Oct. 23, 1945. F. E. TIFFANY 2,387,478

SAFETY MEANS FOR POWER OPERATED TOOLS

Filed March 28, 1944

Fig. 1

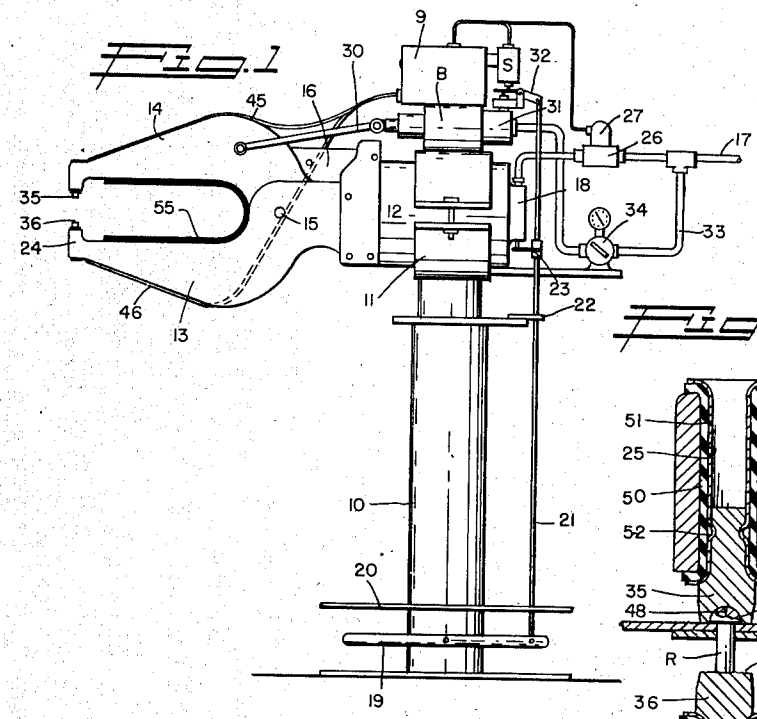


Fig. 2

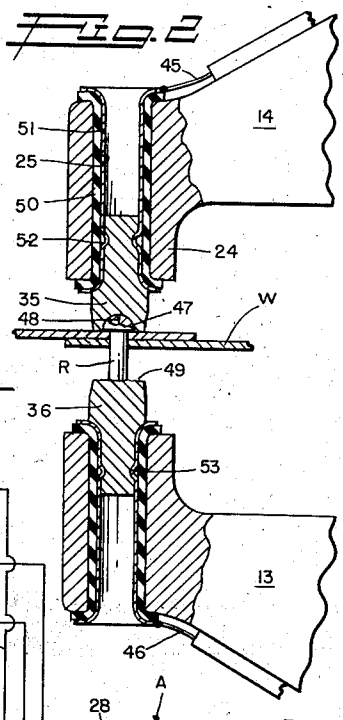
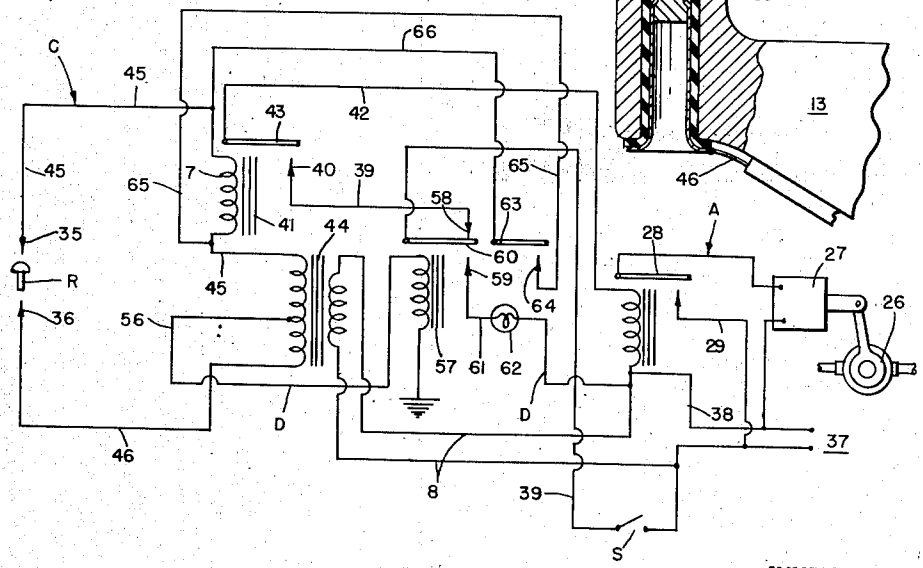


Fig. 3



INVENTOR.

