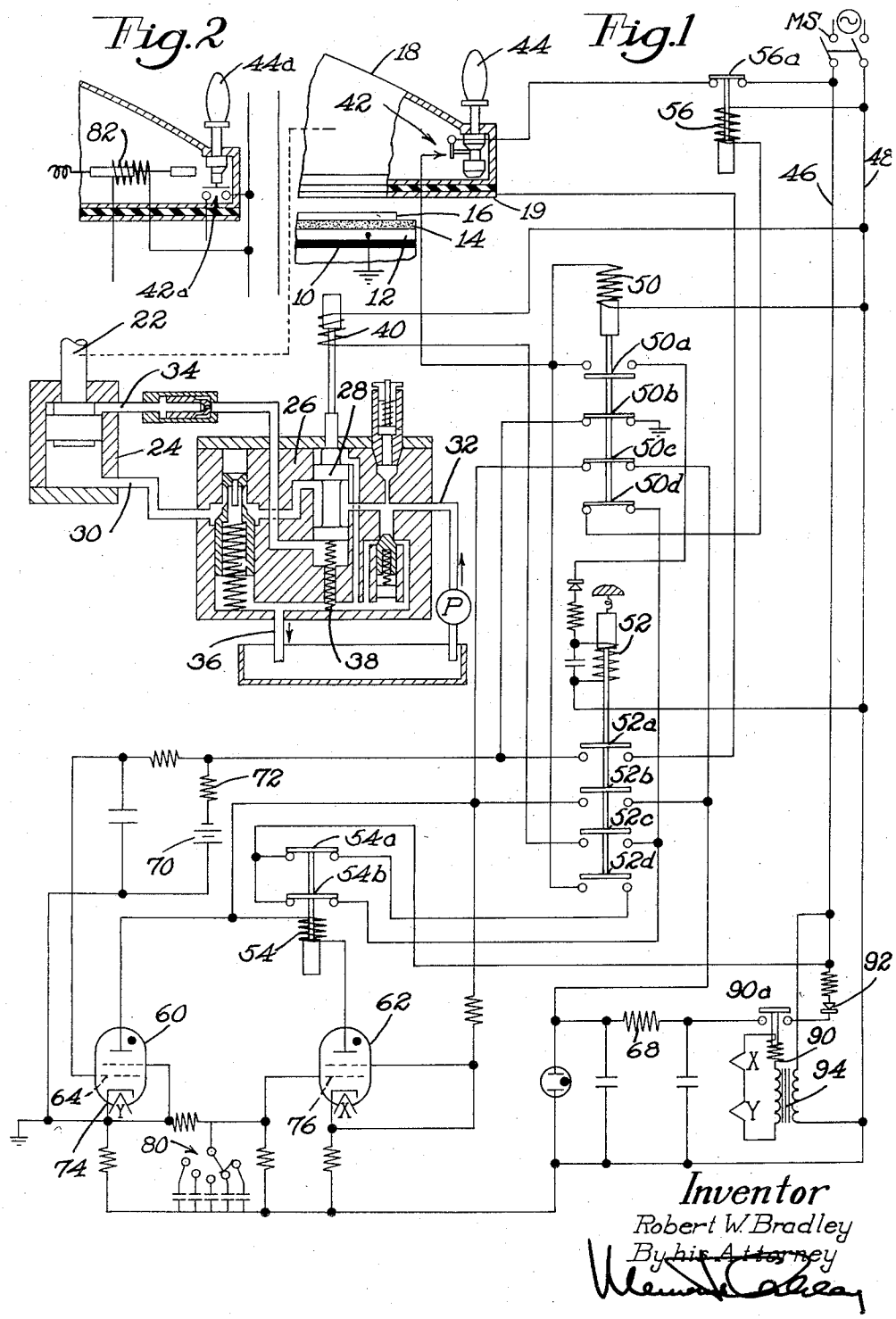
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APPARATUS CONTROL SYSTEMS

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APPARATUS CONTROL SYSTEMS

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This invention relates to improvements in control systems for power driven apparatus and more specifically to improvements in control systems for such apparatus to provide certain safety features.

Many types of apparatus employ a control organization including an element manually operable to initiate a power driven activity of the apparatus and control means for automatically modifying the aforesaid power driven activity upon the occurrence of a given event. In many cases the modifying action which the modifying control is depended upon to perform is so important that failure of the control to operate upon the occurrence of such an event, permitting unmodified power driven activity of the apparatus, may result in severe damage or even personal injury.

