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STALL RELEASES FOR PRESSES

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Fig. 1

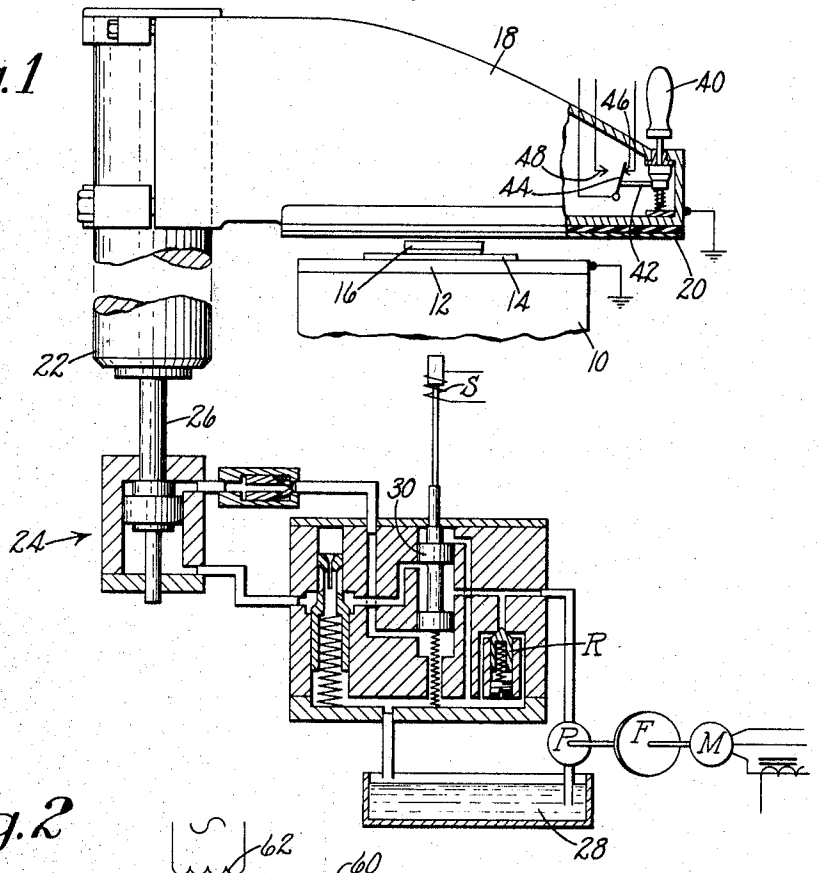
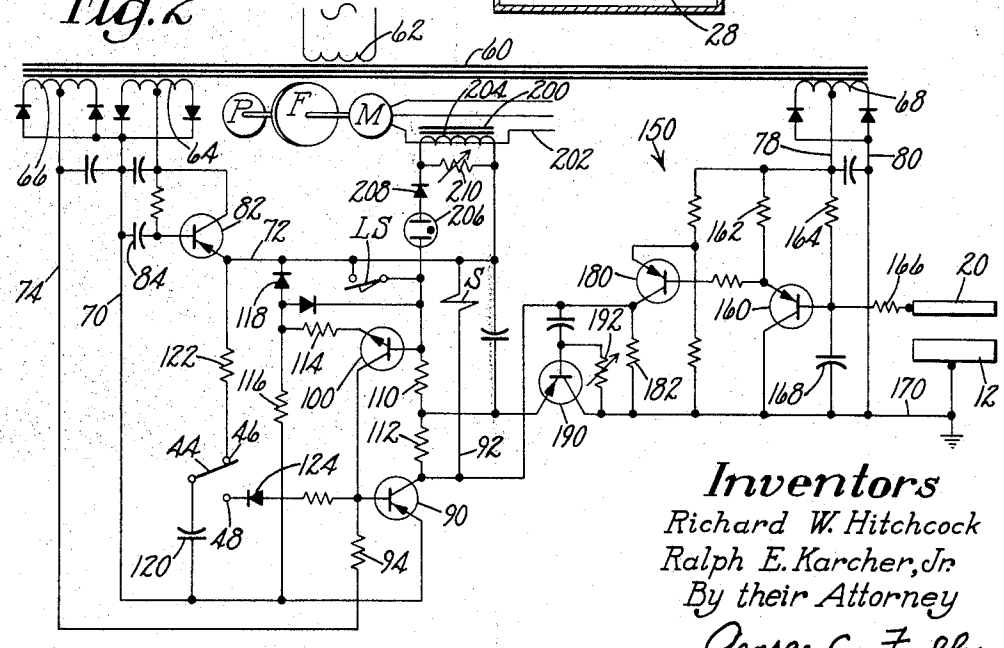


