May 31, 1949. J. B. WINTHER 2,471,505

PUNCH PRESS

Filed Jan. 4, 1947 4 Sheets-Sheet 1

FIG. 1.

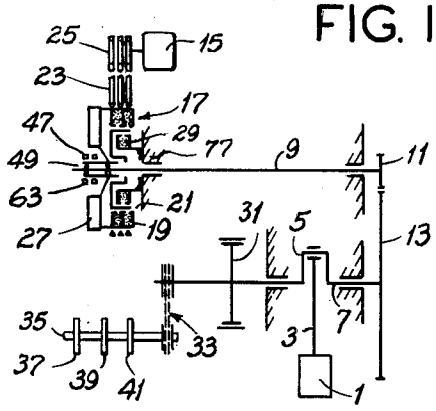


FIG. 4.

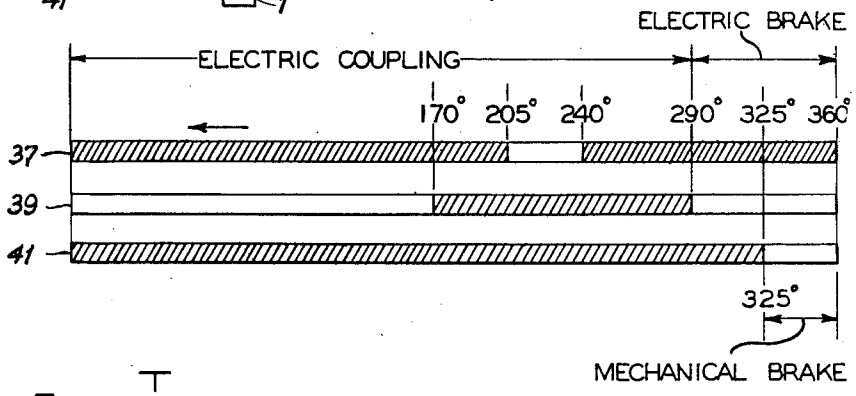
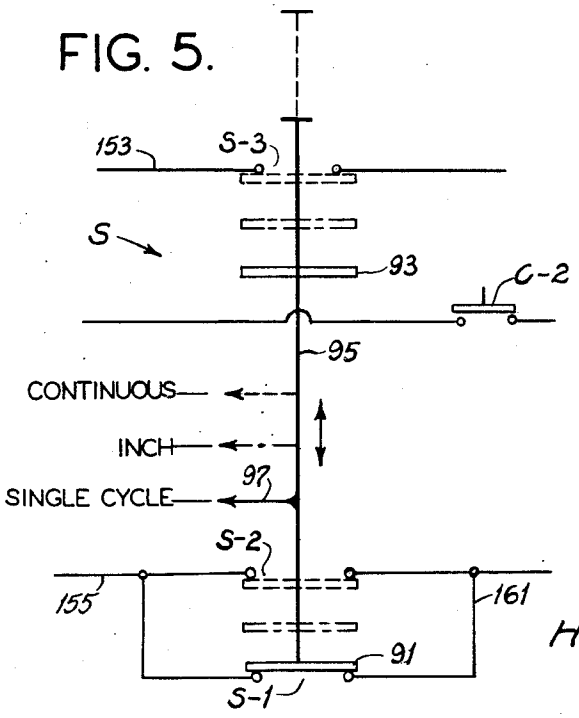


FIG. 5.



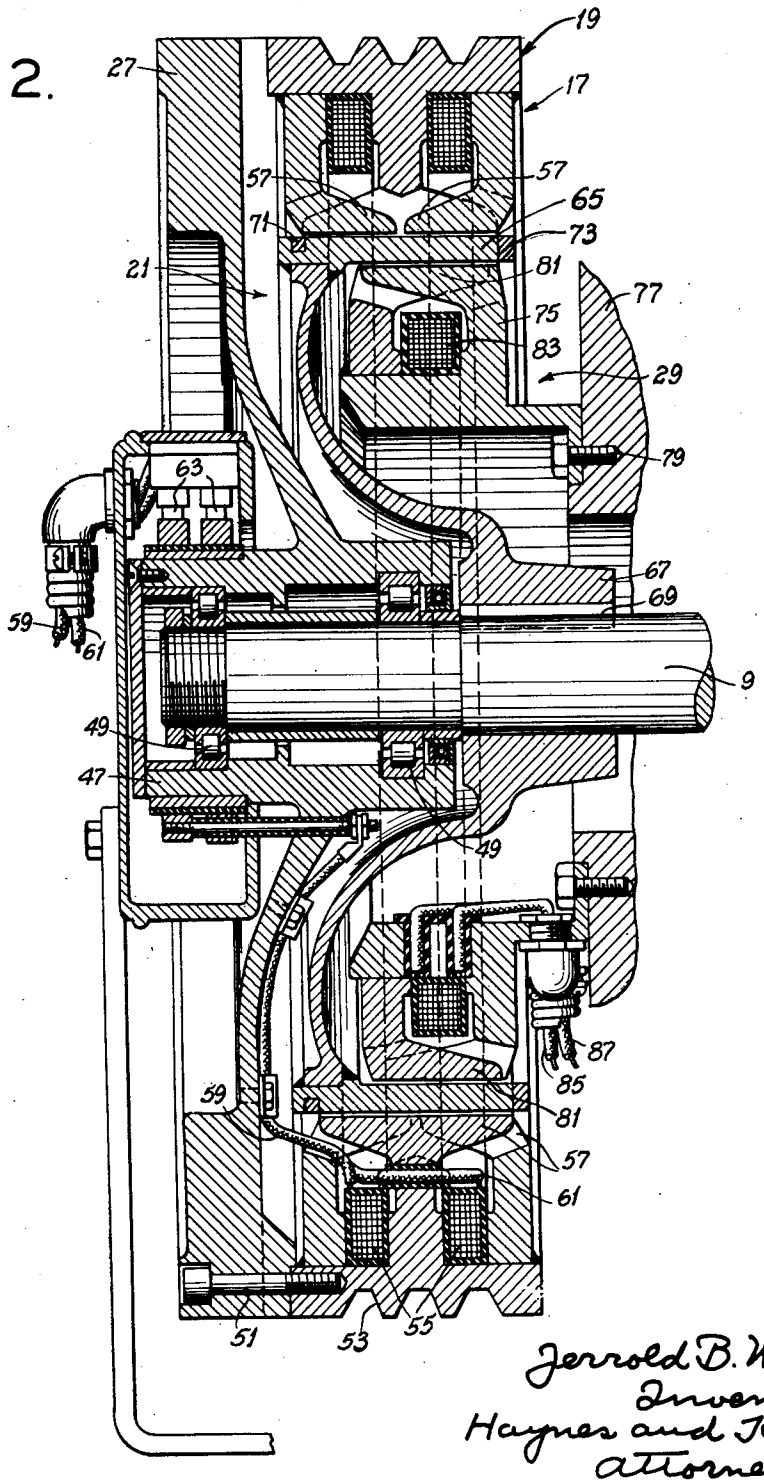
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FIG. 2.