As an example, the invention is illustrated as embodied in a cutting press of the type disclosed in United States Patent No. 2,783,838, granted March 5, 1957, on an application filed in the names of Roy G. Ericson and Frank E. Stratton.

In such apparatus, as disclosed in said application, the press comprises a work support upon which a piece of sheet material is placed, with a cutting die superposed thereon, beneath a power driven platen. Means including a handle operated switch on the platen, is provided to initiate the operation of power means to move the platen toward the work support to press the die through the material. Both the platen and the work support comprise conductive members which are electrically connected by the die upon cutting through the material to reduce the resistance between the platen member and the support member to a low value. Correct operation of the press depends upon the functioning of an electron tube relay control, sometimes designated a stroke terminating control, to modify the activity of the power means to terminate the cutting stroke in response to the reduction of such intermember resistance below a predetermined value. Failure of the electron tube relay to operate after initiation of a stroke could result in a stuck die or failure to stop the stroke upon contact of the platen with the operator's hand.

In other types of apparatus, the control may have a function, other than modification of the operation of the power driven means, which is vital to the safety of the operator or to the proper operation of the machine and, accordingly, of such a nature that the power driven means of the machine should not be started if the control is incapable of exercising its control function. Such functions include, for example, the operation of warning signals and the operation of guard or release mechanisms.

Accordingly, an important object of the invention is the provision, in power driven apparatus having an automatic control, of means to prevent initiation of the power driven operation of the apparatus if the automatic control is not then capable of exercising its control function.

To this end and in accordance with a feature of the invention there is provided in such apparatus, in combination with the power initiating means and the control,

means operative to disable the initiating means, means for temporarily transferring the control function of the control to control of said disabling means to cause said means to disable the initiating means while the control is not exercising its control function, that is, when the control is not in the operating condition in which it should be in response to the establishment of a predetermined input condition, means for establishing said predetermined input condition of said control to cause said control to exercise its control function to terminate the operation of the disabling means, whereby if said control is then capable of exercising its control function the initiating means is operative, and means operated by the initiating means for retransferring the control function of the control to its original function of controlling the power means.

Another object of the invention is the provision of an improved control for power means which control will prevent the operation of the power means when an automatic relay control depended upon for proper or safe operation is inoperative.

To this end and in accordance with a feature of the invention, a relay control is provided having an operating control, power control means operable thereby to modify the transmission of power, relay means adapted to exercise a control function on a controlled element in response to the establishment of a predetermined input condition of said relay means, means normally establishing said predetermined input condition, means operable to disable operation of the power control means by the operating control, means temporarily transferring the control function of said relay means to said disabling means for preventing operation thereof when said relay means is exercising its control function, and means operating in response to operation of said operating control in operating the power control means to discontinue the operation of said condition-establishing means and to retransfer the control function of the relay means for exercise on the controlled element.

Other features and advantages of the invention will best be understood from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of apparatus embodying the present invention; and

Fig. 2 is a partial vertical section of a modification of an element similarly shown in Fig. 1.

Referring to Fig. 1, there is illustrated a cutting press organization which comprises a work support **10** including a conductive work support member **12**, which may consist of conductive rubber, for supporting work pieces **14** of sheet material, such as leather fabric or the like to be operated upon by a freely movable die **16** to produce blanks. A platen or beam **18**, including a metallic striking plate **19** providing a conductive platen member, is mounted for swinging movement across the support **10** and for movement toward and away from the support to force the die **16** through the work piece. For safety reasons the plate **19** is insulated from the rest of the platen as disclosed in the above-mentioned Patent No. 2,783,838.

