

March 5, 1935.

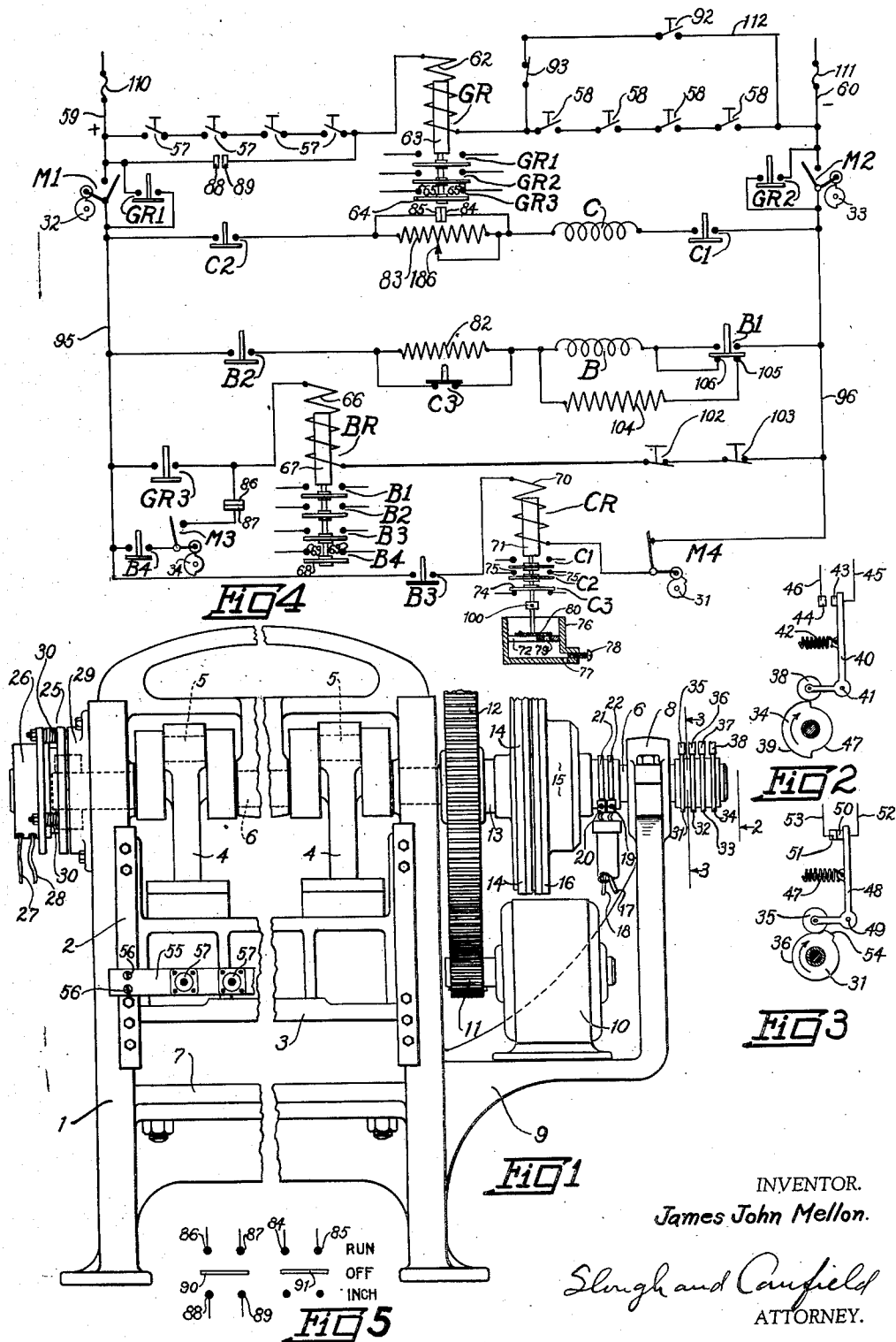
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1,993,413

ELECTRIC CONTROL METHOD AND MEANS FOR POWER OPERATED MACHINERY

Filed Aug. 25, 1932

2 Sheets-Sheet 1



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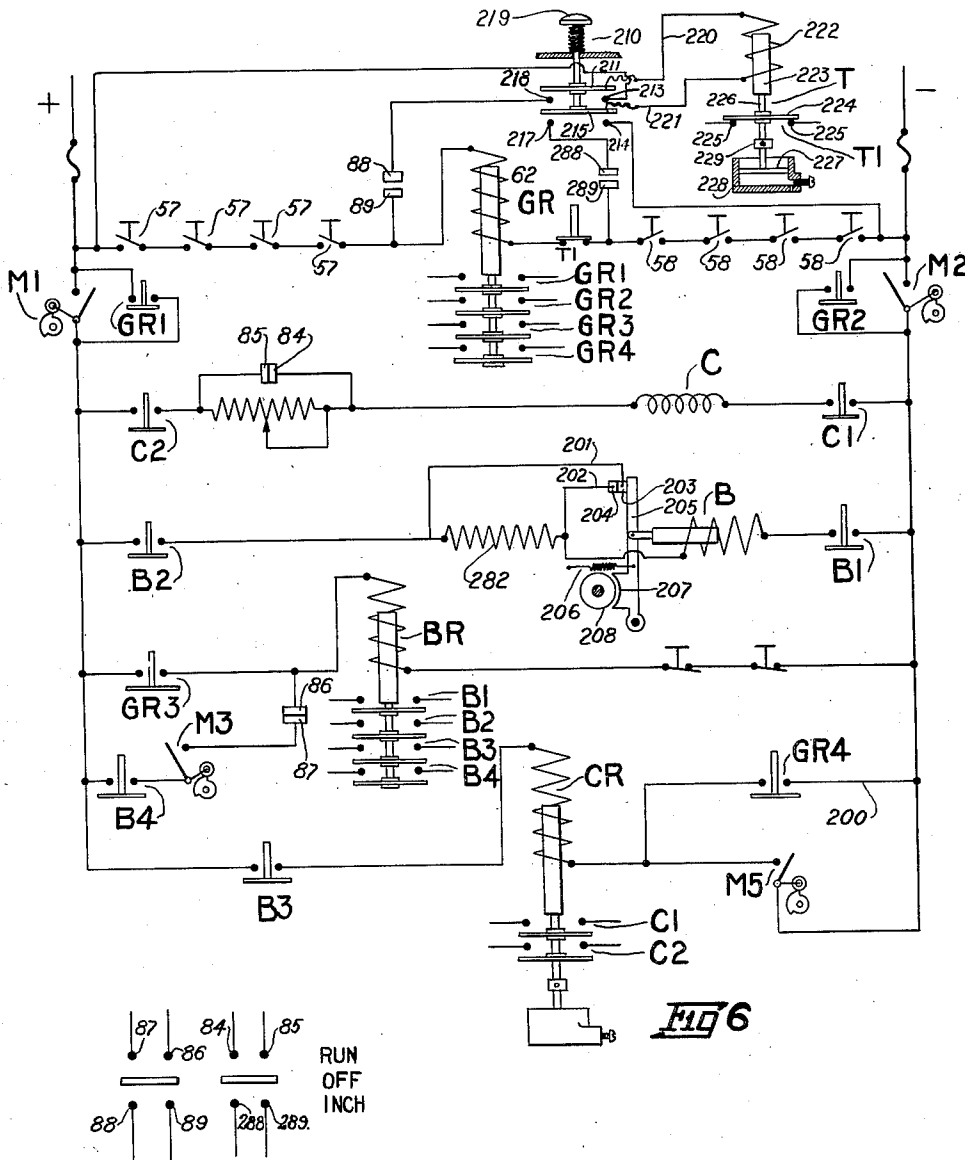
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UNITED STATES PATENT OFFICE

1,993,413

ELECTRIC CONTROL METHOD AND MEANS
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Application August 25, 1932, Serial No. 630,449

46 Claims. (Cl. 192—144)

This invention relates to electric control systems and apparatus as applied to the control of power-operated machine tools, and particularly to machine tools having a repeating cycle of operating movements.