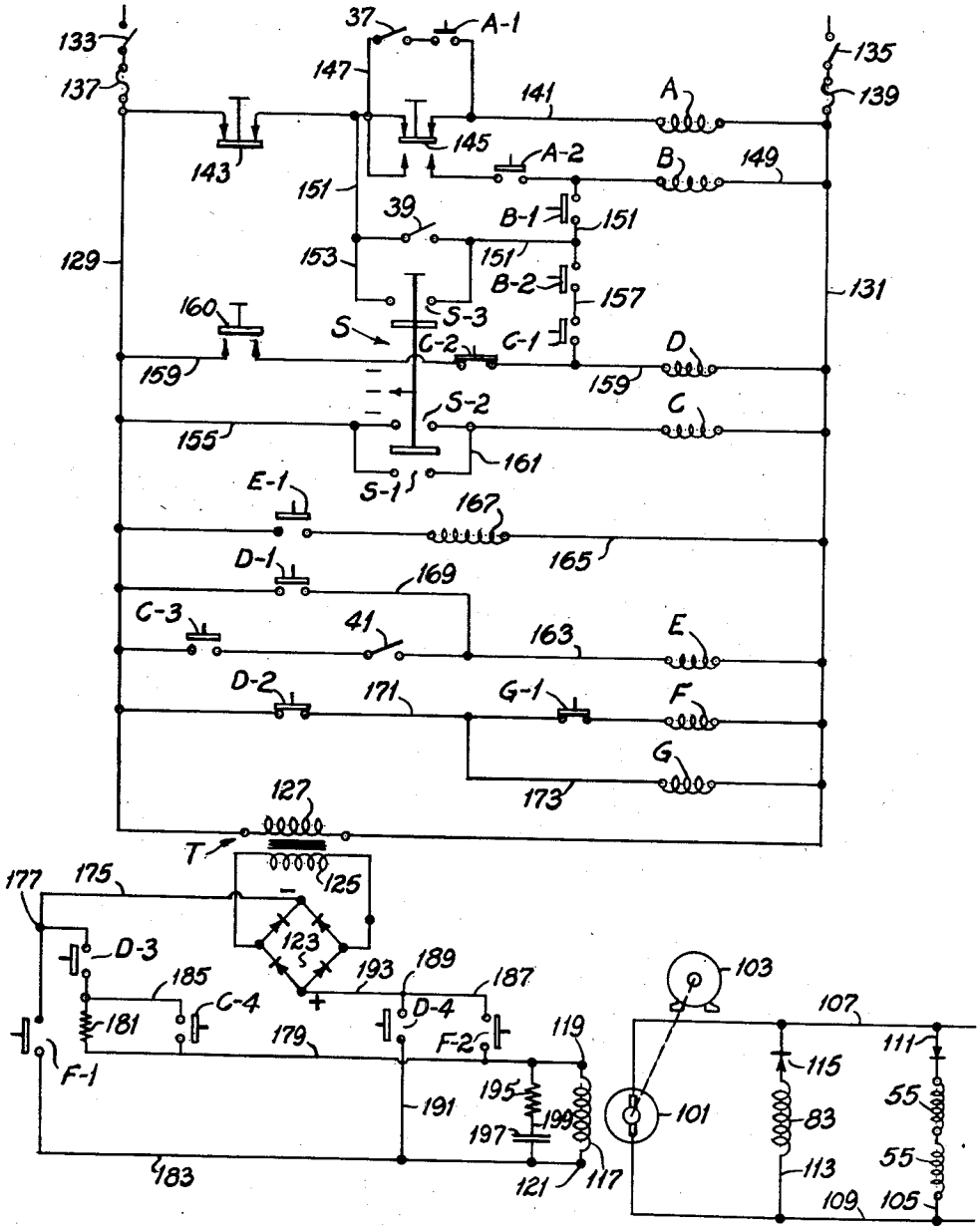
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FIG. 3.