Power means for reciprocating the platen **18** are preferably fluid operated and are illustrated as comprising a piston **22** connected to the platen, as indicated by the broken line in Fig. 1, and slidably mounted in a cylinder **24**, the cylinder and the piston providing a fluid-operated motor. Control of the fluid-operated motor is provided by a valve **26** having an axially movable valve element **28**. When the valve element **28** is in its upper position, as shown, a lower port **30** in the cylinder **24** is connected to a supply pipe **32** and an upper port **34** is connected to an exhaust pipe **36** so that the piston **22** is urged upwardly. When the valve element **28** is in its lowermost position, the connections to the ports are reversed so

that the piston is urged downwardly. The valve element **28** is normally biased upwardly by a spring **38** so that in its normal or rest position, the platen is elevated. A solenoid **40** is arranged, by connection of its armature to the valve element **28**, to move the element into its lowermost position when the solenoid is energized. The hydraulic system is more completely described in a copending United States application Serial No. 487,634, filed February 11, 1955, in the names of Frank E. Stratton and Fred T. MacKenzie, now Patent No. 2,818,922.

Stroke initiating means for controlling the fluid-operated motor to initiate a downward stroke of a platen **18** comprises a switch mechanism **42** having an operating handle **44** disposed at the front of the platen **18**. When the initiating means is operative, downward movement of the handle **44** is effective to connect the solenoid **40** across A. C. supply lines **46** and **48**. The initiating circuit involves four relays, **50**, **52**, **54** and **56**. Operation of the initiating means begins by energizing the relay **50** through a circuit beginning at line **46** through relay contacts **56***a*, switch **42**, the coil of relay **50** and back to line **48**. Energization of relay **50** causes a delayed energization of relay **52** from switch **42** through contacts **50***a*, the coil of relay **52** and back to the line **48**. To provide delayed closure of relay **52**, a condenser is shunted across its coil while a resistor and rectifier are inserted in series therewith as shown in Fig. 1. The reason for so delaying closure of relay **52** will become evident later. Upon energization of relay **52**, a lock-in circuit for the relay **50** is formed which can be traced in Fig. 1 starting near the lower end of line **46** through contacts **54***a*, contacts **52***d* to the coil of relay **50** and back to line **48**. At the same time, an energizing circuit for the solenoid **40** is completed starting from the same point on line **46** through contacts **54***b*, through contacts **52***c* to the solenoid and back to line **48**.

A control for automatically modifying the operation of the power means in response to a given event comprises a stroke-terminating control shown in the lower left-hand portion of Fig. 1. This control, more completely described in copending United States application Serial No. 487,553, filed February 11, 1955, in the name of Robert W. Bradley, now Patent No. 2,821,670, comprises two thyratrons **60**, **62** which are normally biased nonconductive but which are connected to be fired in sequence upon the establishment of a predetermined input condition of the control, that is, a value below the critical value of the bias voltage at the control grid **64** of tube **60**, to energize the relay **54** from a power supply **68** through the contacts **52***b* of the relay **52** or through the contacts **50***c* of the relay **50**. Energization of the relay **54** opens the contacts **54***a* and **54***b* respectively, to interrupt both the lock-in circuit to the relay **50** and the energizing circuit to the solenoid **40**, thus causing the power means to return the platen to its original position. The event chosen to produce this modification is the reduction of the electrical resistance between the conductive support member **12** and the striking plate **19** below a predetermined value, a value which may be selected to be reached at the instant at which the cutting die penetrates the work piece on the support member **12**. The biasing circuit for the tube **60** comprises a source of direct current **70** in series with a relatively high value resistor **72** connected effectively between the grid **64** and the cathode **74** of tube **60** normally to bias the tube non-conductive. The conductive members **12** and **19** of the press are connected in shunt with the resulting high impedance bias source so that the resistance between the press members controls the voltage at the grid **64**. Penetration of the cutting die at the completion of a cut may thus be made effective to cause a drop in the grid bias voltage sufficient to fire the thyratron **60**. The resulting positive wave of voltage at the cathode **74** is transmitted to the grid **76** of the thyratron **62** through a timed delay circuit **80** as described in application Serial No. 487,553, to fire the thyratron **62** for energizing the relay **54**. Since this arrangement is designed not only to reverse the movement of the platen upon the completion of a cut but also to reverse the platen in case a portion of the operator's body should accidentally come between the platen and the work support during a cutting stroke, it is evident that it is extremely important for the modifying control to be capable of performing its control function of opening the contacts **54***a* and **54***b* in response to a signal of the type described.

To this end, means for disabling the initiating circuit unless the modifying control is capable of performing its control function comprises means for disabling the initiating means, the relay **56** whose contacts **56***a* are in series with the switch **42**. Energization of the relay **56** opens the contacts **56***a* to interrupt the energizing circuit of the relay **50** and thus to paralyze the initiating means. An equivalent disabling means is shown in Fig. 2 where a solenoid **82** is shown as arranged to bar movement of the handle **44***a* when energized.