FRANK E. TIFFANY

BY

George C. Sullivan

AGENT

Patented Oct. 23, 1945 2,387,478

UNITED STATES PATENT OFFICE

2,387,478

SAFETY MEANS FOR POWER-OPERATED TOOLS

Frank E. Tiffany, Claremont, Calif., assignor to Lockheed Aircraft Corporation, Burbank, Calif.

Application March 28, 1944, Serial No. 528,487

16 Claims. (Cl. 192—130)

This invention relates to power operated tools and equipment, and relates more particularly to manually controlled power operated tools and machines such as riveting machines, and the like. It is a general object of this invention to provide a practical, inexpensive and dependable safety means for tools and machines of such character.

Many power actuated tools and machines such as riveters, squeezers, punches, presses, etc., are dangerous to operate. It is customary to provide foot pedals for initiating the operation of such machines so that the operator's hands are free to handle the work and place it between the active parts of the machine. In the event the pedal is depressed at a time when the operator's hands are between the active machine parts, serious physical injury may result. Safety guards and devices installed at the active machine parts have been introduced to reduce the hazard, but such guards and devices are not satisfactory because they interfere with the handling and locating of the work pieces.

An object of the present invention is to provide a safety means for a squeezing, pressing, punching or riveting machine that positively precludes the possibility of injury to the operator in the event the machine is put into operation when his hand or any other part of his body is between the active parts of the machine. The safety means is such that the active force or full power of the machine cannot come into play in the event any part of the operator's body or clothing is accidentally or unintentionally engaged between the squeezing, punching, pressing or riveting elements of the machine when the machine is put into operation. The safety control is entirely dependable and will respond to the presence of even a single thickness of paper engaged between the work piece and an active machine part.

Another object of the invention is to provide a safety means of the character referred to that does not in any way alter the normal operation of the machine or interfere with the customary manual acts required in the handling of the work and the control of the machine. The safety means of the invention is entirely automatic and does not necessitate additional acts on the part of the operator and does not embody parts which require manual operation or adjustment. The device is at all times conditioned for automatic action.

It is another object of the invention to provide a safety means of the class referred to that does not require the use of guards, shields or other elements at the active working parts of the machine, and there is nothing to interfere with the free, normal handling of the work piece.

Another object of the invention is to provide a safety means of the character mentioned that may be constructed in the form of an appliance or attachment for ready connection with a tool or machine, or that may be embodied in the tool or machine as an original part thereof. In either instance, the employment of the safety device does not necessitate material alteration of the machine or change in its normal mode of operation.

Still another object of the invention is to provide a safety means of the class mentioned which embodies a signal conditioned to automatically go into operation in the event the circuit of the safety means is shorted.

A further object of the invention is to provide a safety means of the class referred to that serves to positively prevent operation of the power machine in the event the control circuit becomes shorted. If for any reason the control circuit of the safety means becomes shorted, the signal is immediately put into operation and the main circuit of the safety device is held open, preventing operation of the machine until such time as the short is cured.

A still further object of the invention is to provide a safety control of the kind above referred to in which a low potential control circuit must be completed through the work parts to condition the tool or machine for operation. Any object such as a workman's hand or finger interposed between the work and an active part of the machine prevents completion of the low potential control circuit and the tool or machine cannot operate or complete its operation. The low potential control circuit cannot injure either the work pieces or the operator.

Other objects and features of the invention will be readily understood from the following detailed description of a typical preferred form of the invention wherein reference will be made to the accompanying drawing in which:

Figure 1 is a side elevation of a squeezer machine provided with or embodying the safety means of the invention;

Figure 2 is an enlarged fragmentary side elevation of the outer portions of the machine arms with portions appearing in vertical cross section to illustrate the mounting of the work-engaging machine parts, and

Figure 3 is a schematic wiring diagram illustrating the circuits embodied in the invention.

The safety means of the invention is capable

of embodiment in tools and machines of different characters and may be varied considerably to adapt it for such embodiment. Furthermore, the invention may be constructed in the form of attachments for tools and machines and such attachments may be varied to suit their particular applications. In the following detailed description I will refer to the form of the invention illustrated in the drawing, it being understood that this description is not to be construed as limiting either the scope or application of the invention.

