks in the open position, air still is prevented from passing from the air source to the clutch mechanism by the presence of the other.

The valves which are most commonly used for clutch interlocking are poppet valves, and these are of two types; ones which can be connected in series; or ones which can be connected in either series or in parallel. In the latter, when in parallel, the chamber ports of the two valves are connected together and to the machine clutch mechanism, and a characteristic of the valves is that if one should be open and the other closed, the flow from the chamber port of the open valve is exhausted through an exhaust port of the closed valve. Both valves have to be open for flow of air to the clutch mechanism.

To energize the solenoid actuated air valves, the electrical control circuit provided usually comprises a run circuit which leads to the clutch valve solenoid coils. This circuit normally employs at least two normally closed contacts in series responsive to the positions of the dual clutch valves so that if one of the valves is faulty or fails in an open position, the circuit is opened preventing the flow of current to the coil for the solenoid of the unstuck or backup valve and inadvertent flow of source air to the press clutch. This prevents operation of the press until the faulty valve is repaired or replaced.

Conventionally, dual clutch valve interlocking with an electrical circuit is accomplished by providing mechanically actuated electrical limit switches connected to the bottom of the poppet valve housings actuated by the indicating pins for the valves. When a valve is in the open position, the indicating pin for that valve engages the lever of the limit switch connected to the valve opening the switch contacts, which contacts are connected in the electrical run circuit.

Because of the mass of these indicating pins, and the valve poppets to which they are connected, and because of the force and speed of the pins against the switch levers, the operating life of the limit switches is relatively short. The switches must be exactly or correctly mounted on the valve housings, and roller levers must be used to obtain even a short life. Accordingly, installation and adjustment costs for the switches are relatively high.

It is possible to purchase dual valves with integrally mounted switches, which are longer lasting, but this is an expensive proposition, substantially exceeding the cost of dual valves with limit switches other than integrally mounted.

Switches other than mechanically actuated limit switches, for instance pressure switches, are of course known. However, there are problems connected with their use which heretofore have restricted the art to the use of limit switches. For instance, a pressure switch associated with the chamber port of a single valve, which in turn is connected with a source of air, will respond to chamber port pressure when the valve is opened. However, if the valve is the second one of a pair of valves in series, connected to a source of air through the first valve, and if the first valve is closed, the second valve could be stuck in an open position without this fact being monitored by the pressure switch. The reason is that there would be no chamber port pressure in the second valve to actuate the switch.

Another well-known type of switch is a proximity switch, actuated by movement of a metallic mass into the field of the switch. The problem with the use of this type of switch, to monitor the position of a poppet valve, is that there is no obvious way to position the proximity switch close to the open position of the valve poppet without the mass of the valve housing being within the field of the switch. Also a proximity switch only monitors the position of the valve and does not provide information on the absence or existence of a pressure in the valve chamber port.

Quite clearly, it is impossible to guarantee that a valve will not stick, so that some interlocking system is required.

Accordingly, it is an object of the present invention to provide a novel and improved pneumatic-electrical interlocking system for machinery, and in particular a means by which the use of mechanically actuated limit switches is avoided.

In particular, it is an object of the present invention to provide a novel and improved pneumatic-electrical interlocking system and means by which switches of the class consisting of pressure and proximity switches can be employed to monitor the positions of solenoid actuated dual clutch valves.

In accordance with the present invention, there is provided an improved pneumatic-electrical interlocking system comprising an electrical run circuit; a pair of contacts in series in said run circuit; a pneumatic clutch circuit including dual solenoid actuated poppet valves arranged so that if one of said valves should fail in the open position, the other valve prevents the inadvertent flow of air in said pneumatic circuit; the solenoids of said valves being connected in said run circuit; switch means responsive to the positions of said poppet valves actuating said contacts, said switch means being of the class consisting of pressure switches and proximity switches; said pressure switch means being responsive to valve chamber port pressure; said proximity switch means being responsive to valve indicating pin position, including a metallic mass movable with the valve indicating pin to which the proximity switch is sensitive; the system further including means by which actuation of the switch means of one valve is independent of the position of the other valve.