Illustrative of such machine tools are power-driven presses, shears, bulldozers, etc.

Hereinafter I have described and illustrated my invention as applied to power-driven presses.

It is the practice with power-driven presses, particularly of large size, to stop the movable head or platen of the press after each operation thereof. Thus, to perform a pressing operation, the head is started and moved, say, downwardly, effects an operation on the work at the bottom of the stroke, and is then retracted upwardly and stopped at or near the top of the stroke.

The power, such for example as that of a continuously running electric motor, is applied periodically to the press through a clutch, and the motion of the press is stopped after each operation by the application of a brake.

For well known reasons it has been found advantageous to employ electric clutches and brakes for these purposes and to control the operation thereof by suitable electric circuits and circuit-controlling apparatus; but heretofore such control systems and apparatus have not been wholly satisfactory.

One of the difficulties encountered has been to time the operation of the brake and of the clutch so that they will, respectively, engage and disengage at the proper moment. When the brake and clutch are not correctly timed, they may both be engaged concurrently for short periods of time; for example, when the clutch is taking hold and the brake is letting go, one tending to drive the press and the other tending to prevent its being driven, resulting in excessive wear and tear on the apparatus as well as unreliable performance thereof.

Another difficulty has been to positively prevent operation of the press at all times except when the operator or operators who attend the press are prepared for its operation and are not in a position to be injured thereby.

In some instances of electrically controlled presses, accidental "grounds" in the wiring connections of the control systems have caused the press to be operated unexpectedly; or have caused it to unexpectedly repeat its operation, resulting in damage to the work or to the press and in some cases causing injury to the operators who place the work in the press and remove it therefrom.

It is therefore an object of this invention to provide an improved electric control system and apparatus generally for power-driven machine tools of the class having an intermittently repeating cycle of operating movements.

Another object of my invention is to provide generally an improved electric control system and apparatus for power-driven presses.

Another object is to provide an electric control system and apparatus for power-driven machine tools of the class referred to having improved means for preventing accidental, unintended starting of the press.

Another object is to provide in an electric control system and apparatus for power-driven machine tools of the class referred to, improved means to insure that the hands, arms and other anatomical parts of the operators of the machine may be safely disposed at the machine before it may start its cycle of operative movements.

Another object is to provide an electric control system and apparatus for power-driven machines of the class referred to wherein an accidental "ground" in the wiring connection cannot initiate an operative movement of the machine.

Another object is to provide, in a machine tool of the class referred to, having an electric brake and clutch, an improved electric system and apparatus for controlling the same.

Another object is to provide, in an electrically controlled machine tool of the class referred to, an improved means to effect the well known "inching" movement of the machine.

Another object is to provide, in a machine tool of the class referred to, having an electrically actuatable clutch, an improved electric control for the clutch whereby it optionally may be fully energized to drive the machine or energized only sufficiently to inch the machine ahead.

Another object is to provide generally an improved electric control system and apparatus for controlling the energization of a power transmitting electric clutch.

Another object is to provide an improved control system and apparatus for an electric clutch comprising improved adjusting means for adjusting the energization of the clutch during certain phases of its operation.

Another object is to provide an electric control system and apparatus for an electrically energized machine tool driving clutch having improved means for controlling an inching operation of the clutch.

Another object is to provide generally an im-

proved electric system and apparatus for controlling the operation of an electric brake.

Another object is to provide an electric system and apparatus for controlling the operations of an electric brake and comprising means for rendering the brake more quickly releasable.

Other objects will be apparent to those skilled in the art to which my invention appertains.

My invention is fully disclosed in the following description taken in connection with the accompanying drawings, in which:—

Fig. 1 is a front elevational view in simplified form of a power-driven press illustrating the application of my invention thereto;

Figs. 2 and 3 are, respectively, cross-sectional views taken approximately from the planes 2—2 and 3—3 of Fig. 1, these views being semi-diagrammatic in form;

Fig. 4 is a diagrammatic view illustrating a system of electrical connections and apparatus which I may employ for controlling the press of Fig. 1 according to my invention;

Fig. 5 is a diagrammatic view illustrating a manual circuit changing controller which I may employ in connection with the system of connections illustrated in Fig. 4;

Fig. 6 is a diagrammatic view similar to Fig. 4, illustrating a modification of the system of connections and apparatus which I may employ;

Fig. 7 is a view generally similar to Fig. 5, but illustrating in diagrammatic view a manual circuit changing controller which I may employ in connection with the system of connections of Fig. 6.

Referring to the drawings, Fig. 1, I have shown generally at 1 the main frame of a press having vertical guides or ways in which or on which a head or platen 3 may reciprocate vertically. To reciprocate the head 3, a plurality of connecting rods 4—4 are connected thereto at their lower ends and at their upper ends have bearings on cranks 5—5 formed on a crank shaft 6 extending horizontally through the press, and supported in suitable bearings in the main frame thereof.

The press as viewed in Fig. 1 may have any suitable width and may be driven by any necessary number of connecting rods 4—4, the figure being broken in the middle to condense the same in the drawings for the sake of simplicity.

Rigidly connected to the main frame is a lower head or platen 7 upon which work to be operated upon may be placed. Suitable punches, forming dies, etc. may be provided on the platens 3 and 7 to operate upon work when the upper platen 3 is forcibly depressed by rotation of the crank shaft 6 in a well known manner.

The crank shaft 6 is extended outwardly from the frame of the press (the extension being made longer than normal in the drawings for purposes of illustration), and is supported adjacent its outer end in an outboard bearing 8 formed on a bracket 9 on the main frame.

A power-supplying electric motor 10, supported on the bracket 9, has a pinion 11 meshed with a relatively large gear 12 freely rotatably supported on the shaft 6. A central hub portion 13 of the gear 12 is connected to the driving element 14 of an electrically actuated clutch device 15. The driven element 16 of the clutch device 15 is rigidly keyed or otherwise secured to the shaft 6. An electro-magnet or magnets (not shown) are disposed within the elements 14 and 16 of the clutch device and are adapted to be energized by electric current conducted thereto through conducting wires 17 and 18 and stationary brushes

19 and 20 engaging rotating rings 21 and 22 supported on the clutch device 15 and rotatable therewith, the terminals of the electro-magnet within the clutch device 15 being connected to the rings 21 and 22.

The motor 10 is connected to any suitable electric circuit and is adapted to run continuously and thus to continuously rotate the gear 12. The clutch element 14 continuously rotates with the gear 12 relative to the clutch element 16. Upon energizing the clutch device 15 by current through the wires 17 and 18, the two clutch elements 14 and 16 frictionally engage each other to transmit the torque of the element 14 to the element 16 and thence to the shaft 6 to rotate the same. Upon de-energizing the clutch device 15 by breaking the circuit of the wires 17 and 18, the two clutch elements 14 and 16 are released from each other and the gear 12 and element 14 go on rotating as before; and the element 16 and its connected shaft 6 stop rotating or may be suitably stopped by a brake to be described.