The tool or machine illustrated is a pneumatically operated riveter or squeezer suited for squeezing or driving aluminum alloy rivets, etc. The machine includes a post or pedestal 10 suitably supported on the floor. A clamp or yoke 11 on the upper end of the pedestal 10 carries the main cylinder and piston mechanism 12. A lower arm 13 projects forwardly from the mechanism 12 and is fixed or stationary. An upper arm 14 is hinged or pivoted on the lower arm 13 at 15 and is operated by the mechanism 12. The present invention is not primarily concerned with the details of the operative connection between the mechanism 12 and the upper arm, and it will suffice to say that this connection includes the linkage indicated at 16. An air pressure supply pipe 17, extending from a suitable source of air under pressure, leads to a valve 18 at the rear of the mechanism 12. The valve 18 is adapted for control by a foot pedal arrangement. In the case illustrated, a foot pedal 19 is pivoted on the base portion of the pedestal 10 below a guard 20. A link or rod 21 is pivotally connected with the pedal 19 and extends upwardly in parallel relation to the pedestal, being guided by one or more guides 22. An arm 23 on the rod 21 acts on the stem of the valve 18 to operate the valve when the pedal 19 is depressed. This operation of the valve 18 results in actuation of the mechanism 12 to force the arm 14 downwardly, assuming that actuating air under pressure is supplied to the valve. When the pressure is removed from the pedal 19, the valve 18 returns to its normal position and the mechanism 12 operates to restore the arm 14 to its raised or open position. Opposed and vertically aligned bosses 24 are provided on the outer parts of the arms 13 and 14. Aligned openings 25 extend through the arms 13 and 14 and their bosses 24; see Figure 2. The openings 25 are provided to receive the work-engaging parts to be later described. The machine thus far described may be considered as conventional or standard.

The safety means of the invention may be said to comprise generally a main circuit A operable to control the delivery of actuating pressure to the mechanism 12, a low pressure cylinder and piston mechanism B for initiating operation of the arm 14, a low potential circuit C adapted to be completed through the work piece to control the main circuit A, and a secondary safety and signal circuit D operable to hold the main circuit A open and provide a signal in the event a short occurs in the control circuit C.

The main circuit A includes a suitable solenoid operated valve 26 interposed in the main air supply line 17. Any selected type of solenoid operated valve may be utilized, and I have shown a conventional valve and a solenoid combination 26 and 27 in a diagrammatic manner. The main circuit A further includes a relay 28 and leads 29 extending between the terminals of the solenoid 27 and the contacts of the relay 28. The circuit A is suitably tapped into lines 38 and 39 extending from a power source 37. The relay 28 is preferably housed in a box 9 arranged at the upper end of the low pressure mechanism B, and the leads 29 are preferably carried in a protective or shielded conduit. The valve 26 is such that it is normally closed to prevent the passage of fluid pressure to the valve 18 of the mechanism 12 and the relay 28 is such that it is normally open to maintain the valve 26 in its closed position. Accordingly, the valve 26 is open only during such time as the relay 29 is energized.

The low pressure cylinder and piston mechanism B is operable to move the upper machine arm 14 toward the arm 13 under a relatively low pressure. This action of the arm 14 normally serves to complete the control circuit C through the medium of the work piece W to bring about completion of the main circuit A. However, if the control circuit C cannot be completed through the medium of the work W by reason of the presence of the workman's hand or finger at the work piece, or between the parts 35 and 36, the main circuit A cannot be completed as a result of downward movement of the arm 14 and the machine will remain idle.