Preferably, at least one of said switch means is a pressure switch associated with a first valve of said dual valves to monitor the absence or existence of a positive pressure in addition to the position of the first valve, the second of said dual valves preventing the flow of air in said pneumatic circuit in the event the first valve is stuck in the open position.

In one aspect in accordance with the present invention, the two solenoid actuated poppet valves are arranged in parallel, each switch means being a pressure switch responsive to the pressure at the chamber port of the valve with which it is associated, further comprising a third poppet valve in series with one of the solenoid actuated poppet valves, the third valve being air actuated and including means connecting the pilot chamber thereof with the chamber port of the other of the solenoid actuated valves. By positioning the poppet valves in parallel and utilizing the third air actuated valve, backup in the pneumatic circuit is provided, and at the same time, actuation of the switch means of one valve is independent of the position of the other valve.

In a further aspect in accordance with the invention, the two solenoid actuated valves can be in series or in parallel, and have connected to the housings thereof each a manually actuated air valve positioned so that it is responsive to the indicating pin of the solenoid actuated valve; each switch means comprising a pressure switch connected to the chamber port of one of the manually actuated valves; the inlet ports of the manually actuated valves being connected with the inlet ports of the solenoid actuated valves. In the event one or the other of the solenoid actuated valves is stuck in the open position, the indicating pin of that valve depresses the actuator of the manually actuated valve associated therewith, pressurizing the pressure switch connected to it. This in turn actuates one of the contacts in the electrical run circuit preventing the press from being operated.

In accordance with still a further aspect of the invention, the solenoid actuated valves are in series relationship, the switch means connected to the first valve comprising a pressure switch responsive to the cylinder port pressure of the first valve, the switch means connected to the second valve comprising a proximity switch responsive to the position of the second valve indicating pin. If the first valve fails in the open position, the pressure applied to the pressure switch thereof opens one of the contacts in the electrical run circuit preventing the other clutch valve solenoid from being energized. If the second valve fails in the open position, this is detected by the proximity switch actuating the other of the contacts in the run circuit preventing the press from being started.

The inventions and advantages thereof will become apparent upon consideration of the following specification, with reference to the accompanying drawings, in which:

FIG. 1 is a flow and partial section view of a pneumatic circuit and dual clutch valve assembly in accordance with an embodiment of the invention;

FIG. 2 is a press electrical circuit diagram illustrating the concepts of FIG. 1 in accordance with the present invention;

FIG. 2A is a section view taken through line 2A-2A of the dual clutch valve of FIG. 1;

FIG. 3 is a flow diagram and partial section view of a pneumatic circuit and dual clutch valve assembly in accordance with another embodiment of the invention;

FIG. 4 is a press electrical circuit diagram illustrating the concepts of FIG. 3 in accordance with the invention;

FIG. 5 is an electrical circuit diagram of a further embodiment in accordance with the invention; and

FIG. 5A is an elevation section view of a valve component for use in the embodiment of FIG. 5.

Referring now to the drawings, wherein the showings are for the purposes of illustrating the preferred embodiments of the invention only, and not for the purpose of limiting the same, the FIGS. show a pair of solenoid actuated poppet valves A and B connected in parallel in a pneumatic circuit C to a source of air D. The two solenoid valves A and B are provided with switch mechanisms E and F responsive to the positions of the valves, and connected into the run and hold circuits R and H (FIG. 2) of a press electrical control circuit K. When the valves A and B are in an open position, air from source D (FIG. 1) engages clutch L connecting the press motor M to the press crankshaft P.

FIG. 1 shows one embodiment of the invention in which the two solenoid actuated poppet valves A and B are arranged in separate housings 10 and 12 in parallel with respect to the source of air D. These valves are generally of the same configuration, and will be described with reference to valve A, valve B having essentially the same structure. The valve A is provided with an inlet port 14, connected via line 16 with the air source D; and also is provided with a poppet chamber 18; and a chamber or outlet port 20. In the poppet chamber, axially aligned in the valve housing, is a reciprocable poppet 22 biased upwardly against valve seat 24 by spring 26 to close the poppet chamber 18.