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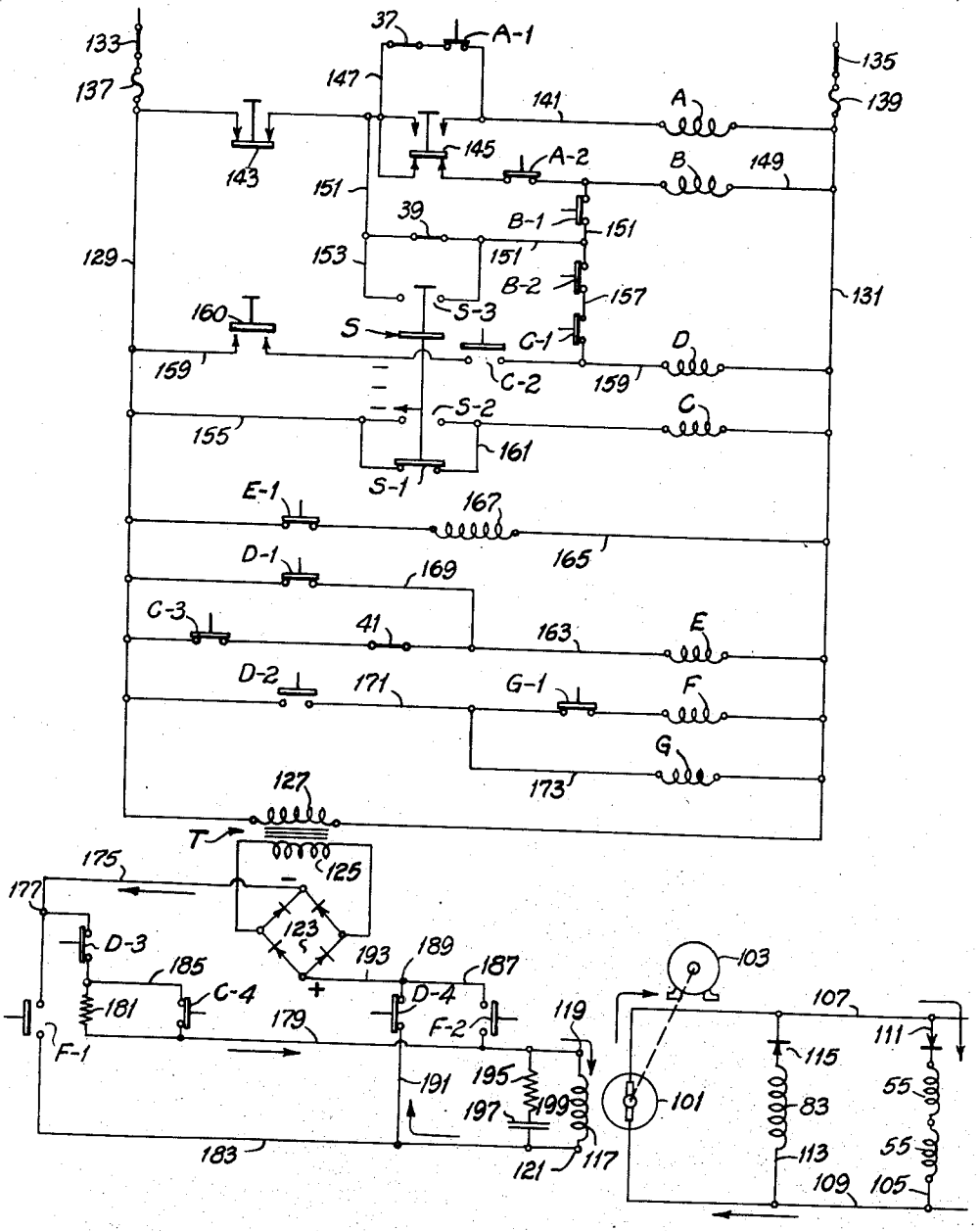
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FIG. 6.



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UNITED STATES PATENT OFFICE

2,471,505

PUNCH PRESS

Jerrold B. Winther, Kenosha, Wis., assignor to Martin P. Winther, as trustee

Application January 4, 1947, Serial No. 720,256

5 Claims. (Cl. 172—284)

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This invention relates to presses, and more particularly to punch presses for punching or forming operations.

Among the several objects of the invention may be noted the provision of an improved, electrically-controlled press, such as a punch press or the like; the provision of a press of this class wherein heavy-current contacts are eliminated from inductive circuits of the electrical control to eliminate arcing across and failure of contacts due to inductive kick; the provision of a press of the class described which may readily be selectively operated to run through one full-stroke operating cycle and stop, or to run continuously, or to inch in either direction; and the provision of such a press which is inexpensive to operate and maintain. Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

Fig. 1 is a simplified, diagrammatic skeleton layout of the press of the invention;

Fig. 2 is an enlarged detail longitudinal section through a flywheel, slip coupling and brake assembly, shown diagrammatically in Fig. 1;

Fig. 3 is an electrical circuit diagram with switches set in neutral positions;

Fig. 4 is a developed diagrammatic view of a group of cam-operated switches associated with the press;

Fig. 5 is an enlarged view of a portion of the electrical circuit, illustrating a master selector switch; and

Fig. 6 is a diagram like Fig. 3, except that the switches are set for the 170° position during single-cycle operation.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

This invention is an improvement upon the press disclosed in the copending and coassigned application of Martin P. Winther for Press, Serial No. 704 552, filed October 21, 1946. That application discloses a press, the drive for which includes an inductive eddy-current slip coupling and an inductive eddy-current brake. The inductive field coils of the coupling and brake are in a rectifier circuit which supplies current thereto under

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the immediate control of relays, the contacts of which are directly in the field coil circuits. As these relays open, inductive current kick tends to cause arcing across their contacts. Such arcing tends to reduce the life of such contacts. The protection for the contacts illustrated in said copending application is effective to a certain extent, but this invention has for its purpose the provision of a press of the type disclosed in said copending application embodying an improved circuit for energizing the field coils of the coupling and brake wherein there are no relay contacts subject to failure due to inductive kick. It thus reduces maintenance troubles from such a source.