My invention is not essentially concerned with any particular construction of magnetic or electric brake such as that above described and illustrated generally in the drawings. Such electric clutches are well known commercial devices and any such known or suitable device having one rotating element which may be drivingly or rigidly connected to the press crank shaft, and another element which may be rotatably driven relative to the crank shaft by a power source such as a motor, and having an electrically actuable means associated with the two elements whereby they may be frictionally engaged with each other to transmit the power from one to the other to drive the crank shaft whenever the means is electrically actuated, may be employed. Furthermore, as is well known in such prior clutch devices, the frictional engagement of the two clutch elements 14 and 16 may be rendered sufficiently powerful to rigidly lock the elements 14 and 16 together or may be rendered barely sufficiently powerful to engage the elements 14 and 16 with a slipping frictional engagement to cause the driven element 16 to rotate slowly relatively to the element 14, these different effects being obtainable in the well known manner by controlling the amount of energizing current conducted to the clutch device 15 by the wires 17 and 18.

In view of the well known construction and mode of operation of such devices, it is believed unnecessary to illustrate and describe them further herein.

On the opposite side of the frame 1 from the clutch device 15, I have illustrated generally at 25 an electric brake of the enclosed type comprising a housing 26 in which an electro-magnet is disposed energizable by current transmitted thereto by conducting wires 27 and 28; and comprising a base portion 29 by which the brake as a whole may be rigidly mounted upon the frame 1.

The crank shaft 6 extends out of the frame 1 and into the housing 26—29 and is associated with rotatable elements of the brake. Corresponding stationary elements of the brake associated with the housing 26—29 are adapted to be brought into frictional engagement with the rotary elements of the brake to apply a braking force or torque to the crank shaft 6 whenever the brake device is electrically de-energized by interrupting current in the wires 27—28.

Spring devices such as illustrated at 30—30

effect an application of the braking torque when the device is electrically de-energized.

Such brake devices are well known in this art and form no essential part of my invention. Any such well known commercial or any suitable type of brake may be employed which, upon de-energizing the electro-magnetic or like device within the housing 26, permits the springs 30—30 to apply braking torque to the shaft 6.

At 31 to 34 respectively I have illustrated cam devices mounted upon the extended crank shaft 6 and rotatable therewith and at 35 to 38 respectively I have illustrated roller or other cam followers engaging the cams 31 to 34, the cam followers being connected to switch arms which have been broken away in Fig. 1 to simplify the drawings.

The cams 32 to 34 and the cam followers and switches associated therewith may be all identically alike and one of them is illustrated in Fig. 2 in a semi-diagrammatic view. The cam 31 and its associated follower and switch is illustrated in Fig. 3 in a similar view.

Referring to Fig. 2, the cam 34 is so formed that when the press platen 3 is at the top of its stroke, the cam follower 38 rides out upon a cam portion 39 of large diameter, thus rocking clockwise a switch arm 40 pivotally mounted at 41, against the tension of a spring 42 causing a contact 43 on the arm to be separated from a stationary contact 44 to break an electric circuit comprising the wires 45 and 46. Similarly, when the platen is at the bottom of its stroke, the cam follower 38 rides down upon a cam portion 47 of relatively smaller diameter whereupon the spring 42 closes the circuit at the contacts 43—44.

The exact positions in the stroke of the platen at which the switch contacts 43—44 are operated is not essential but I prefer to effect this operation at the extreme upper and lower stroke positions of the platen.

Referring to Fig. 3, the cam 31 is shown in a position corresponding to that of the cam 34 of Fig. 2. The cam 31 is so formed that approximately at the extreme top of the platen stroke, the cam follower 35 rides down upon a cam portion of relatively small radius 36 whereupon a spring 47 moves a switch arm 48, pivotally mounted at 49, to move a contact 50 into engagement with a stationary contact 51 and close an electric circuit 52—53.

The cam 31 has a cam portion 54 of relatively large diameter and of such circumferential extent that when the platen 3 has passed over approximately three-fourths of its upward stroke, the cam portion 54 will move the cam follower 35 to open the switch contacts 50—51, permitting them to close again as above just described upon attainment of the top of the stroke.

The switch device as illustrated in Figs. 1, 2 and 3, just described, may be of any suitable or known construction of cam-operated spring-closing switch, commercial types of which are old in this art.

In the operation of presses of this general character, particularly presses which operate upon heavy or bulky work pieces such for example as large blanks of sheet metal, it is necessary and customary to position a plurality of operators on opposite sides of the press, the operators working as a team to feed a blank into the machine and after the pressing operation thereon, to remove it therefrom. Obviously, some means must be provided to prevent the press from operating in each case until all the work of removing the

formed blank and feeding a fresh one into the machine has been performed to insure that all of the operators will have their hands and arms etc. out of the path of movement of the platen 3 to avoid injury thereto.

This has been heretofore accomplished by providing for each operator a pair of switches such as push button switches and connecting all of the switches in a single control system or circuit so that all of such switches must be closed before the press can operate, and so locating the push button switches that the operators must all have their hands and arms out of danger of injury. In the practice of my invention, such a system of push button switches is employed. In Fig. 1, I have illustrated at 55 a rail extending transversely across the press and secured thereto as by bolts or screws 56. Mounted upon the rail is a plurality of push button switches 57—57. Only a fragment of the rail 55 is shown but it will be understood that it may extend across the entire machine or be otherwise disposed thereupon and have mounted thereon any suitable number of push button switches; and that a similar rail and set of push button switches may be provided on the opposite side of the press for operators positioned on that side.

In Fig. 4, taken in connection with the other figures, I have illustrated an electric control system and control apparatus by which a press having a brake 25 and a clutch 15 and push buttons 57—57 may be operated in a manner to overcome the dangers, defects and disadvantages of operation of prior presses, including those which have been enumerated hereinbefore.

Referring to Fig. 4, I have indicated at B the electromagnetic winding of a brake such as the brake 25 and at C, I have illustrated the electromagnetic winding of a clutch such as the clutch 15. At 57—57 are indicated a bank of four push button switches such as might be under the control of the four hands of two operators on one side of a press; and at 58—58 is indicated a bank of similar push buttons which may be disposed convenient to the four hands of two operators on the opposite side of the machine.

At M¹, M² and M³ I have indicated cam-operated switches such as the switch of Fig. 2, all of which may be identical and which may be operated respectively by the cams 32, 33 and 34 of Fig. 1 and Fig. 2, these switches being illustrated in Fig. 4 in the open position which indicates generally, in connection with the above description of the press, that the press is at the top of its stroke.

The push button switches 57—57 and 58—58 are all connected in series across the positive and negative mains 59 and 60 which may be connected to any suitable source of current, and in series with the push button switches is the winding 62 of an electro-magnetic switch indicated generally at GR. The switch GR may be of any known or suitable construction but in the diagrammatic form illustrated, comprises a plunger 63 adapted to be elevated when the winding 62 is energized, and comprises three simultaneously operated switches GR¹, GR² and GR³, each switch comprising a bridging contact 64 adapted to bridge a pair of contacts 65—65 when the plunger 63 is elevated.

To simplify the diagram, each of the switches GR¹, GR² and GR³ is reproduced in the circuit at suitable points of the diagram where its connection in the system is completed.

At BR is indicated an electro-magnetic switch

having a winding 66. This switch may also be of any known or suitable construction but in the diagram illustrated has a plunger 67 which when elevated by energization of the winding closes simultaneously a plurality of switches B¹, B², B³ and B⁴, all of which may be identical and each of which may comprise a bridging element 68 and a pair of contacts 69—69 adapted to be bridged thereby.

The switches B¹ to B⁴ inclusive are reproduced elsewhere in the diagram to render the diagram simple and in such reproduction are connected to the rest of the circuit.

At CR is indicated a third electro-magnetic switch having an energizing winding 70. This switch has in it a time element whereby its complete operation is delayed after energization of the winding for a predetermined interval of time. Such switches are well known in the art and the switch CR may be any known or suitable switch but in the diagrammatic form illustrated comprises a plunger 71 adapted to be elevated upon energization of the winding 70, two switches, C¹ and C², adapted to be closed, and a third switch C³ normally closed and adapted to be opened upon elevation of the plunger. These switches are reproduced elsewhere in the system to simplify the diagram.