Above the poppet chamber 18 is a pilot chamber 28, connected to the inlet port 14 via passageway 30. Extending

downwardly from the pilot chamber is a piston housing 32, axially aligned with the poppet chamber 18, containing piston member 34. The latter is mounted on a valve stem 36 connected with the valve poppet 22 so that the poppet is reciprocable up and down within the poppet chamber 18 on vertical movement of the piston member 34.

Between the passageway 30 and pilot chamber 28 is a pilot chamber valve mechanism 38 which closes the passageway 30, this mechanism being actuated through a linkage not shown by means of a solenoid 40 mounted on top of the spool valve housing 10.

Opening the poppet valve is accomplished in the following way. Normally the pilot chamber 28 of the valve is isolated from the pressure of air source D or inlet port 14 by means of the pilot chamber valve mechanism 38, but on energizing the poppet valve solenoid 40, the pilot chamber valve mechanism is moved to its open position and pilot chamber is pressurized. This pressure acts on the exposed surface area 42 of the poppet piston member forcing the piston member downwardly in turn moving the valve poppet 22 away from its valve seat 24.

Valve B is opened in the same way, the solenoid 44 therefor causing the pilot chamber (not shown) of the valve to be pressurized, actuating the valve poppet (shown as item 45) away from its valve seat. As with valve A, valve B is provided with inlet and chamber ports 47 and 49 respectively.

In accordance with the invention, there is provided a third air operated valve 46 which is opened in a way different from the solenoid actuated valves A and B. As shown in FIG. 1, it is not provided with a solenoid. Physically, the valve 46 is attached to and part of the valve housing 10 of valve A, and generally defines with valve A a dual poppet valve configuration similar to the conventional dual solenoid operated valve of the prior art. In this respect, the housing 51 for the third valve (46) is integral with the housing 10 of valve A; and, similar to valve A, the third valve defines an inlet port 48, a chamber port 50, and a poppet chamber 52 between the inlet and chamber ports. Within the poppet chamber is a poppet 54 actuated away from its valve seat 56 by means of a valve stem 58 connected to a piston member similar to the piston member of A. Valve 46 also is provided with a pilot chamber 59 (shown in FIG. 2A) similar to the pilot chamber 28 for valve A.

A common passageway 60 between the chamber port 20 for valve A and the inlet port 48 for valve 46 connects the valves together, the chamber port 50 of valve 46 being connected to the clutch mechanism L.

The pilot chamber 59 (FIG. 2A) for the third valve 46 is connected to an air line 61 via drilled connection 62 in the valve housing 51, air line 61 being connected in turn to the chamber port 49 of solenoid actuated valve B. Opening valve 46 requires actuation of solenoid operated valve B; the latter when opened allowing the flow of source air via line 61 to the pilot chamber 59. The resulting pressure in the pilot chamber forces the valve poppet 54 of valve 46 away from its valve seat; in this respect, the valve 46 being similar to valves A and B.

In operation, the clutch L is engaged by energizing the solenoid 40 for valve A and the solenoid 44 for valve B, the latter when opened causing valve 46 to open. The opened valves (A and 46) in series allow the flow of source air to the clutch L, engaging the press crankshaft. Should solenoid actuated valve A be stuck in the open position, valve B through the air actuated valve 46 prevents the flow of air to the clutch L, and similarly, should solenoid actuated valve B be stuck in the open position (valve 46 thereby being open), valve A provides the safety backup against flow of air to the clutch.

FIG. 2 shows how the valves A and B are interlocked into the electrical circuit K via the switch mechanisms E and F, these mechanisms comprising contacts 66, 68, 70 and 72 (FIG. 2) in the two circuits R and H. The contacts 66 and 68 in run circuit R are normally closed, and those in hold circuit H, contacts 70 and 72, are normally open. These contacts are mechanically actuated to the open and closed positions

respectively by the switch mechanisms E and F, the contacts being arranged so that each such switch mechanism comprises a contact in each of the two circuits R and H.