Fig. 2



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STALL RELEASES FOR PRESSES

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This invention relates to improvements in die cutting presses and more particularly to improvements in controls for hydraulic die cutting presses having electric motor driven pumps for providing the operating fluid pressure.

As commonly organized, such a press has a work support and a beam movable toward and away from the work support for pressing dies through sheet material on the support. Such presses commonly also include a control for the hydraulic motor of the press which control is actuatable by the operator to initiate a stroke of the beam and which operates automatically, suitably in response to the actuation of a limit switch or by conductive engagement of the die with a conductive surface of the work support, to effect reversal of the movement of the beam.

In such presses, the maximum hydraulic system pressure is determined by a relief valve suitably set to open at a pressure which will not unduly strain the hydraulic and mechanical portions of the press. At this pressure, in the usual design of cutting press where a flywheel is coupled to the motor to provide supplementary rotational inertia, the power output of the pump at normal speed is several times that of the motor so that the pump is stalling the motor, slowing it and the flywheel. However, their rotational inertia provides an energy reservoir so that in the brief period of a normal cutting stroke, even where the hydraulic pressure may approach the maximum system pressure, conversion of rotational energy prevents complete stall of the motor. However, if the downward movement of the beam is mechanically checked, the motor will shortly stall and protective heater switches therein will open the motor circuit. Resetting of these switches may involve a delay of from about two to ten minutes.

Accordingly, there has commonly been provided a control which operates automatically to effect beam reversal upon actuation of a pressure switch in the hydraulic system suitably at a pressure approaching as closely as feasible the maximum system pressure. By this means an overload on the press which might result from failure to cut through the work or from failure in response to other stroke termination conditions will effect beam reversal instead of stalling the motor.

Although the provision in such presses of a control for returning the beam to rest position in response to the occurrence of a predetermined system pressure has advantageously met the desired purposes in most instances, nevertheless, such a control suffers certain economic and operational disadvantages.

Inasmuch as this control function is provided by a pressure switch which is connected into a solenoid valve stroke controlling relay circuit which is a normally provided part of the press organization, the cost of the pressure switch is an important consideration in providing the over pressure control function. The cost of such a switch is proportional to its reliability and in the present state of the art a pressure switch which can be counted upon to be actuated at a given pressure setting without drifting is relatively expensive.

From an operational point of view, while it is desirable to relieve the machine by terminating the stroke when hydraulic conditions reflect an impasse in the cutting stroke not provided for by other stroke terminating control functions, the need for the pressure switch to be set for actuation at a pressure below relief pressure correspondingly lowers the capacity of the press. Generally speaking, the cheaper the pressure switch, the less reliable it may be expected to be and the greater must be the margin left between its presumed setting and the maximum operating pressure.

Further, again from an operational point of view, there exist circumstances in which a pressure switch, even when operating properly, will effect an undesired stroke termination. In the general situation here comprehended, pressure transients are produced during a normal cutting stroke which do not reflect a checking of the downward movement of the beam which would stall the motor, but which transients would cause actuation of the pressure switch undesirably to terminate the stroke. A typical situation may, for example, exist in the cutting of certain materials which, as in the case of certain plastics, briefly resist the pressure of the sharp edge of the die before yielding to permit the die to complete its cut. Many materials appear to possess a time under stress cutting characteristic in which the force required to start the cut exceeds that required to continue the cut to completion. The initial force required may well approach that corresponding to the maximum system pressure in which case a pressure switch would prevent cutting of the material.