Means for temporarily transferring the control function of the modifying control to the disabling means comprises the relays **50** and **52**. When these relays are deenergized, their contacts are in the positions illustrated and if the relay **54** is not energized, the relay **56** will be energized through a circuit extending from the line **46** near the bottom through contacts **54***b*, through contacts **50***d*, to the coil of relay **56** and back to line **48**.

At the same time, however, the relay **50** through its contacts **50***b* provides a means for establishing the predetermined input condition of the modifying control which should cause it to perform its control function and open the contacts **54***b*. Thus closure of the contacts **50***b* operates to shunt out all bias voltage by effectively connecting the grid **64** to the cathode **74** by grounding the negative side of the bias voltage supply. If the modifying control is then able to perform its function, the relay **56** (or alternatively the solenoid **82**) will be deenergized and the initiating means will be operative to initiate a cutting stroke.

It will be seen that the relays **50** and **52** provide a means, operating upon operation of the initiating means, to return the control function of the modifying control to the power means by re-connecting the contacts **54***b* in the energizing circuit to the solenoid valve **40** which circuit has been described above. At the same time the bias supply is ungrounded and the modifying control is returned to its normal operating conditions.

In operation, the initial condition of the circuits and control relays is as shown in Fig. 1. When the main switch MS is closed, the disabling circuit is immediately energized from line **46** through contacts **54***b*, **50***d*, through the cold relay **56** and back to line **48**. This condition continues until the thyratrons **60** and **62** have fired, at which time the relay **54** will deenergize the disabling circuit and the operator may then proceed to use the machine. If at any subsequent time, tube or component failure should render the modifying control unable to function to energize the relay **54**, the operator will be unable to initiate a cutting stroke. Otherwise, each time the operator presses down the handle **44**, the relay **50** will be energized: (*a*) to energize a delayed energizing circuit for relay **52**, (*b*) to unground the input grid of the modifying control, (*c*) to disconnect the plate voltage supply from the thyratrons to permit them to deionize, and (*d*) to interrupt the disabling circuit. Shortly thereafter the relay **52** pulls in to restore the plate voltage to the tubes, to complete the energizing circuit to the solenoid **40**, and to complete a holding circuit for the relay **50**, thus retransferring the control function of the modifying control to control of the power means. Energization of the relay **52** also closes the contacts **52***a* thus to reconnect one of the input leads of the modifying control to the striking plate **19**. If desired, however, the striking plate **19** may be connected directly to this

input lead, e. g. to the resistor 72, without the intervening contacts 52*a*.

As a further feature of safety, the power supply 68 includes a relay 90 having contacts 90*a* in series with the source of D. C. plate voltage which includes the rectifier 92. The solenoid of the relay is connected in series with the filaments of the thyratrons 60 and 62 so that the relay is energized by a transformer 94 to provide plate voltage to the thyratrons only if their filaments are intact. The filament relay 90, which immediately cuts off plate current in the event of filament failure, avoids the possibility of continued thermal emission after filament failure, preventing operation of the disabling circuit.

While I have described my invention as applied to a cutting press of the clicker type, it will be obvious that the invention has wide usage in many other applications. I therefore desire that my invention be not limited except in so far as is made necessary by the prior art and by the scope of the appended claims.

I claim:

1. In apparatus having power driven operating means, means including a manually operated element for initiating the operation of said power driven means and a control operative automatically to perform a control function in response to the establishment of a predetermined input condition of said control, means for insuring that said control is capable of exercising its control function prior to initiating the operation of said power driven means comprising, in combination, means operative to disable the initiating means, means for temporarily transferring the control function of said control to control of said disabling means, means for establishing said predetermined input condition adapted to cause said control to exercise its control function and thereby to terminate the operation of said disabling means, and means operative upon operation of the initiating means for returning the control function of said control to its original control function.

2. In apparatus having power operating means, means including a manually operated element for initiating the operation of said power means, a modifying control operative automatically to modify the operation of said power means in response to the establishment of a predetermined input condition of said control, and means for establishing said condition in response to the occurrence of a given event, in combination therewith, means for preventing initiation of the operation of said power means unless said modifying control is then capable of performing its control function comprising, in combination, means operative to disable said initiating means, means for temporarily transferring the control function of said modifying control to control of said disabling means, means for establishing said predetermined input condition adapted to cause said control to exercise its control function and thereby to terminate the operation of said disabling means, and means for retransferring the control function of said modifying control to control of said power means upon operation of the initiating means.