The run circuit R and hold circuit H both lead to a pair of coils 74 and 76, energized simultaneously, the former through normally open relay contacts 2CR-1 and 3CR-1, the latter through normally open relay contacts 2CR-2 and 3CR-2. The coils 74 and 76 are those which energize the clutch valve solenoids 40 and 44 of the valves A and B respectively. To close the contacts 2CR-1, 3CR-1, 2CR-2 and 3CR-2, there is provided a pair of clutch relays 2CR and 3CR, connected to run circuit R through a normally open relay contact 1CR-1. Run circuit R is comprised of parallel lines 78 and 80, the line 80 containing relay contact 1CR-1, line 78 containing a relay 1CR, known as an antirepeat relay, which closes contact 1CR-1. Line 78 also contains the contacts 66 and 68 of the clutch valves A and B, plus normally closed contacts 2CR-3 and 3CR-3 opened when relays 2CR and 3CR are energized, and normally closed run-button contacts 82 and 84. The latter are mechanically connected to normally open contacts 86 and 88 in line 80 of the run circuit. The remaining item requiring mention is normally open cam actuated limit switch RLS-1 in hold circuit H, responsive to position of the press crankshaft.

Further details of the circuit can be found with reference to copending application Ser. No. 768,403, filed Oct. 17, 1968, assigned to assignee of the present application.

In operation, there initially is a flow of current in run line 78 through run-button contacts 82, 84 and normally closed switches 66, 68, to the antirepeat relay 1CR, closing contact 1CR-1 in line 80. This contact is held closed by a 1CR hold line (not shown) and current is caused to flow in run line 80 by depressing the run-buttons closing contacts 86 and 88 (The plural buttons require the use of both hands of the operator.). This energizes relays 2CR and 3CR, closing the contacts 2CR-1, 3CR-1, 2CR-2 and 3CR-2 for these relays, and energizing the clutch valve coils 74 and 76.

On opening the clutch valves, the switch mechanisms E and F are actuated opening contacts 66 and 68 of the run circuit R and closing contacts 70 and 72 of the hold circuit H. Subsequently, after the press has run a portion of its cycle, limit switch RLS-1 in the hold circuit is closed maintaining the flow of current to the valve coils 74 and 76, for the rest of the press cycle, permitting the press operator to release the run-buttons opening contacts 86 and 88. Contact 1CR-1 is opened by opening the 1CR hold line (not shown) mentioned above and at this point normally closed contacts 2CR-3 and 3CR-3 in line 78 are also open, to prevent the flow of current to 1CR in this line. The press then is stopped by opening limit switch RLS-1 at the end of the press cycle.

By providing the contacts 70 and 72 in the hold circuit mechanically tied to the contacts 66 and 68, should either of the switches E or F be faulty, and fail to function, these contacts 70 and 72 would remain open and the press would stop immediately when the operator releases the run-buttons opening contacts 86 and 88. This provides assurance of functionality of the interlock system. The safety interlock operates as follows. Should solenoid valve A be stuck in the open position, valve 46 acts as a safety backup preventing the inadvertent flow of source air to the press clutch. At the same time, the contact 68 for the stuck valve A is opened by means of pressure switch E responsive to the chamber port pressure for that valve, preventing the flow of current to the antirepeat relay 1CR and through the normally open contact 1CR-1 to the clutch relays 2CR and 3CR, in turn preventing the valve coil for the second solenoid valve B from being energized. At this point, it is recalled that switch RLS-1 in the hold circuit H also is open so that the clutch valve coil for the solenoid valve B cannot be energized through the hold circuit. This prevents operation of the press until the faulty valve is repaired or replaced.

Should the solenoid valve B be stuck in the open position, this actuates the pressure switch F responsive to the position of that valve, opening contact 66 preventing the flow of cur-

rent to the clutch relays in the same manner as above, and in turn to the valve coil for the unstuck valve A.