In the diagrammatic form of switch CR illustrated, to provide the time element, there is shown a piston 72 connected to a stem 73 depending from the plunger and to which bridging elements 74 adapted to bridge contacts 75—75 of the switches C¹, C², and C³ are also connected. The piston 72 closely fits a dash-pot cylinder 76. The upward movement of the piston 72 is retarded by restricted ingress of air into the cylinder below the piston through a port 77, the effective size of which may adjustably be determined by a screw 78 partially obstructing the port; and the downward movement of the piston 72 upon de-energizing the winding 70 is unretarded by virtue of a relatively large port 79 in the piston covered by flexible one-way flap valve 80 which closes on upward movement of the piston and opens on downward movement thereof.

As explained above, the switch CR is diagrammatic only and any means of retarding its operation may be provided such as thermal, electro-magnetic, etc.

The normally closed switch C³ may be opened after the elapse of the time interval by the engagement of an abutment or collar 100 on the stem 73 picking up the bridging member 74 after a predetermined movement.

At 82 is indicated a resistance in series with the brake winding B normally short-circuited by the switch C³.

At 83 is a resistance in series with the clutch winding C normally short-circuited by a pair of contacts 84 and 85 (to be described) and when the contacts are open to insert the resistance 83 in series with the winding C, the value of the resistance may be adjusted by means of the movable contact 186 diagrammatically illustrated.

In Fig. 5 I have illustrated, diagrammatically, a manually operable controller having a pair of movable bridging elements 90 and 91 which in the "run" position close contacts 84—85, above referred to, and also close a pair of contacts 86—87 which are reproduced in the diagram, Fig. 4. In the "off" position, these said contacts are open. The said controller has a so-called "inch" position in which the contacts 84—85 and 86—87 are open but another pair of contacts

88—89 are closed, these contacts also being reproduced in Fig. 4.

The manually operable controller of Fig. 5 may be of any known or suitable construction having run, off and inch positions, and in these positions making the contact indicated, and the exact construction and operation of the said controller forms no essential part of my invention.

At 92 is indicated a push button "inching" switch and at 93 a normally closed knife switch.

The operation of the press in connection with the diagram of Fig. 4 will now be described.

The apparatus for the diagram is illustrated in the position which parts thereof assume when the press is at the top of its stroke. The switches M¹, M², and M³ are open, being opened and held open at the top of the stroke by their corresponding cams 32, 33 and 34.

The push buttons 57—57 and 58—58 likewise are in their normally open position. The switches GR¹ and GR² which are in parallel with the switches M¹ and M² are normally open and thus all flow of current is cut off from the mains 59 and 60.

Assuming that it is now ready for the press to start, and that the motor 10 and gear 12 are running, the operators close the switches 57 and 58 and when all of them are closed without exception, the winding 62 is energized directly across the mains 59 and 60, lifting the plunger 63 and closing all of the switches GR¹, GR² and GR³.

Current now may flow from the positive main 59 through the contacts of the switch GR¹ to wire 95 and thence through switch GR³ (all other paths being open) energizing the winding 66 and flowing to the opposite wire 96 and thence through the closed switch GR² back to the main 60.

The switch BR operates, the plunger 67 rising and closing all of the switches B¹, B², B³, and B⁴. Current may now flow from the wire 95 through switches B², normally closed switch C³, through the brake winding B and through the switch B¹ to the wire 96, fully energizing the brake winding to release the brake; and current may also flow from the wire 95 through the switch B³, energizing the winding 70 of the switch CR and through the switch M⁴, now closed, to the wire 96. The plunger 71 of the switch CR starts to move upwardly its movement being delayed to introduce a time interval between the time of its energization and the time of its full operation. At the end of the time interval, the switches C¹ and C² will close and the switch C³ will open. Current now flows through switches C¹ and C², energizing the clutch winding C.

It is assumed that at this time the controller of Fig. 5 is in the "run" position in which contacts 84—85 and 86—87 are closed. Current energizing the clutch winding C flows through the contacts 84—85 around the resistance 83 and therefore the clutch is fully energized and transmits the full power of the motor to the press crank shaft and starts the press platen 3 downward on its operating stroke.

Providing that the operators keep their hands on all the push buttons, the press continues to move until it has completed its stroke and is ready to start back up, whereupon the switches M¹, M², and M³ are all closed mechanically by their respective cams 32, 33 and 34 (see Fig. 2). From this time on the upward stroke is out of control of the push buttons and the operators may take their hands therefrom and current may continue to flow from the main 59 through the

switch M^1 to the wire 95, through the switch B^4 , switch M^3 and contacts 86 and 87, through the winding 66 to the wire 96 and back to the main 60 through the switch M^2 , thus maintaining the switch BR energized to maintain the circuit of the brake winding B and maintain the circuit of the switch winding 70 of the switch CR to maintain it in full operated position to in turn maintain energization of the clutch winding. Thus the press head or platen 3 moves upwardly until it reaches approximately three-fourths of its upward stroke, during which time the operators, now free to use their hands to manipulate the work, may remove the formed work piece and insert another blank in the machine. Upon reaching the said three-fourths upstroke position, the switch M^4 is opened by its cam 31. This breaks the circuit of the winding 70 of the switch CR and it opens the switches C^1 , C^2 , and closes C^3 instantly without time interval, thus de-energizing the clutch winding C and releasing the clutch.

The momentum of the moving parts continues the rest of the upward stroke until the cams 32, 33 and 34 open the switches M^1 , M^2 , and M^3 . The switch M^3 breaks the circuit of the switch BR and it opens, opening the switches B^1 to B^4 inclusive, de-energizing the brake winding B and allowing the brake to stop the press at the top of the stroke. The parts are now in the position for another cycle of operations.

It will be observed that on the down stroke, the clutch cannot be energized and engaged until the brake is fully released. This is due to the control of the clutch circuit by the switches C^1 and C^2 which cannot be closed until the switch B^3 is closed to energize the winding 70, (and the switch B^3 cannot be closed without also closing the switches B^1 and B^2 to release the brake) and due to the time interval between the energization of the brake winding and the closure of the switches C^1 and C^2 .

On the up-stroke, the switch M^4 opens before the top of the stroke is reached, thus de-energizing the winding 70 and opening the switches C^1 and C^2 to de-energize and release the clutch, and the brake winding B is not de-energized to set the brake until the top of the stroke is reached; and the switch M^3 , or M^1 , M^2 and M^3 de-energizes the winding 66 and opens the switches B^1 , B^2 .

Again, it will be observed that all eight of the push buttons 57 and 58 must be maintained closed during the down stroke. If any one button is opened by an operator who might remove a hand therefrom, the winding 62 of the switch GR will be de-energized and all of the switches GR^1 to GR^3 will be opened. This will immediately, by opening the switch GR^3 , de-energize the winding 66 of the switch BR, opening the switches B^1 and B^2 and setting the brake; and, by opening the switch B^3 , will de-energize the winding 70 and open the switches C^1 and C^2 and release the clutch. In this instance, of course, there will be a short period of time in which the clutch and the brake are both engaged but in such an emergency, the important thing is to apply the brake as quickly as possible, regardless of the engaged condition of the clutch. In any event, the clutch is released immediately thereafter and such emergency wear and tear on the clutch is negligible.

To further insure that the brake will set instantly in the case of such an emergency, the resistance 82 may be provided. In the normal downward movement of the press, and with the

switch CR fully operated, the switch C^3 will be open and the brake winding B will have relatively small excitation. Thus when the emergency occurs, opening the switch GR^3 and immediately thereafter opening the switches B^1 and B^2 , the relatively weak current in the brake winding B will die out very rapidly to the brake-setting value before the switch C^3 can close to short-circuit the resistance 82. Resistance 82 also functions as a protective resistance to cut down the current in the winding B after the brake has operated.