It is accordingly an object of the present invention to provide in a press of the class described, a stroke terminating control which is responsive to the hydraulic conditions resulting from a checked beam to effect return of the beam to its rest position, but which control will neither reduce the pressing capability of the press nor effect beam return because of transient loading of the hydraulic circuit to its maximum pressure. Another object of the present invention is to provide in a beam stroke return control means for providing an over-pressure return function which means is less costly and more reliable than a pressure switch of adequate reliability.

To this end, and in accordance with a feature of the present invention, there is provided in a machine of the class described a stroke terminating control comprising means operative in response to slowing of the electric motor to a predetermined speed for effecting return of the beam. Suitably, as illustrated, the means comprises a transducer associated with a motor lead and transistorized relay means controlled thereby in response to rise in the current in said motor lead above a predetermined value for effecting termination of a press stroke.

In the illustrative press one of the leads of a three phase motor employed to drive the pump has in circuit therewith a current transformer for providing an output voltage proportional to the motor current. The output of the transformer is connected in circuit with the stroke control of the press so that when the output voltage exceeds a predetermined value it is operative to cause the control to effect termination of the downward pressure of the beam and to effect return movement of the beam to an upper position.

By establishing pump speed or the magnitude of motor current as the criterion of the beam control function of this control, it will be seen that a brief period of maximum hydraulic pressure is permitted to be maintained for cutting initially resistant materials while at the same time providing for release and return of the beam in case of complete check thereof before motor stall is complete. While the control of the present invention is illustrated as applied to a three phase motor, it is obviously adaptable to any other type of motor suitable for driving a pump in a press of the class described.

It will be understood that the illustrative machine embodying the present invention is not shown as a limita-

tion thereof. The principles and features of this invention may be employed in varied and numerous embodiments without departing from the scope of the invention and are best understood from the following description taken in connection with the accompanying drawing in which:

FIG. 1 is a diagrammatic view partly in section of a cutting press provided with an embodiment of the present invention, showing details of the hydraulic control mechanism; and

FIG. 2 is a circuit diagram of electric control apparatus embodying the present invention.

The press shown in FIG. 1 comprises a work support **10** supporting a cutting pad **12** made of conductive plastic material. On the pad **12** a work piece of sheet material **14** is disposed with a cutting die **16** superimposed on top of the work piece. A beam **18**, carrying in insulated relation on its lower surface a striking plate **20**, is attached to a post **22** mounted in bearings, not shown, for vertical movement toward and away from the support **10**. Such movement is imparted to the beam **18** by a hydraulic motor **24** connected to the post **22** by a rod **26**. The motor **24** is supplied with hydraulic fluid from a sump **28** by a pump P driven by a three phase motor M which also drives a flywheel F, the pump P supplying hydraulic fluid through a solenoid valve having a movable spool **30** and a winding S energizable to cause the spool **30** to be moved downwardly. As will be seen, when the solenoid is not energized, and the spool **30** is in its illustrative upper position, fluid from the pump is directed to the lower chamber of the hydraulic motor **24**, while when the solenoid is energized the fluid is directed to the upper chamber. A relief valve R limits the maximum hydraulic system pressure. At the outer end of the beam **18** a movable handle **40** is mounted, controlling a switch **42** so that downward movement of the handle **40** causes an armature **44** of the switch to transfer from a contact **46** to a contact **48**. In the operation of the press, it is desired that downward movement of the handle **40** cause the beam **18** to be moved downwardly through energization of the solenoid S and that this downward movement be terminated by de-energization of the solenoid when the stricking plate **20** is connected to the pad **12** by the die **16** as it cuts through the work or else by contact of the striking plate with the body of the operator.