The low pressure cylinder and piston mechanism B may be secured to the top of the clamp or yoke 11 of the machine. I have shown the mechanism B arranged in spaced parallel relation to the main fluid pressure mechanism 12. Suitable linkage serves to operatively connect the low pressure mechanism B with the upper arm. In practice links 30 may be pivotally connected with the piston rod of the mechanism B and the arm 14 to serve as the operative connection. A valve 31 is provided to control the mechanism B. The valve 31 is shown arranged at the rear of the mechanism B and is equipped with an operating lever 32. The valve lever 32 is pivotally connected with the upper end of the pedal rod 21. This linkage is such that depression of the pedal 19 operates the valve 31 to a position to cause operation of the mechanism B and downward movement of the machine arm 14. A pipe 33 extends from the fluid pressure supply line 17 to the valve 31. The pipe 33 is connected in the supply line 17 at the upstream side of the solenoid operated valve 26 to be independent of that valve. A pressure reducing device or valve 34 is connected in the line 33. The pressure supply line 17 may normally carry air under substantial pressure, say, at 100 pounds pressure, and it is desirable to deliver actuating air pressure to the auxiliary mechanism B at a relatively low pressure, say, at 5 or 6 pounds. The valve 34 may be any selected type of pressure reducer capable of bringing about such reduction in pressure. It is to be observed that the mechanism B will be operated to cause lowering of the arm 14 each time the pedal 19 is depressed. The mechanism B exerts a small force and moves the arm 14 downwardly under, say, 4 or 5 pounds pressure. This low pressure is insufficient to cause injury to a hand or finger that may be at the work piece. When the foot pressure is removed from the pedal 19 the valve 31 returns to its normal position permitting restoration of the low pressure cylinder and piston mechanism B.

The control circuit C is a feature of the invention. It includes active work-engaging parts 35 and 36 carried by the machine arms 13 and 14 and adapted to act on the work; see Figure 2. The control circuit C is completed through these parts 35 and 36 and the work to cause energization of the relay 28 and resultant opening

of the valve 26. Until the control circuit C is thus completed between the work parts 35 and 36, through the medium of the work W, the valve 26 remains closed and depression of the pedal 19 cannot produce operation of the mechanism 12. The safety means of the invention may be connected in any available electric power source. For example, it may be connected into a 110 volt source 37. A lead or conductor 38 may extend directly from one side of the power source 37 to a terminal of the relay 28. A lead 39 extends from the other side of the power source 37 to a contact 40 of a relay 41. The relay 41 is housed in the box 9. A conductor 42 extends from the contactor 43 of the relay 41 to the second terminal of the relay 28. It will be seen that upon energization of the relay 41, the contacts 40 and 43 close to bring about energization of the relay 28 to complete the circuit A and open the valve 26.

The control circuit C further includes a low voltage transformer 44 and a low potential circuit extending from the transformer to the work parts 35 and 36. The transformer 41 is preferably housed in the box 9. Leads 8 extend from the conductors 38 and 39 to the terminals of the primary winding of the transformer 44. The connections may be such that the transformer 44 is at all times connected in the power circuit. A lead 45 extends from one end of the transformer's secondary to the active work-engaging part 35 and a similar lead 46 extends from the other terminal of the secondary to the work-engaging part 36. The turns ratio of the transformer 44 is such that the leads 45 and 46 are supplied with a low potential current of, say, 6 volts. The leads 45 and 46 are suitably shielded and extend through or along the arms 14 and 13 respectively to connect with their work-engaging parts 35 and 36. The coil 7 of the relay 41 is connected in the potential circuit. I have shown the relay winding 7 interposed in the lead 45.

The work-engaging parts 35 and 36 may be varied depending upon the nature of the operation to be performed. The part 35 may be in the form of a hammer and the part 36 may be in the nature of an anvil. As illustrated, the work W comprises two work pieces having lapped edge portions and a rivet R is arranged through openings in the lapped portions. The part 35 has a socket 48 in its end to receive the rivet head while the part 36 presents a flat end face for cooperating with the end of the rivet shank. In the event the rivets to be driven have an anodic coating or other dielectric covering, the socket 47 may have a sharp point 48 for piercing the coating to insure an electrical connection between the work part 35 and the rivet R when the two come into pressure contact. The active surface of the part 36 may be knurled or engraved as shown at 49 to likewise insure electrical connection between the part 36 and the rivet R. In practice, the engraving 49 may be very fine because the anodic coating is readily broken or pierced when the rivet and work surface are pressed one against the other.

The parts 35 and 36 are carried in the openings 25 of the arms 13 and 14, and it is necessary to electrically insulate the parts from the arms. Sleeves 50 of suitable dielectric material cover the walls of the openings 25 and their ends are flanged to be held against displacement. Inner sleeves 51 of steel, copper or other conducting material engage in and conform to the dielectric sleeves 50. The conductors 45 and 46 of the low potential circuit are electrically connected with the outer ends of the sleeves 51 as by soldering. The sleeves 51 are provided with resilient inwardly projecting latch knobs 52. The active work-engaging parts 35 and 36 have shanks adapted to be entered into the sleeves 51. Annular grooves 53 are provided in the shanks to receive the knobs 52. The engagement of the knobs 52 in the grooves 53 removably latches the parts 35 and 36 in their working positions on the arms 13 and 14 and insures good electrical contact between the parts and sleeves 51. It is to be understood that the parts 35 and 36 may be readily replaced by similar parts suited for acting on rivets and the like, of different sizes and types.