Referring now more particularly to Fig. 1, there is shown at 1 the slide or ram of a press, which may be a punch press for punching or forming metal or the like. The ram is linked by a connecting rod 3 to the crank or eccentric 5 of a crankshaft or ram shaft 7. The crankshaft is driven from a drive shaft 9 through speed-reducing gears 11 and 13. The drive shaft 9 is driven by a motor 15 through an electromagnetic eddy-current slip coupling 17. This coupling includes a driving field rotor 19 and a driven inductor member 21. The field rotor is formed as a pulley and is driven by V-belts 23 from a pulley 25 on the shaft of motor 15. The field rotor is mounted upon a flywheel 27, which is rotary on the end of drive shaft 9. The inductor member 21 is adapted to be decelerated electromagnetically by a stationary braking field member 29. This brakes the drive and crankshafts. The crankshaft is also under the control of a mechanical brake 31 and is coupled by a 1:1 ratio chain and sprocket drive 33 to the camshaft 35 of a group of cam-operated switches 37, 39 and 41, the function of which will be described subsequently.

Details of the flywheel, electromagnetic clutch and electromagnetic brake assemblies are shown in Fig. 2. As illustrated, flywheel 27 has a hub 47 journalled by roller bearings 49 on the end of the drive shaft. The field rotor 19 includes a hollow ring-like structure secured to the flywheel by screws 51 and formed with peripheral grooves 53 to receive the belts 23. Within the hollow ring-like structure are two annular field coils 55. The ring structure is formed internally with a series of peripherally spaced and axially lapped magnetic pole teeth 57, which are broadly similar to those described in U. S. Patent 2,367,636, dated January 16, 1945. The field coils are energized from wires 59 and 61 through slip-ring connections 63. When energized, the coils induce mag-

netic poles in the pole teeth 57 of the field rotor. These poles extend radially inward.

The inductor member 21 comprises a smooth, magnetic, eddy-current inductor ring 65 fixed on a hub 67 which is keyed to the drive shaft 9, as indicated at 69. Two copper end rings 71 and 73 are attached to the ring 65 to reduce the resistance to flow of eddy currents therein, in the manner described in coassigned, copending application of Martin P. and Anthony Winther, Serial No. 684,112, filed July 17, 1946, for Electromagnetic coupling. When the field coils 55 of rotor 19 are energized and the rotor driven by motor 15, the inductor member 65 has eddy currents engendered therein and is driven by magnetic reaction. This rotates drive shaft 9. The degree of coupling is a function of the excitation of coils 55.

The braking field member 29 comprises a hollow ring structure 75 secured by screws 79 to the press frame 77. This ring structure, disposed within the inductor ring 65, is formed with alternate oppositely directed pole teeth 81 similar to teeth 57 above mentioned, except that they extend outward towards the inside of the inductor 65. An annular field coil 83 disposed in the hollow ring structure is adapted to be energized by wires 85 and 87. When energized, coil 83 induces magnetic poles in pole teeth 81 to brake the inductively related inductor member 21 by magnetic reaction, according to the excitation of coil 83.

It will be clear from the above description that when the motor 15 is energized to drive the field rotor 19 and flywheel 27, and the coils 55 are energized, the drive shaft 9 will be driven through the slip coupling and will drive crankshaft 7 to reciprocate the ram. When coils 55 are deenergized, and the coil 83 of the braking field is energized, the drive shaft will be braked to stop rotation of the crankshaft and hence to stop the ram.

The invention includes means whereby the operator may readily selectively control the press, through control of the motor 15, the electromagnetic clutch and brake and the mechanical brake 31, to run through one full stroke or cycle of the ram (one revolution of crankshaft 7) and then automatically stop, or to cycle continuously without stopping between cycles, or to "inch," which means to creep by small increments through any portion of a cycle in either direction. This selective control is effected by means of a master selector switch S (Figs. 3 and 5).

The switch S includes three pairs of contacts S—1, S—2 and S—3 and two contactor bars 91 and 93 on a push-pull rod 95. Contactor bar 91 is cooperable either with contacts S—1 or S—2. Contactor bar 93 is cooperable with contacts S—3. In one end position of rod 95, bar 91 bridges contacts S—1. This conditions the press for operation through one full-stroke cycle and then to stop. This position is indicated in full lines in Fig. 5 and by the pointer 97 on rod 95 being aligned with an index mark designated "Single cycle." In the other end position of rod 95, bar 91 bridges contacts S—2 and bar 93 bridges contacts S—3. This conditions the press to operate continuously without stopping between cycles. This position is indicated in dotted lines in Fig. 5 and by the pointer 97 being aligned with an index mark designated "Continuous." In an intermediate position of rod 95, contacts S—1, S—2 and S—3 are open. This conditions the press for inching at slow speed through any part of a cycle. This position is indicated in Fig. 3 and in dot-dash lines in Fig. 5 and by the pointer 97 being aligned with an index mark designated "Inch." The manner in which such control is effected will be developed below.

Motor 15 is reversible and is energized for driving drive shaft 9 in one direction or the other by any suitable control circuit, for example, the motor control circuit illustrated in the aforesaid copending application Serial No. 704,552.