It is also intended that in the event that the current drawn by the motor M by one of its leads exceeds a predetermined value during the beam stroke, the solenoid S be de-energized to terminate the downward movement of the beam and to cause it to return to an upper position.

Referring now to FIG. 2, the control for providing the foregoing functions comprises a transformer **60** having a primary **62** with means for connecting it to a power line, and three secondary windings **64**, **66** and **68**. Each of the secondary windings is center-tapped and provided with rectifying diodes and capacitor filter means to provide direct current, respectively at 30 volts across the leads **70**, **72**, at 8 volts for bias across the leads **74** and **70**, and at 30 volts across the leads **78** and **80**. In the circuit comprising the secondary **64** is a transistorized delay circuit, comprising a transistor **82** which prevents current from passing until a capacitor **84** has charged, for the purpose of preventing the application of voltage to transistors of the circuit before the bias voltage has been built up.

For controlling the energization of the solenoid winding S from the leads **70** and **72**, a PNP power transistor **90** has its emitter connected to the lead **70** and its collector connected to a lead **92** so that the winding S is connected across the leads **70** and **72** in series relation with the emitter and collector of the transistor **90**. The base of the transistor **90** is connected through a resistor **94** to the lead **74**, thereby applying a reverse bias of 8 volts to the emitter-base junction of the transistor.

A control transistor **100** has its emitter and collector connected in series in a circuit extending between the lead **72** and the base of the transistor **90** while the latter has its emitter and collector connected in series in a circuit extending between the lead **70** and the base of the transistor **100**. When neither transistor is conducting, the base of the transistor **100** is substantially at the potential of the lead **72** by connection thereto through a resistor **110**, and resistor **112**, the lead **92**, and the winding S. The emitter base function of the transistor **100** is given a reverse bias of a substantial fraction of a volt by connection of the emitter through a resistor **114** to the junction of a resistor **116** and a diode **118** polarized for conduction from the lead **70** to the lead **72** so that the forward voltage drop of the diode **118** provides a bias holding the transistor **100** normally non-conducting.

During the time the armature **44** is engaging the contact **46**, a capacitor **120** is charging through a resistor **122** so that the armature **44** is at about 30 volts negative with respect to the lead **70**.

To trip the control circuit for locking up the transistors **90** and **100** in their condition for energizing the solenoid winding S, the handle **40** is moved downwardly until the armature **44** engages the contact **48**. Through a diode **124**, the base of the transistor **90** is thus brought substantially negative with respect to its emitter, permitting the transistor to conduct current from the lead **70** through the solenoid winding S while at the same time the potential of the collector of the transistor **90** rises substantially, causing current to flow from the base of the transistor **100** to its emitter, thereby turning on the transistor **100**. This, in turn, causes the collector of the transistor **100** and the base of the transistor **90** to go negative to a value approaching the potential of the lead **72**, thus locking both transistors in conductive condition. Thus, regardless of whether the armature **44** is held against the contact **48** or not, the solenoid winding will remain in energized condition until the circuit is unlocked. If the handle is held down, the diode **124** prevents the capacitor **120** from being recharged from current passing through the collector of the transistor **100**. Thus holding down the handle does not prevent the circuit from being properly unlocked, nor will it result in recycling the stroke.

Unlocking the control circuit is accomplished by applying to the base of the transistor **100** a voltage which is negative with respect to its emitter, for example, by closure of a switch LS which suitably may determine the lower extent of movement of the platen. In the case of a power sensitive source, as hereinafter described, the voltage may be applied across the resistor **112**. Application of cut-off voltage to the transistor **100** permits the bias supply comprising the secondary **66** to apply turn-off reverse bias to the transistor **90**, thus de-energizing the solenoid S.

A beam contact sensing circuit **150** comprises two stages of amplification and one stage providing a variable time delay. Thus, a transistor **160** connected in the grounded collector configuration has an emitter resistor **162** connected between its emitter and the lead **78**. The base of the transistor **160** is connected to the lead **78** through a resistor **164** and through a resistor **166** to the striking plate **20**.