A switch S is interposed in the lead 39 and is arranged to be closed upon depression of the pedal 19. The control part of the switch S may be operatively associated with the above described lever 32 so that the switch is closed simultaneously with operation of the valve 31 associated with the low pressure cylinder and piston mechanism B. With the structure thus far described, depression of the pedal 19 results in actuation of the mechanism B and downward movement of the arm 14, and upon engagement of the part 35 with the rivet R the low potential circuit 45—46 is completed to energize the relay 41. The relay 41 in turn completes the circuit through the relay 28 so that the valve 26 is opened to deliver air under substantial pressure to the mechanism 12 to complete the rivet squeezing operation. If, however, the operator's hand or any dielectric object is between the parts 35 and 36, or interferes with the engagement of either work part 35 or 36 with the rivet R, the low potential circuit is not completed, with the result that the relays 41 and 28 remain de-energized and the squeezing operation cannot take place.

The secondary safety or protective circuit D serves to positively prevent completion of the main circuit A in the event a short develops in the low potential circuit 45—46 and further operates to provide a signal in the event of such a short. It is preferred to cover the inner portions of the arms 35 and 36 with a dielectric shield 55 to prevent the work from shorting between the parts 35 and 36 and the machine structure. When the shield 55 is used there is little possibility of the work W contacting the machine frame to produce a short in the low potential circuit 45—46. However, the dielectric sleeves 50 may fail or wear and cause shorting of the circuit 45—46. The safety circuit D includes a center tap or lead 56 extending from the secondary winding of the transformer 44 to one terminal of a relay 57. The other side of the relay 57 is grounded to the frame. The relay 57 may be housed in the box 9. The center tap 56 supplying the relay 57 carries a low potential current of, say, 3 volts. The relay 57 has a pair of spaced contacts 58 and 59 and a contactor 60 movable between the contacts. The contact 58 and the contactor 60 are connected in the lead 39 which supplies current to the relay 28 of the main circuit A. The contactor 60 is biased to normally engage the contact 58. When the relay 57 is energized, the contactor 60 is disengaged from the contact 58 and the circuit to the relay 28 cannot thereafter be completed even though the relay 41 may be energized. The action of the relay 57 positively prevents energization of

the relay 28 and opening of the valve 26 in the event a short occurs in the low potential circuit 45—46. It will be understood how such a short energizes the relay 57 through the grounded pole of the relay and the transformer tap 56.

A conductor or lead 61 extends from the contact 59 of relay 57 to the power lead 38. A selected signal means is connected in the lead 61. The signal means may be operative to produce visible or audible signals, or both. In the simple case illustrated, a lamp 62 is connected in the lead 61 to constitute the signal means. The lamp 62 may be exposed at the front of the box 9 where it may be provided with a suitable lens. Upon energization of the relay 57, as a result of a short in the circuit 45—46, a circuit is completed from the power line 38 through the lead 61, contact 59 and contactor 60 to the power lead 39, thus energizing the signal light 32.

The relay 57 of the safety circuit D further includes a second movable contactor 63 and a stationary contact 64. A lead 65 extends from the contact 64 to one terminal of the relay 41 and a similar lead 66 extends from the contactor 63 to the other terminal of the relay. The conductors 65 and 66 constitute a shunt and when the relay 57 is energized to bring the contactor 63 into engagement with the contactor 64 the relay 41 is shunted out. Thus the relay 41 is prevented from operating in the event a short develops in the low potential circuit 45 and 46. With the relay 41 shunted out the circuit to the relay 28 of the main circuit A cannot be completed to open the valve 26.