The field coils 55 and 83 of the field rotor 19 and braking field member 29, respectively, are adapted selectively to be energized by means of direct current supplied thereto by a direct current reversible pole generator 101 driven at constant speed by an induction motor 103 or any other suitable prime mover (Fig. 3). Coils 55 are connected in a line 105 across the output leads 107 and 109 of the generator. It will be understood that line 105 includes the aforesaid wires 59 and 61 (Fig. 2). This line also includes an electric valve 111, such as a copper oxide rectifier or the like, which permits current to flow in line 105 and coils 55 only when output lead 107 is at a higher potential than lead 109. Coil 83 is connected in a line 113 across leads 107 and 109, this line including an electric valve 115 which permits current to flow in line 113 and coil 83 only when output lead 109 is at a higher potential than lead 107. It will be understood that line 113 includes the aforesaid wires 85 and 87 (Fig. 2).

The generator 101 is excited by a separate field 117. This field is in a circuit embodying controls for supplying rectified current to flow through the field in one direction or the other so as to reverse the polarity of the generator. The arrangement is such that upon flow of current from field terminal 119 through field 117 to its other terminal 121, the polarity of generator 101 is such that current flows from lead 107 to lead 109 in line 105 including coils 55 through valve 111. Line 113 including coil 83, however, is blocked by valve 115, and coil 83 is deenergized. Upon reverse flow of current in the generator field 117 (from field terminal 121 through 117 to terminal 119), the polarity of the generator is reversed, and current flows from lead 109 to lead 107 in line 113 including coil 83 through valve 115. Under these conditions, line 105 including coils 55 is blocked by valve 111, and coils 55 are deenergized.

Direct current for the supply of generator field 117 is derived from a bridge rectifier 123, the input of which is fed by the secondary 125 of a transformer T. The primary 127 of this transformer is connected across power leads 129 and 131 of a two-wire single phase alternating current system. The power supply is under the control of switches 133 and 135 and fuses 137 and 139 in these leads. Power leads 129 and 131 are also adapted to energize a plurality of relay coils A, B, C, D, E, F and G, each of which controls certain contacts associated therewith in a manner to be described. It is to be understood the D. C. source for the generator field 117 need not be a rectifier but may assume other forms such as a D. C. exciter or battery.

Relay coil A is connected across leads 129 and 131 in a line 141 including a normally closed push button stop switch 143 and the upper contacts of a double-pole push button control switch 145. The switch 145 is biased so that its upper contacts in line 141 normally are closed. Coil A when energized closes contacts A—1 and A—2. Contacts A—1 are in a line 147 shunted around the upper contacts of switch 145 including cam-operated

switch 37. When coil A is energized, contacts A—1 are closed and this shunt functions as a holding circuit for coil A as long as cam-operated switch 37 is closed, whereby switch 145 may be operated without deenergizing coil A.

Relay coil B is connected in parallel with coil A in a line 149 including the lower contacts of control switch 145 and contacts A—2 and in series with switch 143. This coil B when energized closes contacts B—1 and B—2. Contact B—1 is in a line 151 shunted around the lower contacts of control switch 145 and contacts A—2. This line also includes the cam-operated switch 39. A line 153 shunted around switch 39 includes contacts S—3 of the master selector switch S.

Relay coil C is connected in a line 155 across power leads 129 and 131 including contacts S—2 of the master selector switch. This coil when energized closes normally open contacts C—1, C—3 and C—4, and opens normally closed contacts C—2, all of which are associated with the coil C for group operation. Contacts C—4 are in the rectifier circuit for supplying direct current to generator field 117, as will be described. Contacts C—1 are in a line 157 connecting line 151 and a line 159. Line 157 also includes contacts B—2 operated by relay coil B. Line 159 is connected across power leads 129 and 131 and includes a normally open push button inching control switch 160, contacts C—2, and relay coil D. A line 161 shunted around contacts S—2 includes contacts S—1 of the master selector switch S.

Relay coil D when energized closes normally open contacts D—1, D—3 and D—4 and opens normally closed contacts D—2, all associated therewith for group operation. Contacts D—3 and D—4 are in the generator field circuit, as will be made clear.

Relay coil E is connected in a line 163 across power leads 129 and 131 including contacts C—3 and cam-operated switch 41. This coil when energized closes contacts E—1 in a line 165 connected across power leads 129 and 131 and including a solenoid coil 167. This solenoid coil is a control solenoid for the mechanical brake 31. When the solenoid is energized, the brake is released. The linkage through which the solenoid releases the brake is not shown, being of any suitable conventional form. A line 169 shunted around contacts C—3 and cam-operated switch 41 includes contacts D—1 operated by relay coil D.

Relay coil F is connected in a line 171 connected across power leads 129 and 131 and includes normally closed contacts D—2 and normally closed contacts G—1 operated by a time-delay relay coil G. This coil G is connected in a line 173 shunted around contacts G—1 and coil F and when energized opens contacts G—1 after a predetermined time interval for a purpose to be described. Coil F when energized closes contacts F—1 and F—2 in the generator field rectifier circuit.

The generator field rectifier circuit includes a supply line 175 connecting the negative output terminal of bridge rectifier 123 and a terminal 177. From terminal 177 a supply line 179 including contacts D—3 and a resistor 181 connects to generator field terminal 119. Also, from terminal 177 a line 183 including contacts F—1 connects to generator field terminal 121. Contacts C—4 are in a shunt 185 around resistor 181. A line 187 including contacts F—2 connects line 179 and a terminal 189. A line 191 including contacts D—4 connects line 183 and terminal 189. A line 193 connects terminal 189 to the positive output terminal of the bridge rectifier. A protecting resistance 195 and condenser 197 are connected in a line 199 in parallel with generator field 117.

As illustrated in the development of Fig. 4, the cams for the cam-operated switches are so designed and phased as to maintain switch 37 closed for the first 205° of the cycle of the crankshaft 7 and the press ram, to reopen this switch over the portion of the cycle between 205° and 240°, and to reclose this switch over the remainder of the cycle (240°–360°). The cam for switch 39 opens this switch for the first 170° of the cycle, recloses it from 170° to 290°, and reopens it from 290° to 360°. The cam for switch 41 closes the switch for 325° of the cycle, and reopens it during the remainder.