The base of the transistor **160** is connected through a capacitor **168** to the ground line **170**. Emitter-base reverse bias is provided substantially entirely by leakage current which provides a fraction of a volt biasing the transistor against conduction. However, when any conductive path is provided from the striking plate **20** to ground, for example, by engagement of the striking hand **20** with the hand of an operator while the latter is grounded by grasping the handle **40**, or when the die, in cutting through the work, engages the support **12**, the potential at the base of the transistor **160** will swing negative. Thereby the transistor **160** will be caused to conduct and, in turn, cause the second stage transistor **180** to become

conductive. This transistor, connected in the grounded emitted configuration has a resistor **182** connected between the collector and the ground lead **170**. The voltage produced across the resistor **182** is applied to a time delay stage of conventional configuration comprising a transistor **190**. After a time delay, determined by a variable resistor **192**, the voltage across the resistor **182** is applied across the resistor **112** polarized to cut off the transistor **100**, as previously described, to de-energize the winding S.

In accordance with a feature of the present invention, means is provided for operating the solenoid valve to effect beam return in response to slowing of the pump to a predetermined speed. Because of characteristics of electric motors, this is indicated by the presence of current above a predetermined value in a lead of the electric motor. Such means could be a speed responsive switch suitably operated by centrifugal force or a magnetic switch connected to cut off the supply of energy to the solenoid when the current in a lead rises sufficiently. However, since a solid state relay control for the solenoid is normally employed in the presses of the type illustrated to provide other control functions, the present invention is embodied in a control utilizing the previously described transistor lock-up switching circuit together with a transducer in the form of a current transformer connected in circuit with a motor lead for providing a voltage proportional to current and elements which suitably polarize the voltage for application to the transistor circuit and prevent the application of any voltage from the transducer to the circuit and isolate the circuits until the voltage exceeds a predetermined value. Such isolation not only prevents interference with the other functions of the control but improves the definiteness of the new control function as no signal comes through until a threshhold is exceeded.

Thus, in accordnace with a feature of the present invention, a current transformer **200** is connected with its primary in series with a lead **202** comprising a supply lead to the motor M, the current in which reflects the speed and load of the motor as previously described. The secondary **204** of the transformer is connected in a circuit extending between the base of the transistor **100** and the lead **72** through a neon tube **206**, a diode **208** and the primary in series relation. The diode is poled so that a negative voltage only is applied to the neon tube **206** which, when it exceeds the breakdown voltage of the tube, is applied to the base of the transistor **100** to turn it off. The relation of the secondary voltage to the motor current is controllable by a variable resistor **210** connected across the secondary of the transformer **200**.

While it will be appreciated that the alternating current output from the current transformer **200** could be employed directly in certain types of relays for controlling the termination of the stroke and return of the beam, the illustrative circuit provides no output signal and isolates the circuit until the magnitude of the output voltage from the transformer exceeds a predetermined breakdown value. This step function operation also promotes stability against spurious voltage transients which might affect operation at, or near, the critical input voltage for switching.

In operation of the illustrative apparatus with the circuits energized and the motor M running, the operator locates a work piece **14** on the work support **10** and locates a die **16** on the work where a cut is to be made. The operator then swings the beam **18** over the work and depresses the handle **40** to initiate a stroke. Normally, this stroke would be terminated and the beam caused to return by a conductive path formed between the striking plate **20** through the die **16** to the pad **12**, as described above. However, should the work piece resist the cutting force of the die and stop the beam, this termination signal will not take place and the hydraulic motor **24** will still be urging the beam downwardly. Since the flow of hydraulic fluid to the motor is checked, the fluid output of the pump is bypassed through the valve R at the maximum system pressure which exceeds that at which the motor M can drive the pump. Accordingly, the motor M is slowed progressively and the current in its lead **202** rises accordingly. At a predetermined value of motor current, the voltage of the winding **204** exceeds the breakdown of voltage of the tube **206** and a large negative voltage is supplied to the base of the transistor **100**, turning off the solenoid current, as previously described.