It is believed that the operation of the safety means of the invention will be readily understood from the foregoing description. The work W carrying the rivet R is placed or held in the machine so that the rivet R rests on the part 36. The operator then depresses the pedal 19. This operates the valves 18 and 31 and closes switch S. Operation of the valve 31 causes the low pressure mechanism B to move the arm 14 downwardly so that the part 35 engages the rivet head R and exerts a pressure of, say, 5 or 6 pounds on the rivet R. If there is no intervening dielectric object between the parts 35 and 36 and the rivet R, the low potential circuit 45—46 is completed to energize the relay 41. Energization of the relay 41 completes the circuit to the relay 28. Energization of relay 28 completes the main circuit A to open the valve 26. This admits the high pressure air to the mechanism 12 and the arm 14 is actuated with sufficient force to squeeze or upset the rivet R, completing the riveting operation.

In the event a dielectric object or the operator's hand prevents direct engagement of the parts 35 and 36 or prevents direct contact of either the work part 35 or the work part 36 with the rivet R, downward movement of the arm 14 produced by the low pressure mechanism B will fail to complete the low potential circuit 45—46. So long as the low potential circuit remains open, the relay 41 remains de-energized and the circuit A cannot be completed to open the valve 26. Accordingly, the high pressure mechanism 12 does not go into operation. The minor force exerted by the low pressure mechanism B does not injure the operator's hand, and because the high pressure mechanism 12 cannot go into operation so long as the hand prevents completion of the low potential circuit, no injury can result. It has already been described how the circuit D positively prevents operation of the machine and provides a signal if a short develops in the low potential circuit.

It is to be noted that the safety means does not change in any way the normal mode of operation of the machine and does not require the installation of equipment that may interfere with the work at the active parts of the machine. The safety means is entirely automatic and requires no control or adjustment.

Having described only a typical form of the invention, I do not wish to be limited to the specific details herein set forth, but wish to reserve to myself any variation or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

I claim:

1. In a machine having a part movable into engagement with a work piece, a mechanism for operating said part to act on the work piece, and a power source for said mechanism, the combination of means for controlling the delivery of power from said source to said mechanism, means for moving said part against the work piece, and a low potential circuit capable of being completed through the work piece and said part following actuation of the last named means and operable when thus completed to cause the first named means to deliver power to said mechanism.

2. In a machine having a part for acting on a work piece and a mechanism for operating said part, the combination of a control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, means for moving said part into engagement with the work piece, and a circuit completed through said part and the work piece following operation of the last named means to cause actuation of said control.

3. In a machine having a part for acting on a work piece and a mechanism for operating said part, the combination of a control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a circuit for actuating said control, means for moving said part into light pressure engagement with the work piece, and a circuit adapted to be completed through the work piece and said part following said engagement to influence the first named circuit and thus cause actuation of said control.

4. In a machine having a movable part for acting on a work piece and a high pressure mechanism for operating said part, the combination of a primary control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a low pressure means for moving said part into contact with the work piece, and safety means operable following said contact of said part with the work piece to actuate the primary control, the safety means including a low potential circuit completed through said part and the work piece upon said contact, the completion of said circuit being essential to the operation of the safety means.

5. In a machine having a movable part for acting on a work piece and a high pressure mechanism for operating said part, the combination of a first control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a low pressure means for moving said part into contact with the work piece, and a second control operable following said contact of said part with the work piece to actuate the first control, the second control including a circuit operable when conditioned

to actuate the first control, and a normally open low potential circuit that is completed through said part and work piece when there is nothing to interfere with electrical contact therebetween and operable when completed to condition the first named circuit for the actuation of the first control.

6. In a machine having a movable part for acting on a work piece and a high pressure mechanism for operating said part, the combination of a first control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a low pressure means for moving said part into contact with the work piece, a second control operable following said contact of the work piece and said part comprising a low potential circuit completed by said contact and operable when completed to cause operation of the first control, and manually operable means for initiating operation of the low pressure means.

7. In a machine having a pair of spaced parts for acting on the work piece, at least one of said parts being movable, and a high pressure mechanism for operating the movable part, the combination of a main control normally preventing operation of said mechanism and operable when actuated to cause operation of the mechanism, a second mechanism for moving said movable part against the work so that the work piece is engaged between said parts under a light pressure, and a second control including a normally open low potential circuit completed through said parts and the work piece upon said engagement of the work piece and operable when completed to cause actuation of the main control.