At 102 and 103, I have shown emergency push button switches which may be disposed at any convenient readily accessible position. In case any emergency arises at which it may be desirable to instantly stop the movement of the press, either of these push buttons may be operated to break the circuit of the winding 66 of the switch BR which will have the emergency effect of setting the brake and releasing the clutch above described.

In cases where it is desired to continue the energization of the clutch substantially to the top of the full stroke, the cam 31 may be correspondingly timed to the movement of the press to open the switch M^4 at the top of the stroke. This will have the effect of de-energizing the winding 70 and 66 of the switches CR and BR substantially simultaneously and the brake may set before the clutch is released. In such instances, if desirable, a discharge resistance 104 may be connected across the terminals of the winding B through which the brake winding may slowly discharge when its circuit is broken at the switches B^1 and B^2 to delay the setting of the brake until the clutch has been fully de-energized.

If desired, the resistance 104 may have its circuit closed on a pair of contacts 105—106 disposed to be connected upon opening of the switch B^1 in a manner which will be understood from the arrangement of these contacts in the diagram.

Obviously, if the operators wish the press to repeat its cycle it is only necessary to maintain the push buttons 57 and 58 in closed position and as long as the circuit therethrough is maintained to energize the winding 62 of the switch GR, the press will continue to operate through its cycle.

On the other hand, however, it is impossible for the press to unexpectedly and therefore dangerously repeat its cycle as sometimes happens in control systems of the prior art due to an accidental ground of one or another of the circuit connections.

In this connection it will be observed that the winding 62 is opened at both sides thereof, and some of the push button switches are between the winding 62 and one side of the line and others between the other side of the winding 62 and the other line. In other words, the primary control switch GR is energized directly across the current supply mains 59 and 60 with control switches 57 and 58 between each side of the line and the winding 62. With this arrangement, there is no place where an accidental ground or short circuit can effect an energization of the winding 62; and thus in no case can the press cycle accidentally be repeated or initially started.

Again, it is important to note that a ground or short circuit which may occur in the general supply system of the plant in which such a press and control system are located, cannot effect the operation of the above described system local to the press with which it is utilized. So long as posi-

tive and negative mains are available at the press, it may be continued to operate without danger of accidental repeating. This will be true even if grounds local to the press system occur.

Any ground in the circuit or system local to the press which would affect the control of the switch GR or of any of the other elements of the system would have to be a ground occurring upon both sides of such element and this would be a short circuit on the system sufficient to blow a fuse situated at 110 or 111. These advantages result from energizing each of the electrical elements of the system directly across positive and negative mains local to the press system.

It is one of the advantages of the system of control and control apparatus embodying my invention that the well known "inching" operation may be performed in a highly improved and efficient manner. To perform the inching operation, the controller, Fig. 5, is moved to the "inch" position, opening the contacts 84—85 and the contacts 86—87 and connecting the contacts 88—89. The contacts 88—89 close a short circuit around all of the push button switches 57—57. Another circuit comprising a wire 112, an inching push button switch 92, and an optional knife switch 93 close a local circuit around the other set of push buttons 58—58. The control of the switch GR is now placed solely upon the inching push button switch 92 and each time this button is pressed, the switch GR will close; and when the button 92 is released, the switch GR will open. Thus intermittent periodic closure of the switch GR may be effected at will.

Upon each closure of the switch GR, the operation of the brake and clutch will be effected as described in the ordinary operation with the exception that when the press reaches the bottom of the stroke, although the switch M³ may close, the holding circuit for the switch BR is not established because the contacts 86—87 are open on the manual control of Fig. 5. Thus the inching control is maintained all the way down to the bottom of the stroke, through the bottom and all the way back up through the upward stroke.

At each inching movement, the brake is first fully released before the clutch is engaged. During all of the inching movements, the clutch winding C is energized through the adjustable resistance 83, the contacts 84—85 being open, so that the clutch does not seize or grip to transmit its full torque; but instead, the two elements of the clutch engage each other with a slipping engagement. By suitably adjusting the resistance 83 by the contact 186, any desired amount of slippage can be provided in the clutch for inching purposes; so that the press may be inched ahead very gradually and accurately for any of the usual purposes.

It may sometimes occur that after slipping the clutch during inching operation, or after the clutch has been used continuously in primary press operations, the clutch may become slightly worn and thus change the slipping inching effect. In such cases, the desired amount of slip can again be restored by suitably adjusting the contact 186 to change the amount of resistance 83.

In Fig. 1, I have illustrated the cams 31, 32, 33, and 34, as mounted directly upon the main shaft 6. As stated hereinbefore, this view is somewhat diagrammatic, and it will be understood that in actual practice, these cams may be upon a separate drum rotatably driven by a connection with the shaft of the press.

In the form of my invention illustrated in Figs. 6 and 7, the general nature of the control effected in the press thereby, is similar to that of the form of Fig. 4. The following differences may be noted.

The switch GR, besides the set of switch contacts GR¹, GR², and GR³, of the first form, has an additional set of contacts GR⁴ and these contacts, which are reproduced elsewhere by diagram, are in a circuit comprising a wire 200 connected in parallel across a normally open cam operated switch M⁵, which replaces the normally closed cam operated switch M⁴ of the first form.

The brake resistance 282 is in this form not short-circuited by the switch contacts C³, and these contacts therefore are omitted from the switch CR. The resistance 282, however, is adapted to be short-circuited by a pair of switch contacts 203 and 204, and connecting wires 201 and 202, the contacts being operated by a movable element at the brake mechanism itself, energized by the winding B.

Any suitable or known type of switch operable by a movement of an element of the brake may be provided for this purpose. In the diagrammatic showing of Fig. 6, such a means is illustrated, diagrammatically. The brake lever 205 is normally constrained by means of a spring 206 to hold a brake surface 207 in engagement with a brake drum 208 on the rotating part of the mechanism to be braked, and the movable contact 203 is carried on the end of the arm. Normally this contact engages the contact 204 to short-circuit the resistance 282. Upon energization of the brake winding B to release the brake, and preferably after full stroke movement of the brake, the contact 203 disengages the contact 204 and inserts the resistance 282 in the circuit of the brake winding B.

The brake is thus not only protected against overheating from the energization required to operate it, but its energization is reduced after operation so that it may quickly set when de-energized.

It is believed that it will be clearly understood without further description how a switch having a mode of operation just described may be associated with the brake of the general type illustrated in Fig. 1.

In the form of Fig. 6, also, a different arrangement is provided to effect the above described inching operation. Whereas in the first form, a pair of contacts 88—89 were provided on the manual controller, in a bridge across the series of push buttons 57—57, in this form an additional pair of contacts 288—289 are provided on the manual controller in a bridge across the other set of push buttons 58—58. A four point manually operable push button switch 210 is provided having a blade 211 adapted to engage and connect corresponding contacts 213 and 218 in series with the contacts 88—89 in the bridge across the buttons 57; and a blade 215 adapted to engage and connect a pair of contacts 217 and 214 in series with the contacts 288 and 289 and in the bridge across the buttons 58.

The switch blades 211 and 215 may be simultaneously operated by a button or lever 219. The pair of blades above described are connected by wires 220 and 221 to the winding 222 of a switch T having normally closed contacts T¹, which contacts are reproduced elsewhere in the system for the sake of clearness in connection with its operation, and which contacts are adapted to be opened by the elevation of a plunger 223 when

the winding 222 is energized. The contact T¹ comprises a bridging member 224 normally bridging contacts 225 and a stem 226 connected to the plunger 223. The stem is connected to the piston 227 of a dash-pot 228 whereby movement of the plunger 223 may be delayed after its energization, and by means of collar 229 on the stem 226 a time interval between the energization of the winding 222 and the opening of the contact may be provided.