The value of motor current at which cutting off occurs is controlled by the variable resistor **210**. This resistor may be set to effect stroke termination at the motor current corresponding to a suitably low motor speed, for example, about 500 r.p.m., at which speed most of the energy of the flywheel has been expended in keeping the pump rotating. With a flywheel of reasonable size, this provides a delay in stroke termination, during which the beam is applying maximum pressure to the die and which is sufficient in many instances to allow the cut to be completed where, without such delay, the stroke would be terminated. At the same time, if the press beam is truly checked in its downward movement, the stroke will definitely be terminated at the end of the brief delay period.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In a press of the class described having a pair of presser members, at least one of which is mounted for movement toward and away from the other, a fluid pressure operated motor for moving the movable presser member, a pump driven by an electric motor for providing fluid under pressure for operating the fluid pressure operated motor and valve means connected with said pump means and the fluid pressure operated motor for controlling the fluid flow to and from the fluid pressure operated motor and operative selectively to cause said last motor to move said movable member toward or away from the other member and manually actuatable means for operating said valve means to cause said fluid pressure operated motor to move the movable member toward the other, in combination therewith, means operative in response to slowing of the pump to a predetermined speed for operating the valve means to effect movement of the movable member away from the other.

2. In a cutting press having first and second presser members, at least one of which is mounted for movement toward and away from the other for pressing dies through work pieces, fluid pressure motor means operative to effect such movement, fluid pressure supply means comprising an electric motor and a pump driven thereby, a control for said fluid pressure motor means comprising valve means controlling the flow of fluid to and from said motor means and operable selectively to cause the motor means to urge said one member toward or away from the other, and means manually actuatable by the operator for operating the valve means to initiate movement of the one member toward the other member, in combination therewith, means including an electric circuit operative in response to the flow of current in excess of a predetermined value in a lead of said electric motor for operating said valve means to cause the motor means to urge said one member away from the other member.

3. In a die cutting press of the class described having first and second presser members, at least one of which is mounted for movement toward and away from the other for pressing dies through work pieces, fluid pressure operated motor means operative to effect such movement, fluid pressure supply means comprising an electric motor and a pump driven thereby, a control for said fluid pressure motor means comprising valve means controlling the flow of fluid to and from said motor and operable selectively to cause the motor means to force said

one member toward or away from the other member, and means comprising a manual trip element for operating the valve means in response to actuation of said trip element to cause the motor means to force the movable presser member toward the other member, in combination therewith, transducer means operatively associated with the supply circuit of said electric motor and valve operating means controlled by said transducer for effecting reversal of the motor means in response to flow of a predetermined current in said motor circuit occasioned by slowing of said electric motor under load.

4. In a cutting press of the class described having a pair of presser members at least one of which is mounted for movement toward and away from the other, a fluid pressure operated motor for providing such movement, fluid pressure supply means comprising an electric motor and a pump driven thereby, a control for said fluid motor means comprising solenoid valve means controlling the flow of fluid to and from said motor and energizable selectively to cause the motor means to force the movable member toward or away from the other member, a transistor switching circuit for selectively energizing said solenoid valve means, said switching circuit having input means responsive to a first predetermined electric signal for causing operation of the solenoid valve means to effect movement of the movable member toward the other member and responsive to a second electric signal of predetermined voltage and polarity for causing operation of said valve means to effect reversal of the movement of the movable member, in combination therewith, means for providing to the input means of said switching circuit a voltage corresponding to said second signal in response to slowing of the pump to a predetermined speed comprising a transformer having its primary connected in circuit with a lead of said electric motor and its secondary connected to said switching circuit through a diode polarized to provide the desired polarity and a voltage threshold breakdown element operative electrically to isolate the switching circuit from the transformer secondary until the breakdown voltage threshold has been exceeded.

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