Operation is as follows:

Assuming that motor 15 and belts 23 are driving the field rotor 19 and that motor 103 is driving the generator 101, switches 133 and 135 are closed to supply power to the A. C. power leads 129 and 131 (Figs. 3 and 6). To operate the press for a single cycle (one reciprocation of the press ram and return), the master selector switch is set in the "single cycle" position wherein contacts S—1 are closed. This completes a circuit through line 155, shunting open contacts S—2 through line 161, and energizes relay coil C. Energization of coil C closes associated contacts C—1, C—3 and C—4, and opens normally closed contacts C—2.

At the start of a cycle, cam-operated switches 37 and 41 are closed and cam-operated switch 39 is open (Fig. 4). Later at 170° of operation switch 39 closes and this latter condition is shown in Fig. 6. Referring again to the beginning of the cycle at 0°, stop switch 143 and the upper contacts of control switch 145 are closed and a circuit through line 141 including coil A is completed. It will be understood that Fig. 6 shows a later condition at 170° so far as switch 145 is concerned. Energization of coil A closes contacts A—1 and A—2. With switch 37 and contacts A—1 closed, a holding circuit shunted around the upper contacts of switch 145 is completed through line 147 to maintain coil A energized when switch 145 is operated.

With contacts C—3 and cam-operated switch 41 closed as stated, a circuit is completed through line 163 and coil E. Energization of coil E closes contacts E—1 in line 165 and completes a circuit through solenoid coil 167. This coil thereupon releases the mechanical brake 31 to permit crankshaft 7 to rotate.

To start the cycling of the press, the operator presses in on control switch 145 to close its lower contacts. This completes a circuit through line 149 and coil B, the lower contacts of switch 145 and contacts A—2 in this line being closed. Coil A remains energized through the holding circuit 147. Energization of coil B closes associated contacts B—1 and B—2. Contacts C—1 are already closed, as previously described. A circuit through relay coil D is thereupon completed from power lead 129, through part of line 141, part of line 149, line 151, line 157 and line 159 (including coil D) to the other power lead 131. Energization of coil D closes contacts D—1, D—3 and D—4, opens normally closed contacts D—2. Closure of contacts D—1 establishes a holding circuit through line 169 around contacts C—3 and cam-operated switch 41. Opening of contacts D—2 breaks the circuit through line 171 including coil F. The resultant deenergization of coil F opens contacts F—1 and F—2 in the generator field rectifier circuit. Of course when

there is a delay in actuating the switch 145 after energization of power leads 129 and 131, the time-delay relay G operates to open switch G—1 and deenergizes coil F. Closure of contacts D—3 completes a supply circuit from the negative output terminal of the bridge rectifier to the generator field terminal 119 through line 175 to terminal 177, and line 179, with resistor 181 shunted out by line 185 including presently closed contacts C—4. Closure of contacts D—4 completes a return circuit from generator field terminal 121 through a portion of line 183, line 191 including closed contacts D—4, terminal 189 and line 193 to the positive output terminal of the bridge rectifier. Rectified current from bridge rectifier 123 thereupon flows from terminal 119 through generator field 117 to terminal 121.

Generator field 117 thereupon excites the generator so that it generates direct current with its polarity such that line 107 is at a higher potential than line 109. Current thereupon flows through valve 111 and the coupling field coils 55. Current flow through braking field coil 83 is blocked by valve 115 and the braking field member 29 is deenergized.

With the coils 55 of field rotor 19 energized as above described, the press is driven from the motor 15 and flywheel 27 through the slip coupling to perform the punching, forming or like operation. The operator retains control switch 145 pressed in to keep its bottom contacts closed until the press has cycled through at least 170°. At 170°, cam-operated switch 39 closes (Fig. 4). The operator may now release control switch 145. This opens its bottom contacts, but since switch 39 is now closed, shunt holding circuits are provided to maintain relay coils B and D energized. The holding circuit for coil B is through line 151 including closed switch 39 and contacts B—1. The holding circuit for coil D is through line 151 including closed switch 39 and line 157 including closed contacts B—2 and C—1. Fig. 6 shows the switch positions at this stage in the single-cycle operation. It also shows by arrows at the lower right how current is flowing at this stage.

The coils 55 continue to be energized to drive the press until the press has cycled through 290°, whereupon cam-operated switch 39 opens. Since the operator has released control switch 145, its bottom contacts are open. With these bottom contacts open and switch 39 open, the circuits for coils B and D are open. Upon deenergization of coil D, contacts D—1, D—3 and D—4 open; contacts D—2 close. Upon closure of contacts D—2, a circuit is completed through line 171 including closed contacts D—2 and G—1 and coil F. Energization of coil F closes contacts F—1 and F—2 in the generator field rectifier circuit. Closure of contact F—1 completes a supply circuit from the negative output terminal of bridge rectifier 123 to the generator field terminal 121 through line 175 to terminal 177 and thence through line 183 (including closed contacts F—1). Closure of contacts F—2 completes a return circuit from generator field terminal 119 through a portion of line 179, line 187 (including closed contacts F—2), terminal 189 and line 193 to the positive output terminal of the bridge rectifier. Rectified current thereupon flows from terminal 121 through generator field 117 to terminal 119.

Generator field 117 thereupon excites the generator so that it generates direct current with its polarity such that line 109 is at a higher potential than line 107. Current thereupon flows through valve 115 and the braking field coil 83. Current flow through coupling field coils 55 is blocked by valve 111 and the electromagnetic clutch is deenergized.