The switch T may be of any known or suitable construction, and the time interval thereof may be provided otherwise than as diagrammatically illustrated, for example, thermally, electromagnetically, etc.; the dash-pot form diagrammatically illustrated may be provided as illustrated in Fig. 4 with an escapement means by which the time interval of its movement may be adjustably predetermined.

In the operation of my invention according to Figs. 6 and 7, with the controller of Fig. 7 in the "run" position and upon closing all of the push buttons 57 and 58 without exception, the switch GR will operate, and as described for the first form, current will flow to energize the switch BR and operate it to release the brake and to energize the switch CR to energize the clutch, as described for the first form.

The press begins to move downwardly and when the bottom of the stroke has been reached, the cam operated switches M¹, M², M³, and M⁵, all close, and the operators may release the buttons 57 and 58, and although the switch GR opens, opening the contacts GR¹, GR², GR³, and GR⁴, the brake and clutch remain energized, through the switch M³ bridged around the contact GR³, and through the switch M⁵ bridged around the contact GR⁴.

At or near the top of the stroke, preferably at about three-fourths of the upward stroke, the switch M⁵ opens, de-energizing the switch CR releasing the clutch; and at the top of the stroke the other cam operated switches open de-energizing the circuit and setting the brake to stop the press.

In this form, as in the other form, the cam operated switches may be set to operate at any desired point of the stroke. In some cases, particularly in the form of Fig. 6, I have found it desirable to operate the switches in M¹, M², and M⁵ at a point about three-fourths of the downward stroke of the press, because at this time the mechanism is usually in such condition and die elements so nearly closed that it is substantially impossible for an operator to get his hands or arms in a position for injury, and thus it is safe for him to take his hands from the push button switches. Again, I have found it desirable to close the switches M¹, M², and M⁵ a short time before closing the switch M³ to insure that the change of connection to the clutch is effected safely before the change of connection to the brake, but in many respects the advantages of my invention may be enjoyed irrespective of any particular setting of the cam operated switches.

When it is desired to effect the inching operation with the system of Fig. 6, the manual controller of Fig. 7 is moved to the inch position opening the contacts 84 and 85, and the contacts 86 and 87 for the purposes, and with the result described in connection with the other form. At each manual operation of the inching switch 210, all the push buttons 57 are short-circuited through the contacts 88—89, and the contacts 213 and 218, and all of the push buttons 58 are short-circuited through the contacts 289 and

288, and the contacts 217 and 214, thus the switch GR is energized and remains energized, however, only so long as the inching switch 210 remains in operative position. Thus the inching ahead operation described hereinbefore may be performed.

In some instances it is desirable that whenever the inching switch is operated, the press or machine will be inched ahead a predetermined amount and then stopped whether the inching switch 210 is restored to normal or not. This may be effected by the arrangement shown in Fig. 6. At each operation of the inching switch 210, to close the contacts thereof, the winding 222 of the electro-magnetic switch T is energized, the circuit being from, say, the positive main to contact 213 of the inching switch, then by wire 220 to the winding 222, by wire 221 to the contact 214, and thence to the negative. Energization of the winding 222 starts the upward movement of the stem 226 and after the predetermined time interval, provided as hereinbefore described, the contacts T¹ will be opened, de-energizing the switch GR and stopping the press. After each such successive inching operation, the inching switch 210 may be restored to its open contact position to de-energize the winding 222 and permit the plunger to fall and to close the contact T¹. Thereafter, upon again operating the inching switch 210 to close its contact, another predetermined inching operation may be performed.

It will be observed that by omitting the switch T an inching movement of any desired extent may be determined corresponding to the length of time that the contacts of the inching switch 210 are retained closed.

My invention is not limited to exact details of construction, nor to any particular design of apparatus indicated diagrammatically in the drawings; nor is it limited to the exact arrangement of the circuits of the apparatus of the system of connections illustrated and described. Many changes and modifications other than those hereinbefore set forth may be made within the scope and spirit of my invention, and without sacrificing its advantages.

I claim:—

1. In combination with a machine tool, a continuously operable source of power for operatively moving the machine, an electrically actuatable clutch device for coupling the machine and the source when electrically energized and for uncoupling it therefrom when de-energized, an electrically actuatable brake device adapted when electrically de-energized to stop operative movement of the machine, when uncoupled from the source and controlling means for energizing the clutch only after energization of the brake and for de-energizing the brake only after de-energizing of the clutch.

2. In combination with a machine tool, a source of power for operatively moving the machine, an electrically controlled clutch device for transmitting power from the source to the machine, an electric clutch-device-circuit, and electrically controlled brake device for stopping operative movement of the machine, an electric brake-device-circuit, an electrically actuatable delayed-operation switch controlling the clutch-device-circuit, and a brake-device-circuit controlling switch also controlling energization of the delayed-operation switch.

3. In combination with a machine tool, a source of power for operatively moving the machine, an electrically controlled clutch device for trans-

- mitting power from the source to the machine, an electric clutch-device-circuit, an electrically controlled brake device for stopping operative movement of the machine, an electric brake-device-circuit, a first switch operable to control energization of the brake-device-circuit to effect release of the brake, an electrically actuatable delayed-operation switch for controlling energization of the clutch-device-circuit to effect operative actuation of the clutch device, and movable contacts for controlling actuation of the electrically actuatable switch movable by operation of the first switch.
4. In an electric system and apparatus for controlling the electrically operable clutch and brake of a machine tool, a first electro-magnetic switch having contacts controlling energization of the clutch, a second electro-magnetic switch having contacts controlling energization of the brake and also controlling energization of the first electro-magnetic switch, a third electro-magnetic switch having contacts controlling energization of the second electro-magnetic switch, and a plurality of manually operable switches controlling energization of the third switch.
5. In an electric system and apparatus for controlling the electrically operable clutch and brake of a machine tool, a delayed-operation electro-magnetic switch having contacts controlling energization of the clutch, a second electro-magnetic switch having contacts controlling energization of the brake and also controlling energization of the delayed-operation electro-magnetic switch, a third electro-magnetic switch having contacts controlling energization of the second electro-magnetic switch, and a plurality of manually operable switches controlling energization of the third switch.
6. In an electric system and apparatus for controlling the electrically operable clutch and brake of a machine tool, a first electro-magnetic switch having contacts controlling energization of the clutch, a second electro-magnetic switch having contacts controlling energization of the brake and also controlling energization of the first electro-magnetic switch, a third electro-magnetic switch having contacts controlling energization of the second electro-magnetic switch, and a plurality of manually operable switches controlling energization of the third switch, connected in series with the winding of the third electro-magnetic switch across a pair of current supply mains.
7. In an electric system and apparatus for controlling the electrically operable clutch and brake of a machine tool, a first electro-magnetic switch having contacts controlling energization of the clutch, a second electro-magnetic switch having contacts controlling energization of the brake and also controlling energization of the first electro-magnetic switch, a third electro-magnetic switch having contacts controlling energization of the second electro-magnetic switch, and a first manually operable switch, a winding of the third electro-magnetic switch and a second manually operable switch all connected in series across a pair of current supply mains.
8. In an electric system and apparatus for controlling the electrically operable clutch and brake of a machine tool, a first electro-magnetic switch having contacts controlling energization of the clutch, a second electro-magnetic switch having contacts controlling energization of the brake and also controlling energization of the first electro-magnetic switch, a third electro-magnetic switch having contacts controlling energization of the second electro-magnetic switch, and a first plurality of manually operable switches, a winding of the third electro-magnetic switch and a second plurality of manually operable switches all connected in series across a pair of current supply mains.
9. In an electric system and apparatus a machine tool, a continuously operable source of power, an electrically operable clutch and brake for respectively coupling the tool to and uncoupling it from the source and for stopping the tool when uncoupled from the source, a pair of current supply mains, electrically energizable circuits for the brake and clutch, electrically operable means for controlling energization of both the said circuits to effect release of the brake before coupling by the clutch and release of the clutch before engagement of the brake, said electrically operable means comprising a winding and a plurality of manually operable switches between each main and the said winding and controlling energization of the winding.
10. In combination with a machine tool, a continuously operable source of power for operatively moving the machine, an electrically actuatable clutch device for coupling the machine to the source of power and uncoupling it therefrom, an electric clutch-device-circuit, an electrically actuatable brake device for stopping operative movement of the machine when uncoupled from the power source, an electric brake-device-circuit, operable control means controlling the clutch-device-circuit and brake-device-circuit to effect actuation of the clutch-device and brake device to effect releasing of the brake device before coupling actuation of the clutch device and to effect uncoupling actuation of the clutch device before setting of the brake.
11. In combination with a machine tool, a source of power for operatively cyclically moving the machine, an electrically controlled clutch device for transmitting power from the source to the machine, an electric clutch-device circuit, an electrically controlled brake device for stopping operative movement of the machine, an electric brake-device-circuit, and means operable by operative movement of the machine tool at a predetermined point in its cycle to control the said circuits and to effect an operation of the clutch and brake devices in the order named.
12. In combination with a machine tool, a source of power for operatively cyclically moving the machine, an electrically controlled clutch device for transmitting power from the source to the machine, an electric clutch-device-circuit, an electrically controlled brake device for stopping operative movement of the machine, an electric brake-device-circuit, and means operable by operative movement of the machine at a predetermined point in its cycle to control the said circuits to effect releasing of the clutch and setting of the brake in the order named.
13. In an electric system and apparatus for controlling a machine tool having an electrically operable clutch and brake, a source of power for operatively moving the machine in alternate directions, a clutch circuit and a brake circuit, an electrically actuatable device in the clutch circuit for controlling its energization, a switch in the brake circuit for controlling its energization, the brake controlling switch also controlling operation of the electrically actuatable device to effect operation of the brake to release the same prior to operation of the clutch to operatively move the tool in one direction, means operable by operative