At the bottom of valve housing 10, there is shown an indicating pin 90, penetrating the housing through a sealed plug 92 in the housing. Conventionally, a mechanical limit switch attached to the bottom of a solenoid valve housing was positioned so that the lever of the limit switch would be contacted by the indicating pin as the valve poppet was actuated downwardly from its valve seats. As mentioned, the operating life of a mechanical limit switch is limited because of the force and speed with which the valve poppet moves.

To employ a pressure switch in place of the conventional limit switch, actuated by an indicator pin, the pressure switch for valve A is connected with the valve chamber port 20, by physically connecting the switch to the air operated valve housing 51. This is accomplished by providing the air operated valve 46 with an adapter plug 94, having a passageway 96, and the indicator pin for the valve is removed. The switch E is threaded onto the adapter plug so that the bellows 98 for the switch is in communication with the adapter plug passageway 96, air flowing through poppet chamber 18 for valve A, adjacent ports 20 and 48 for the two valves, and passageway 96 into the pressure switch, when valve A is in the open position.

The switch E is of conventional design, one suitable switch being that shown, of the bellows-type, made by the Allen-Bradley Company, although other types and makes of switches can be used and are within the scope of the present invention. Expansion of the bellows 98 in the switch opens one pair of contacts, and automatically closes another. Four lines leave the switch housing, two for the normally open contact 72 and two for the normally closed contact 68.

The pressure switch F for the second solenoid operated valve B is similar to the pressure switch E for the first valve A, except that it is simply connected to the line 61 between the chamber port for valve B and the pilot port for air operated poppet valve 46.

It should now be apparent that the embodiment of FIGS. 1-3, in addition to providing a safety backup in the clutch pneumatic circuit, also provides a novel and useful means for monitoring the positions of the two solenoid operated valves utilizing pressure switches instead of the conventional limit switches of the prior art, wherein the monitoring of one valve is independent of the position of the other valve. Monitoring the position of valve A with pressure switch E is clearly independent of the position of valve B, and vice versa.

In the embodiment of FIG. 3 and 4, the method for sensing the positions of the two solenoid actuated valves A and B is slightly different. In this example, the two solenoid actuated valves are in separate housings 102 and 104, and are in series in the pneumatic circuit C for the press. The pressure switch 106 for the first valve simply is connected to the cylinder port 108 of the valve in line 110 leading to the second valve B. With reference to FIG. 4, this switch is provided with normally closed contacts 112 in the run line 78 and normally open contacts 114 in the hold line H of the electrical circuit K.

Whereas a pressure switch can be employed to monitor valve A, such a switch cannot be used to detect the position of the second valve B, connected to the chamber port of the latter. The reason for this is that, until the press is started, valve A is closed, and there would be no chamber pressure in the second valve B to actuate a switch should the second valve be stuck in the open position.

Accordingly, to detect whether the second valve is open or closed, a proximity switch 116 positioned on the second valve housing 104 in the proximity of the indicating pin 118 for the valve. The proximity switch is of conventional design and is attached to the bottom surface of the valve housing, positioned so that the indicating pin 118, when it is moved downwardly with movement of the valve poppet comes within the field of the proximity switch. The lower end of the indicating pin is provided with sufficient mass 120 to sensitize the proximity switch. As with the pressure switch, the proximity switch is provided with four lines leading from normally open and normally closed contacts (shown as items 122 and 124 in FIG. 4).

The pressure switch 106 being responsive to the cylinder port pressure of the first valve A and interlocked into the clutch circuit insures that if the first valve were to fail in the open position, air pressure would be applied to the pressure switch opening its normally closed contact 112 in the run circuit preventing the antirepeat relay ICR from being energized and insuring that the second clutch valve B could not be energized.

By placing the proximity switch 116 on the second valve B to sense the position of the indicating pin thereof, the switch insures that if the valve is not returned to its normally closed position when voltage is off on the valve coil, indicating the valve is stuck in the open position, the press cannot be started because of the switch contact 112 in the press run line.

It should be apparent that this embodiment as with the embodiment of FIGS. 1-3, provides a means for avoiding the use of limit switches, and further one by which the actuation of the switch of one valve is independent of the position of the other valve.