With coil 83 energized, braking field member 29 is energized to exert a braking action on the inductor member 21. This occurs without any substantial overlap between electric clutch and brake actions (see Fig. 4). At 325° in the cycle of the press, cam-operated switch 41 opens (Fig. 4). This breaks the circuit of relay coil E, whereupon contacts E—1 open and break the circuit of solenoid coil 167. This applies mechanical brake 31, and the combined braking action of the electromagnetic brake and the mechanical brake brings the press to a stop after it has cycled through 360° back to its initial position at 0°.

If the operator should fail to release control switch 145, the press is prevented from repeating the cycle by the action of cam-operated switch 37. This switch opens at 205° in the cycle and breaks the holding circuit 147 for coil A. If switch 145 is pressed down at this time, its upper contacts will be opened and coil A deenergized. This opens contacts A—1 and A—2. Coils B and D remain energized through line 151 including cam-operated switch 39 as long as this switch is closed, but when this switch opens at 290°, as previously described, coils B and D are deenergized to deenergize the electromagnetic clutch and apply the brake to stop the press after one cycle. Thus, there is provided an anti-repeat means to prevent repetition of the cycle when the selector switch is set for "single cycle" operation should the operator inadvertently fail to release push button switch 145 or repress this switch after having released it.

After the press comes to a stop, relay coil F continues to be energized until time-delay relay G is energized after lapse of a predetermined period of time (of the order of 30 seconds) to open contacts G—1 and deenergize coil F. This opens contacts F—1 and F—2 to deenergize generator field 117 and braking field coil 83 in the interests of economy.

To operate the press continuously, without stopping between cycles, the master selector switch S is set in the "continuous" position wherein contacts S—2 and S—3 are closed, as illustrated in dotted lines in Fig. 5. Closure of contacts S—2 completes the circuit through coil C with resultant closure of contacts C—1, C—3 and C—4 and opening of contacts C—2. Closure of contacts S—3 completes the shunt circuit through line 153 around cam-operated switch 39. To start continuous operation of the press, the operator pushes in control switch 145 to close its bottom contacts. This energizes relay coils B and D, as previously described, and closes contacts D—1, D—3 and D—4, opening contacts D—2.

Closure of contacts D—1 completes the shunt 169 around cam-operated switch 41 so that coil E is continuously energized, despite opening of switch 41, to maintain contacts E—1 closed and solenoid coil 167 continuously energized. This continuously maintains the mechanical brake 31 released.

Opening of contacts D—2 deenergizes coil F so that contacts F—1 and F—2 are continuously open. Closing of contacts D—3 and D—4 completes the circuit for generator field 117 in such manner that current flows through the field from terminal 119 to terminal 121. This results in

energization of coupling field coils 55 and de-energization of braking field coil 83 as previously described. With coils 55 energized, the electromagnetic clutch is energized so that the press is driven.

The operator maintains switch 145 pressed in until the press comes up to speed and may then release it. Even though the bottom contacts of this switch are open, coils B and D remain energized through the shunt circuit including line 151 and line 153, since line 153 includes closed contacts S—3 of the master selector switch. The cam-operated switch 39 has no effect on coils B and D since it is shunted out by the line 153 including closed contacts S—3. The press continues to cycle until stop switch 143 is operated to break the circuit for coil B. Thus, during continuous operation of the press, the slip coupling 17 is continuously energized. The mechanical brake 31 is released and braking field coil 83 is deenergized so that there is no braking of crankshaft 7.

To operate the press at very slow inching speed through a portion of the stroke of the ram, the master selector switch is set in the "inch" position, as illustrated in dot-dash lines in Fig. 5, wherein all of the contacts S—1, S—2 and S—3 are open. Thus, coil C is deenergized, and its contacts C—1, C—3 and C—4 are open, contacts C—2 closed. With C—2 closed, inching control switch 160 may be closed to complete a circuit from power lead 129 to lead 131 through line 159 and relay coil D. Upon resultant energization of coil D, its contacts D—1, D—3 and D—4 close, contacts D—2 open. With D—1 closed, coil E is energized, contacts E—1 close and complete the circuit for solenoid coil 167 to release the mechanical brake 31. With D—2 open, coil F is deenergized to open contacts F—1 and F—2. With D—3 closed, a supply circuit for generator field 117 is established from the negative terminal output of rectifier 123 to generator field terminal 119 through line 175 to terminal 177, thence through line 179 including closed contacts D—3 and resistor 181. Contacts C—4 are open so that this resistor is not shunted out. With D—4 closed, a return circuit is established from generator field terminal 121 through line 183, line 191 including closed contacts D—4, terminal 189 and line 193 to the positive output terminal of the rectifier 123.

Rectified current from rectifier 123 thereupon flows from terminal 119 through generator field 117 to terminal 121. This current is relatively weak due to the resistor 181 now in the circuit. The resultant low excitation of generator 101 by its field 117 causes a relatively weak current to flow through coupling field coils 55. Braking field coil 83 is deenergized, as previously explained. The result is that the slip coupling 17 drives the drive shaft 9 with low torque and considerable slip so that the press is driven very slowly for inching operation. The press is driven as long as switch 160 is closed. Inching in reverse direction may be accomplished by reversing the motor 15. This inching operation is not intended for power punching or forming but for fine adjustments of the ram 1 required for setting and aligning dies and the like.

Thus, the coils 55 of the electromagnetic slip coupling and the coil 83 of the electromagnetic brake are adapted to be selectively energized merely by reversal of the polarity of the source of current for the coils, i. e., the generator 101. There are no current contacts in the circuit for the coupling and braking coils subject to failure due to arcing caused by inductive kick. The press may be readily selectively energized to run through one full-stroke operating cycle and stop, or to run continuously, or to inch according to the setting of master selector switch S.