movement of the machine in the other direction to effect releasing of the clutch and setting of the brake in the order named.

14. In an electric system and apparatus for controlling a machine tool having an electrically operable clutch and brake, a source of power for operatively moving the machine in alternate directions, a clutch circuit and a brake circuit, a source of current supply, a first electro-magnetic switch controlling the clutch circuit, a second electro-magnetic switch controlling the brake circuit and controlling energization of the first switch, to effect operative release of the brake prior to operative engagement of the clutch, a third electro-magnetic switch controlling energization of the current supply to the clutch and brake and first and second switches, manual means for controlling operation of the third switch, means operable by movement of the machine adjacent the end of its movement in one direction to maintain control of the current supply to the clutch and brake and first and second switches independently of the third switch, and means operable by movement of the machine in the other direction to control energization of the first and second switches to effect a release operation of the clutch and a setting operation of the brake in the order named to interrupt the current supply.

15. In a control system and apparatus for machine tools having an electric brake and an electric power transmitting clutch, a brake circuit and a clutch circuit, a first switch operable to effect control of the clutch circuit to effect power transmitting engagement and disengagement of the clutch, a second switch operable to effect control of the brake circuit to correspondingly effect releasing and setting of the brake, a resistance associated with the brake circuit, a circuit associated with the resistance and controlled by the first switch to render the resistance effective to change the energization of the brake to accelerate the setting of the brake upon brake-setting operation of the second switch.

16. In a control system and apparatus for machine tools having an electric brake and an electric power transmitting clutch, a brake circuit and a clutch circuit, a first switch operable to effect closing and opening of the clutch circuit to effect engagement and disengagement of the clutch, a second switch operable to effect closing and opening of the brake circuit to effect releasing and setting of the brake, a resistance in the brake circuit, a shunt circuit around the resistance adapted to be opened by operation of the first switch effecting energization of the clutch to weaken the brake energization to accelerate setting movement of the brake upon brake-setting operation of the second switch.

17. In an electric control system and apparatus for machine tools, comprising a power source, an electric clutch for transmitting power from the source to the machine to drive it, a clutch energizing circuit, a switch controlling the circuit, a resistance associated with the clutch circuit, a circuit including switch contacts operable to optionally render the resistance effective or ineffective to adjustably optionally change the energization of the clutch, whereby the clutch may optionally be energized to transmit the full power of the source or to transmit a portion of the power to effect an "inching" movement of the machine.

18. In an electric control system and apparatus for machine tools, comprising a power source, an

electric clutch for transmitting power from the source to the machine to drive it, a clutch energizing circuit, a switch for controlling the circuit, a resistance in the circuit, a circuit around the resistance including switch contacts, whereby on closing or opening the contacts respectively the clutch may be energized sufficiently to transmit the full power of the source and upon opening the contacts the energization may be reduced a predetermined amount to effect an "inching" movement of the machine, and means to adjust the ohmic value of the resistance to adjust the inching effect and to compensate for clutch wear.

19. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch for transmitting power from the source to the machine to drive it, an electric brake for stopping the machine, a source of electric current and circuits for the clutch and brake connected to the source, manually controlled means for effecting energization of the brake and clutch circuit to effect movement of the machine, and automatic means for maintaining said energization for a predetermined time interval only to effect an inching operation of the machine.

20. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch for transmitting power from the source to the machine to drive it, an electric brake for stopping the machine, a source of electric current, circuits for the clutch and brake connected to the source, an electrically actuated switch controlling energization of the clutch and brake circuit to effect disengagement of the brake and engagement of the clutch, an energizing circuit for the electrically actuated switch, manual means for controlling the energization thereof, and automatic means for maintaining the energization thereof to effect engagement of the clutch and disengagement of the brake for a predetermined time interval only to effect an inching operation of the machine.

21. In an electric control system and apparatus, in combination with a continuously operable power source and a machine operable cyclically thereby, an electrically actuatable engageable and disengageable clutch for coupling the machine to and uncoupling it from the power source, an electrically actuatable engageable and disengageable brake for stopping the machine when uncoupled from the source, an electrically actuatable controller for effecting energization of the brake and clutch, the controller comprising, in combination with a pair of current supply mains, an electric switch having a winding and a manually operable switch between each main and the winding controlling energization of the winding, and a controller operable by movement of the machine at a predetermined point in its cycle for de-energizing the clutch and brake.

22. In an electric control system and apparatus, in combination with a continuously operable power source and a machine operable cyclically thereby, an electrically actuatable engageable and disengageable clutch for coupling the machine to and uncoupling it from the power source, an electrically actuatable engageable and disengageable brake for stopping the machine when uncoupled from the source, an electrically actuatable controller for effecting energization of the brake and clutch, the controller comprising, in combination with a pair of current supply mains, an electric switch having a winding and a manually operable switch between each main and

the winding controlling energization of the winding, and a controller operable by movement of the machine at a predetermined point in its cycle for de-energizing the clutch and brake, the electrically actuable controller effecting disengagement of the brake before engagement of the clutch and the machine operated controller effecting disengagement of the clutch before engagement of the brake.

23. In an electric system and apparatus in combination with a machine tool and a power source therefor, an electrically operable clutch and brake for respectively engaging to couple the tool to the power source and disengaging to release the tool, a pair of current supply mains, electrically operable means including circuit means for the brake and clutch for controlling energization of the brake and clutch to effect disengagement of the brake before engagement of the clutch, said electrically operable means comprising a winding, and a manually operable switch between each said main and the said winding and controlling energization of the winding.