As an alternative, two proximity switches could be used affixed to both the valve housings A and B, the second switch being similar to and used in the same way as switch 116.

FIGS. 5 and 5A illustrate a further embodiment in which interlocking of the pneumatic and electrical circuits is accomplished by means of the use of two pressure switches.

Connected to the clutch poppet valve housings 134 and 136, beneath the housings, are two manually actuated small three-way valves 138 and 140, positioned on the housings so that the indicating pins 142 and 144 of the clutch valves move the manual actuators (note FIG. 5A, item 145) of the three-way valve. Suitable manually actuated three-way valves which can be used in this embodiment are miniature poppet valves made by the Clippard Co. identified as "Miniature Control Valves." The air source is connected by means of a pressure line 146 to the input ports 148 and 150 of the three-way valves, the chamber ports 151 and 152 of the two valves being connected to two pressure switches 154 and 156. The exhaust ports W of each of the three-way valves is for the purpose of exhausting pressure from the pressure switches when the three-way valves are closed.

In this embodiment, the pressure switches actuate normally closed contacts 158 and 160 in the run line 78 and normally open contacts 162 and 164 in the rotary limit switch hold circuit H. When the run buttons 82, 84 are depressed to energize the clutch valves via the clutch control relays, both clutch valve solenoid coils of the double valve are energized. Pilot chamber pressures within the double valves move the stems and poppets of the double valves to the open position. In so doing, the indicating pins 142, 144 of the double valves depress the actuators of the manually operated three-way valves, allowing air to pass through these valves to the pressure switches 154, 156. Operation of the circuit in FIG. 5 is otherwise the same as that described with reference to FIG. 2.

When the pressure switches are actuated, the normally closed contacts 158, 160 in the run circuit open and the normally open contacts 162, 164 in the rotary switch hold circuit close. This allows the press to continue to cycle but if either switch 154, 156 were not to function, the press would stop immediately after the run buttons were released.

If either of the pressure switches is actuated while the press is standing idle, or if either one of the clutch valves 134, 136 should be stuck in the open position, the contact interlock for that valve in the clutch run circuit will be moved to the open position and will prevent or insure the press from being operated.

As with the embodiments of FIGS. 1-4, this embodiment provides a means for avoiding the use of limit switches, and at the same time a means by which actuation of a pressure switch of one clutch valve is independent the position of the other valve.

An advantage in this arrangement is that no special porting of the clutch valves is necessary. For instance, it will be recalled that a special adapter is required around the indicating pin of a second valve of the above first described arrangement

for the purpose of communicating the chamber of the first clutch valve with the pressure switch.

FIG. 5 shows the valves connected in parallel. Obviously they could be connected in series, and the concepts of this embodiment of the invention would still be applicable. In order to connect them in parallel, a known poppet valve suitable for parallel connection should be used. This valve is provided with an exhaust port 135 in communication with the valve poppet chamber so that a pressure at the valve chamber port is exhausted to atmosphere when the valve is in a closed position. Accordingly, referring to FIG. 5, as long as valve 136 remains closed (or vice versa), a pressure at the chamber port for the valve (caused by valve 134 being open) is exhausted to atmosphere, and the clutch is not actuated. This has the advantage of producing an audible signal warning the operator of the stuck condition of one of the valves.

Although the invention has been described with reference to specific embodiments, further variations will be apparent to those skilled in the art within the scope of the following claims.

I claim:

1. An improved pneumatic-electrical interlocking system for presses comprising:

- an electrical control circuit (K);
- a pair of contacts (66 and 68 or 70 and 72 or 112 and 122 or 114 and 124 or 158 and 160 or 162 and 164) in said control circuit (K);
- a pneumatic clutch circuit (C) including dual solenoid actuated poppet valves (A and B or 134 and 136) arranged so that if one of said valves should fail the other valve prevents the inadvertent flow of air in said circuit;
- the solenoids (74 and 76) of said poppet valves being connected in said control circuit (K); and
- switch means of the class consisting of pressure switches (E and F or 106 or 154 and 156) and proximity switches (116, 138) responsive to the positions of said poppet valves (A and B or 134 and 136) actuating said contacts (66 and 68 or 70 and 72 or 112 and 122 or 114 and 124 or 158 and 160 or 162 and 164).