In view of the objects of the invention, it may be questioned that switches such as D—3, D—4, F—1 and F—2, are in a D. C. circuit involving inductive coils which may be presumed to kick current across the switches when the circuit is broken. It should be noted, however, that every switch in this category is in a circuit in which the inductive coil 117 is relatively small and the arcing effects of which may readily be minimized in the usual way by means of the by-pass 197, 195. The case of the coils 55 and 83 is different, since these must necessarily have a large number of ampere turns to produce sufficient field for the coupling and brake effects on the inductor 65 and it would not be feasible to produce a by-pass construction large enough.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A press comprising a ram, means for reciprocating the ram including a rotary ram shaft, means for driving the shaft including an electromagnetic inductive coupling having a coupling field coil, an electromagnetic inductive brake for braking said shaft having a braking field coil, a reversible pole generator, a connection across the output of said generator including said coupling coil and an electric valve permitting current flow through said coupling coil only when said generator is of one polarity, a parallel connection across said generator output including said braking coil and an electric valve permitting current flow through said braking coil only when said generator is of opposite polarity, and means coordinated with the motion of the ram shaft for reversing current flow in the field of said generator for reversing its polarity.

2. A press comprising a ram, means for reciprocating the ram including a rotary shaft, means for driving the shaft including an electromagnetic slip coupling having a coupling field coil, an electromagnetic brake for braking said shaft having a braking field coil, a generator, a connection across the output of said generator including said coupling coil and an electric valve permitting current flow through said coupling coil only when said generator is of one polarity, a parallel connection across said generator output including said braking coil and an electric valve permitting current flow through said braking coil only when said generator is of opposite polarity, a separate field for said generator, a rectifier circuit for energizing the generator field, and means in said circuit for reversing current flow in said field for reversing the polarity of the generator.

3. A press comprising a ram, means for reciprocating the ram including a rotary ram shaft, means for driving the shaft including an electromagnetic inductive coupling having a coupling field coil, an electromagnetic inductive brake for braking the shaft and having a braking field coil,

a reversible pole generator having an exciting field coil, a connection across the output of said generator including said coupling coil and an electric valve permitting current flow through said coupling coil only when said generator is of one polarity, a parallel connection across said generator output including said braking coil and an electric valve permitting current flow through said braking coil only when the generator is of opposite polarity, a reversible D. C. circuit for reversing current flow in the generator field coil for reversing the polarity of the generator, control elements in said reversible D. C. circuit adapted initially to establish one polarity of said field coil thereby to apply torque through the coupling to said shaft to reciprocate the ram, and circuit elements coordinated with the ram shaft and operating in phased relation to part of a revolution of the ram shaft adapted automatically to reverse said polarity of the field coil after the ram has passed mid stroke, thus without overlap automatically to deenergize said coupling coil and to energize said brake coil automatically to decelerate the press electrically during a single cycle.

4. A press comprising a ram, means for reciprocating the ram including a rotary ram shaft, means for driving the shaft including an electromagnetic inductive coupling having a coupling field coil, an electromagnetic inductive brake for braking the shaft and having a braking field coil, a reversible pole generator having an exciting field coil, a connection across the output of said generator including said coupling coil and an electric valve permitting current flow through said coupling coil only when said generator is of one polarity, a parallel connection across said generator output including said braking coil and an electric valve permitting current flow through said braking coil only when the generator is of opposite polarity, a reversible D. C. circuit for reversing current flow in the generator field coil for reversing the polarity of the generator, control elements in said reversible D. C. circuit adapted initially to establish one polarity of said field coil thereby to apply torque through the coupling to said shaft to reciprocate the ram, circuit elements coordinated with the ram shaft and operating in phased relation to part of a revolution of the ram shaft adapted automatically to reverse said polarity of said field coil after the ram has passed mid stroke, thus without overlap automatically to deenergize said coupling coil and to energize said brake coil automatically to decelerate the press electrically during a single cycle, and selector elements for selectively connecting said phased elements for single-cycle accelerating and declerating operation of the ram or for shunting said phased elements for continuous operation of the ram under one polarity of the generator.

5. A press comprising a ram, means for reciprocating the ram including a rotary ram shaft, means for driving the shaft including an electromagnetic inductive coupling having a coupling field coil, an electromagnetic inductive brake for braking the shaft and having a braking field coil, a reversible generator having an exciting field coil, a connection across the output of said generator including said coupling coil and an electric valve permitting current flow through said coupling coil only when said generator is of one polarity, a parallel connection across said generator output including said braking coil and an electric valve permitting current flow through said braking coil only when the generator is of opposite polarity, a reversible D. C. circuit for reversing current flow in the generator field coil for reversing the polarity of the generator, control elements in said reversible D. C. circuit adapted initially to establish one polarity of said field coil thereby to apply torque through the coupling to said shaft to reciprocate the ram, phased circuit elements coordinated with the ram shaft and operating in phased relation to part of a revolution of the ram shaft adapted automatically to reverse said polarity of said field coil after the ram has passed mid stroke, thus without overlap automatically to deenergize said coupling coil and to energize said brake coil automatically to decelerate the press electrically during a single cycle, selector elements for selectively connecting said phased elements for single-cycle accelerating and decelerating operation of the ram or for shunting said phased elements for continuous operation of the ram under one polarity of the generator, and inching control means operative continuously at one polarity of the generator adapted to reduce current from the generator to cause said coupling to operate at low torque to reciprocate the ram at low inching speed.

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