8. In a machine having a pair of spaced parts for acting on the work piece, at least one of said parts being movable, and a high pressure mechanism for operating the movable part, the combination of a main control normally preventing operation of said mechanism and operable when actuated to cause operation of the mechanism, the main control including a main circuit and a relay controlling the circuit, a second mechanism for moving said movable part so that the work piece is held between said parts under a light pressure, and a second control for energizing said relay to actuate the main control, the second control comprising a low potential circuit completed only upon the direct engagement of said parts with the work piece and operable when completed to cause energization of said relay.

9. In a machine having a pair of spaced parts for acting on the work piece, one of which is movable, and a high pressure mechanism for operating the movable part, the combination of a main control normally preventing operation of said mechanism and operable when actuated to cause operation of the mechanism, the main control including a circuit and a relay controlling the circuit, a second mechanism for moving said movable part so that the work piece is held between said parts under a light pressure, and a second control for energizing said relay to actuate the main control, the second control comprising a low potential circuit completed only upon the direct engagement of said parts with the work piece and operable when completed to cause energization of said relay, and means for producing a signal in the event said low potential circuit becomes shorted.

10. In a machine having a movable part for acting on a work piece and a high pressure mechanism for operating said part, the combination of a first control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a low pressure means for moving said part into contact with the work piece, and a second control operable following said contact of said part with the work piece to actuate the first control, the second control including a circuit operable when conditioned to actuate the first control, a normally open low potential circuit that is completed through said part and work piece when there is nothing to interfere with electrical contact therebetween and operable when completed to condition the first named circuit for the actuation of the first control, and means responsive to a short circuit condition in said low potential circuit for preventing said conditioning of said first named circuit and for providing a signal.

11. In a machine having a movable part for acting on a work piece and a high pressure mechanism for operating said part, the combination of a first control normally preventing operation of said mechanism and operable when actuated to cause operation of said mechanism, a low pressure means for moving said part into contact with the work piece, and a second control operable following said contact of said part with the work piece to actuate the first control, the second control including a circuit operable when conditioned to actuate the first control, a normally open low potential circuit that is completed through said part and work piece when there is nothing to interfere with electrical contact therebetween and operable when completed to condition the first named circuit for the actuation of the first control, and means responsive to a short circuit condition in said low potential circuit for preventing said conditioning of said first named circuit and for providing a signal.

12. In a machine having a pair of spaced parts for acting on the work piece, one of which is movable, and a high pressure mechanism for operating the movable part, the combination of a main control normally preventing operation of said mechanism and operable when actuated to cause operation of the mechanism, a low pressure mechanism for moving said movable part against the work so that the work piece is engaged between said parts under a light pressure, and a safety control including a low potential circuit adapted to be completed through said parts and the work to cause operation of the main control.

13. In a machine having a pair of spaced parts for acting on the work piece, at least one of which is movable, and a high pressure mechanism for operating the movable part, the combination of a main control normally preventing operation of said mechanism and operable when actuated to cause operation of the mechanism, a second mechanism for moving said movable part against the work so that the work piece is engaged between said parts under a light pressure, means for insulating said parts from the machine, and a second control for actuating the main control upon said engagement of the work piece between said parts, the second control including a normally open low potential circuit completed through said parts and the work piece upon said engagement of the work piece and operable when completed to cause actuation of the main control.

14. A machine of the character described comprising a stationary part, a movable part, said parts being adapted to act on a work piece, a high pressure cylinder and piston mechanism for

operating the movable part, a valve for controlling the delivery of actuating fluid pressure to said mechanism, a main circuit controlling said valve, a low pressure mechanism for moving said movable part against the work, a manually operable valve controlling the low pressure mechanism, a relay controlling said main circuit and having an energizing circuit, a relay in the energizing circuit, and a low potential circuit completed through said parts and the work piece upon actuation of the low pressure mechanism and operable to energize the last named relay and thus complete the energizing circuit.

15. A safety control for a machine having a mechanism for moving one work part toward another to act on a work piece arranged between said parts, the control including means for moving the first named work part against the work piece under a low pressure, and means for initiating operation of said mechanism following operation of the first named means comprising an electrical circuit adapted to be completed through said work parts and the work piece.

16. A safety control for a machine having a mechanism for moving one work part toward another under high pressure to act on a work piece arranged between said parts, the control comprising manually controlled means for moving the first named part into low pressure contact with the work piece, and means for initiating operation of said mechanism to continue actuation of said first named work part under high pressure including an electrical circuit completed through said work parts and work piece upon said first named part being moved into low pressure contact with the work piece by the first named means.

FRANK E. TIFFANY.