2. A system according to claim 1 wherein said pressure switches (E, F, 106, 154, 156) are responsive to the chamber port pressures of said valves and the proximity switches (116, 138) are responsive to the positions of the indicating pins (118) of the valves, the latter including a metallic mass (120) movable with the indicating pin to which the proximity switch is sensitive; further comprising means by which actuation of the switch means of one poppet valve is independent of the position of the other valve.

3. A system according to claim 1 wherein said poppet valves constitute first and second valves in series (A and B FIG. 3), the switch means responsive to the first valve being a pressure switch (106) in flow communication with the chamber port of the first valve (A).

4. A system according to claim 3 including a proximity switch (116) responsive to the position of the indicating pin (118) of said second valve, further including a metallic mass (120) movable with said indicating pin.

5. A system according to claim 4 wherein said valves (A and B) are in separate housings, the pressure switch (106 FIG. 3) of the first valve being connected to the pneumatic circuit between said valves.

6. The system of claim 2, wherein said solenoid valves are in parallel (A and B FIG. 1), said last-mentioned means comprises a third poppet valve (46) in series with one of said solenoid valves, said third poppet valve (46) being air actuated; means (61) connecting the pilot chamber of said third valve (46) with the chamber port of the other of said solenoid valves (B); said switch means comprising first (E) and second (F) pressure switches in flow communication with the chamber ports of said solenoid valves (A and B).

7. The system of claim 6 wherein said one solenoid valve (A) and third valve (46) are integrally connected, comprising an adapter plug (62 FIG. 2A) in the bottom of the third valve

(46) poppet chamber (59); aperture means (62) in said adapter plug; one of said switch means (F) being connected (61) to said aperture means (62).

8. The system of claim 2 wherein said switch means comprises pressure switches (154, 156); further comprising a manually actuated miniature three-way poppet valve (138, 140) connected to each of the solenoid valve housings (134, 136); means (146, 148, 150) connecting the input ports of the manually actuated three-way valves (138, 140) to the source of air (D); means adapting the three-way valves for actuation by the solenoid valve indicating pins (142, 144); said pressure switches (154, 156) being connected to the chamber ports (151, 152) of the three-way valves (138, 140).

9. The system of claim 8 wherein said solenoid valves (134, 136) are in parallel further comprising exhaust port means (135, W) by which the chamber ports of the valves are exhausted to atmosphere when the valves are in closed position.

10. The system of claim 1 wherein said control circuit includes an electrical hold circuit and an electrical run circuit in parallel with said hold circuit; said pair of contacts (68 or 68, 112 or 122, 158 or 160) being in said run circuit a second pair of contacts in said hold circuit; said pair of contacts in said run circuit being normally closed and said second pair of contacts in said hold circuit being normally open; said switch means (E, F, 106, 116, 154, 156) also actuating said second pair of con-

tacts in said hold circuit; the latter being operative to indicate the functionality of said switch means.

11. An improved pneumatic-electrical interlocking system for presses comprising:

an electrical run circuit (R);

a pair of contacts in series in said run circuit;

a pneumatic clutch circuit (C) including dual solenoid actuated poppet valves (A, B), an air source (D) and clutch means (L);

the solenoids of said poppet valves being connected in said run circuit;

pressure switch means (E, 106) responsive to the pressure at the chamber port of the first poppet valve (A) to actuate one of said contacts (68, 112);

said second poppet valve (B) being operable to prevent the flow of air from said first valve (A) to the clutch means (L);

second switch means (F, 116) responsive to the position of said second poppet valve (B) to actuate the other of said contacts (66, 122), said second switch means (F, 116) being of the class consisting of pressure switches and proximity switches; and

means by which actuation of the second switch means (F, 116) is independent of the position of the first valve.

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