3. In a machine for operating upon work pieces, said machine having an element movable to effect an operation on a work piece, power means for moving said element, means, including a manually operable element, to initiate the operation of said power means, modifying control means operative automatically to perform a control function operative to effect a predetermined modification in the operation of said power means in response to the establishment of a predetermined input condition of said control, and connections for controlling said condition in accordance with a condition in relation to which such modification is to be accomplished, in combination therewith, means operable to disable said initiating means, means for transferring the control function of said control between control of said power means and control of said disabling means, said transferring means normally connecting said control to said disabling means for operation thereof in such manner as to prevent operation of said initiating means unless the output of said control would if retransferred to the power means effect the aforesaid modification of its operation, means normally establishing said predetermined input condition of said control whereby if said control is operating properly said disabling means does not prevent the operation of said initiating means, and means responsive to operation of said initiating means for discontinuing the operation of the establishing means and for retransferring the control function of said control to control of said power means.

4. In apparatus having power operating means, means, including a manually operated element, for initiating the operation of said power means and a relay operative in response to the establishment of a predetermined input condition for modifying the operation of said power means, means for preventing the initiating of the operation of said power means unless said relay is capable of exercising its control function in response to such establishment, comprising, in combination, disabling means connected to prevent operation of the initiating means when energized by electric energy, circuit means for connecting said disabling means to a source of electric energy, means for temporarily connecting the modifying control relay in said circuit means in such a manner that when said relay is energized the disabling circuit is interrupted, means for concomitantly establishing said predetermined input condition of said modifying control adapted to cause it to exercise its control function, and relay means operated by said initiating means to reconnect the modifying control for control of the power means.

5. In apparatus having power operating means, initiating means for said power means, including a manually operated switch, a modifying control operative automatically to modify the operation of said power means in response to the establishment of a predetermined input condition and connections for controlling said input condition in accordance with another condition for control in response to the occurrence of a given event, said modifying control comprising an electron tube and an electro-mechanical relay adapted to be energized through said tube in response to said establishment to effect its control function by effecting a predetermined switching operation, in combination therewith, means energizable to disable the operation of said initiating means, switch contact means normally closed to establish said predetermined condition of the input of said modifying control and to connect the contacts of the control relay into an energizing circuit for said disabling means so that said energizing circuit is interrupted by said relay when the relay is energized and its switching function is exercised, and relay means adapted upon operation of said initiating means to open said switch contact means and to reconnect the contacts of the control relay for control of said power means.

6. In apparatus having power operating means, initiating means for said power means including a manually operated switch, a modifying control operative automatically to modify the operation of said power means in response to the establishment of a predetermined input condition of said control, and connections for controlling said condition in accordance with another condition for control in response to the occurrence of a given event, said modifying control comprising at least one electron tube and an electro-mechanical relay adapted to be energized through said tube in response to said establishment to effect its control function by effecting a predetermined switching operation, in combination therewith means energizable to disable the operation of said initiating means, switch contact means normally closed to establish said predetermined condition of the input of said modifying control and to connect the contacts of the control relay into an energizing circuit for said disabling

means so that said energizing circuit is interrupted by said relay when the relay is energized and its switching function is exercised, means for interrupting the energization of said control relay in response to interruption of the continuity of the filament of any electron tube in said modifying control, and relay means adapted upon operation of said initiating means to open said switch contact means and to reconnect the contacts of the control relay for control of said power means.

7. A relay control of the class described comprising, in combination, an operating control, power control means operable by said operating control for modifying the transmission of power, relay means adapted to exercise a control function on a controlled element in response to the establishment of a predetermined input

condition of said relay means, means normally establishing said predetermined input condition, means operable to disable the operation of said power control means by said operating control, means temporarily transferring the control function of said relay means to said disabling means for preventing operation thereof when said relay means is exercising its control function, and means operating in response to operation of said operating control in operating said power control means to discontinue the operation of said condition-establishing means and to retransfer the control function of the relay means for exercise on the controlled element.

No references cited.