24. In combination with a machine tool, a source of power for operatively cyclically moving the machine, an electrically controlled clutch device for transmitting power from the source to the machine, a mechanically set electrically releasable brake device for stopping operative movement of the machine, a source of current, controller means including circuit means for the brake and clutch, and means for rendering the controller means operable by operative movement of the machine at a predetermined point in its cycle, to control the brake and clutch to effect releasing of the clutch and setting of the brake in the order named.

25. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means, to cause release of the brake and subsequent engagement of the clutch to start the machine, a plurality of manually operable switch devices jointly controlling said operation of the controller means, and means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to set the brake and disengage the clutch to stop the machine.

26. In an electric control system and apparatus for machine tools of the reciprocatory type comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means to cause release of the brake and subsequent engagement of the clutch to start the machine in one reciprocatory direction, a plurality of manually operable switch devices all connected in series and jointly controlling said operation of the controller means, means for rendering the controller means operable by movement of the

machine in the return direction after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to set the brake and disengage the clutch to stop the machine.

27. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means, to cause release of the brake and subsequent engagement of the clutch to start the machine, a plurality of manually operable switch devices jointly controlling said operation of the controller means, and means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to cause release of the clutch and subsequent setting of the brake to stop the machine.

28. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means, to cause release of the brake and subsequent engagement of the clutch to start the machine, a plurality of manually operable switch devices jointly controlling said operation of the controller means, and means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to set the brake and disengage the clutch to stop the machine, and a switch operable by an operator of the machine in emergency to effect simultaneous deenergization of the clutch to release it and deenergization of the brake to set it to stop the machine.

29. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means including a delayed operation switch having contacts controlling the clutch circuit means, means for causing contact operating response of the delayed operation switch to be delayed until after a time interval following energization of the brake whereby the brake may be energized to effect release thereof prior to release of the clutch to start the machine, and manually operable switch means controlling actuation of the said controller means.

30. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when en-

energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means including a delayed operation switch having contacts controlling the clutch circuit means, means for causing contact operating response of the delayed operation switch to be delayed until after a time interval following energization of the brake whereby the brake may be energized to effect release thereof prior to release of the clutch to start the machine, manually operable switch means controlling actuation of the said controller means, and means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof for deenergizing the brake and clutch to set the brake and disengage the clutch to stop the machine.

31. An electric control system and apparatus as described in claim 30 and in which the machine operable controller means for stopping the machine effects disengagement of the clutch before setting of the brake.

32. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means to cause release of the brake and subsequent engagement of the clutch to start the machine, a plurality of manually operable switch devices jointly controlling said operation of the controller means, means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to set the brake and disengage the clutch to stop the machine, and means operable by the electromagnetically actuable controller means to reduce the energization of the brake after release thereof.

33. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch which when energized engages and transmits power from the source to the machine to drive it, an electric brake which when deenergized sets and stops the machine and when energized releases, electric circuit means for energizing the clutch and brake, an electromagnetically actuable controller means operable to effect energization of the clutch and brake circuit means to cause release of the brake and subsequent engagement of the clutch to start the machine, a plurality of manually operable switch devices jointly controlling said operation of the controller means, means for rendering the controller means operable by movement of the machine after a predetermined extent of movement thereof, for effecting deenergization of the brake and clutch to set the brake and disengage the clutch to stop the machine, and means operable by the brake energizing current to reduce the energization of the brake after release thereof.

34. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engageable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engageable to stop the machine and releasable when energized, an electromagnetically actuable controller means for energizing the brake and clutch

to start the machine, a manually operable switch for controlling the controller means, the controller means comprising a delayed operation switch for effecting deenergization of the clutch and brake to stop the machine after a predetermined time interval to effect an inching movement of the machine.

35. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engageable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engageable to stop the machine and releasable when energized, an electromagnetically actuable controller means for energizing the brake and clutch to start the machine, a manually operable switch for controlling the controller means, the controller means comprising a delayed operation switch for effecting deenergization of the clutch and brake to stop the machine after a predetermined time interval to effect an inching movement of the machine and means to prevent further energization of the clutch and brake to move the machine, until after the manually operable switch is restored.

36. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engageable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engageable to stop the machine and releasable when energized, an electromagnetically actuable controller means for energizing the brake and clutch to start the machine, a manually operable switch for controlling the controller means, the controller means comprising a delayed operation switch for effecting deenergization of the clutch and brake to stop the machine after a predetermined time interval to effect an inching movement of the machine and means to maintain the delayed operation switch in operated condition to prevent further energization of the clutch and brake to move the machine until after the manually operable switch is restored to unoperated condition.

37. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engageable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engageable to stop the machine and releasable when energized, an electromagnetically actuable controller means for energizing the brake and clutch to start the machine, a manually operable switch for controlling the controller means, the controller means comprising a delayed operation switch for effecting deenergization of the clutch and brake to stop the machine after a predetermined time interval to effect an inching movement of the machine and an adjustable resistance for controlling energization of the clutch for inching operations.

38. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engageable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engageable to stop the machine and releasable when energized, a manually operable switch and means actuable by an operation thereof for effecting energization of the clutch and brake to start the machine moving and means actuated by the said operation of the manually operable switch for effecting deenergization of the clutch

and brake after a predetermined inching movement of the machine.

39. An electric control system and apparatus as described in claim 38 and in which an adjustable resistance is provided for controlling energization of the clutch for inching operations.

40. In an electric control system and apparatus for machine tools comprising a power source, an electric clutch engagable when energized for transmitting power from the source to the machine to drive it, an electric brake normally engagable to stop the machine and releasable when energized, a manually operable switch and means actuable by an operation thereof for effecting energization of the clutch and brake to start the machine moving and means including a delayed operation switch having a predetermined time interval of operation actuated by the said operation of the manually operable switch for effecting deenergization of the clutch and brake after a predetermined inching movement of the machine.

41. An electric system and apparatus as described in claim 38 and in which means is provided for adjustably varying the clutch energization to vary the extent of the inching movement.

42. An electric system and apparatus as described in claim 40 and in which means is provided for adjustably varying the clutch energization to vary the extent of the inching movement.

43. In an electric system and apparatus for controlling the electrically engageable clutch and electrically releasable brake of a machine tool, an electromagnetically actuable controller for effecting energization of the brake and clutch to start the machine, switch means for effecting actuation of the controller, the controller when actuated effecting release of the brake prior to engagement of the clutch and effecting a decrease of energization of the brake after release thereof.

44. In an electric system and apparatus for

controlling the electrically engageable clutch and electrically releasable brake of a machine tool, an electromagnetically actuable controller for effecting energization of the brake and clutch to start the machine, switch means for effecting actuation of the controller, the controller when actuated effecting release of the brake prior to engagement of the clutch and effecting a decrease of energization of the brake after initial energization thereof.

45. In combination with a machine tool, a source of power for operatively moving the machine, an electrically energizable clutch device for transmitting power from the source to the machine, an electrically energizable brake device for stopping operative movement of the machine, an electrically actuable delayed operation switch having contacts controlling the energization of the clutch device, means for causing contact operating response of the delayed operation switch to be delayed after initial energization thereof, and a brake device energization controlling switch also controlling energization of the delayed operation switch.

46. In combination with a machine tool, a source of power for operatively cyclically moving the machine, an electrically controlled clutch device for transmitting power from the source to the machine, a mechanically set electrically releasable brake device for stopping movement of the machine, a source of current, controller means operable by an operator of the machine, and circuit means for the brake and clutch, whereby upon operation of the controller means the brake and clutch may be controlled to effect disengagement of the brake before engagement of the clutch, and means rendering the controller means operable by movement of the machine at a predetermined point in its cycle, to control the brake and clutch to effect engagement of the brake and release of the clutch.

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