

## [54] PRESS CONTROL APPARATUS

[72] Inventor: Kurt K. Luenser, Desota, Tex.

[73] Assignee: Verson Allsteel Press Company, Chicago, Ill.

[22] Filed: Mar. 22, 1971

[21] Appl. No.: 126,809

[52] U.S. Cl. .... 307/112, 340/147 MT

[51] Int. Cl. .... F16p 3/04

[58] Field of Search ..... 340/147 R, 147 MT, 147 B, 147 CN;  
235/151.11; 307/112, 113

## [56] References Cited

### UNITED STATES PATENTS

2,905,838 9/1959 King et al. .... 307/112

Primary Examiner—H. O. Jones

Assistant Examiner—William J. Smith

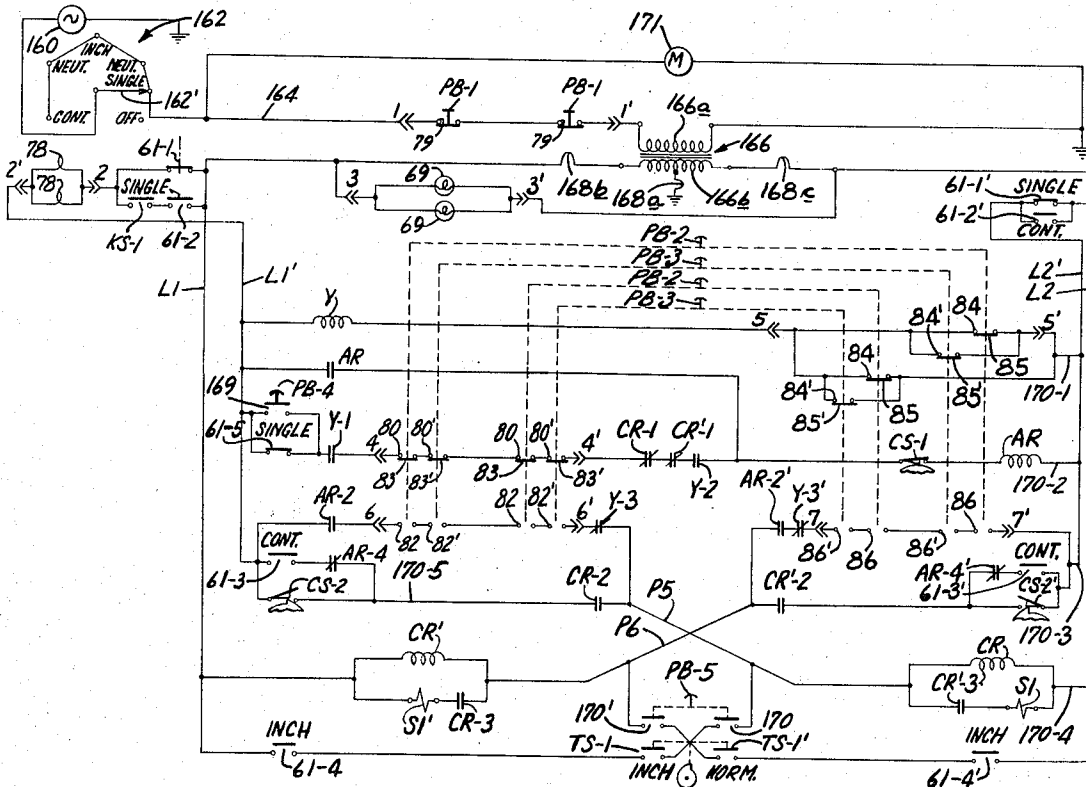
Attorney—Wallenstein, Spangenberg, Hattis & Sprampel

## [57] ABSTRACT

Control apparatus and circuitry for controlling the movement of a press ram or the like including a main electrical connector means having pairs of contact terminals between which are to be connected normally open and normally closed manually operable switch means for operating the press ram or for stopping the same. The main connector means are also provided with another pair of contact terminals which, to permit operation thereof, must be externally short circuited. A con-

necting duplicating unit in some cases also forming an operator control station unit including at least a normally closed manually operable switch is provided having input electrical connector means which may be removably connected to the main electrical connector means and at least one output electrical connector means which duplicates the main electrical connector means. The connector duplicating unit is wired to connect in series circuit relation each manually operable switch of the operator control station unit forming a part thereof and the similar switches of one or more other operator control station unit which may be connected to the one or more output electrical connector means thereof. The circuit of the connector duplicating unit must be completed by the connection to each output electrical connector means of circuit completing means including input electrical connector means removably secured to the output electrical connector means involved. Such circuit completing means may be a terminal operator control station unit or dummy unit not requiring other units to be connected thereto or another combination connector duplicating and operating control station unit requiring such other unit. Any operator control station unit having a normally open switch means is provided with short circuit means for short circuiting the aforementioned other pair of contact terminals of the main electric connector means and any dummy unit or operator control station unit having only normally closed switch means is devoid of any short circuit connections for the aforesaid other pair of contact terminals so that the mistaken connection of such a dummy unit or operator control station unit into the main electrical connector means cannot effect the operation of the press control circuit.

12 Claims, 11 Drawing Figures



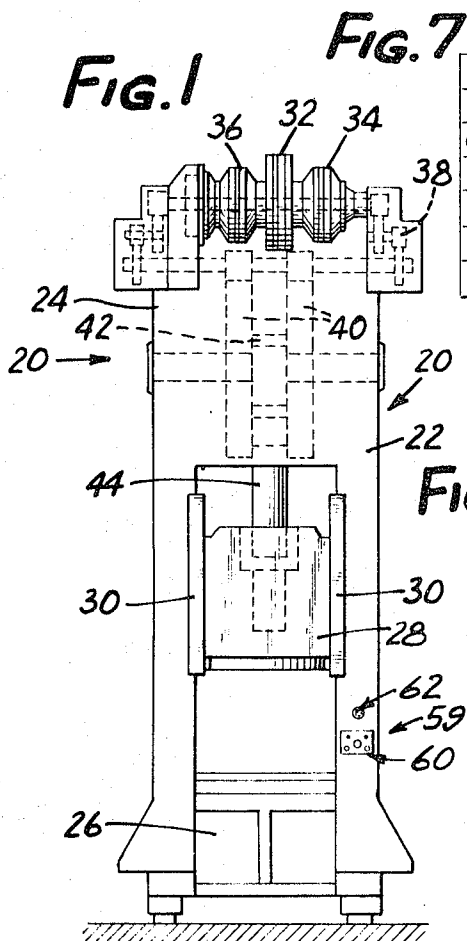


**FIG. 7**

| RAM POS. | RUN BUTTONS                | Y | AR        | CR OR CP  |
|----------|----------------------------|---|-----------|-----------|
| 0°       | ALL RELEASED               | E | $\bar{E}$ | D         |
| 0°-180°  | ALL DEPRESSED              | D | $\bar{E}$ | E         |
| 180°     | ALL RELEASED (CS-2 CLOSED) | E | $\bar{E}$ | $\bar{E}$ |
| 270°     | ALL RELEASED (CS-1 OPENS)  | E | D         | $\bar{E}$ |
| 0°       | ALL RELEASED (CS-2 OPENS)  | E | $\bar{E}$ | D         |

NOTE:  $\bar{E}$  MEANS RELAY LOCKED IN ENERGIZED STATE

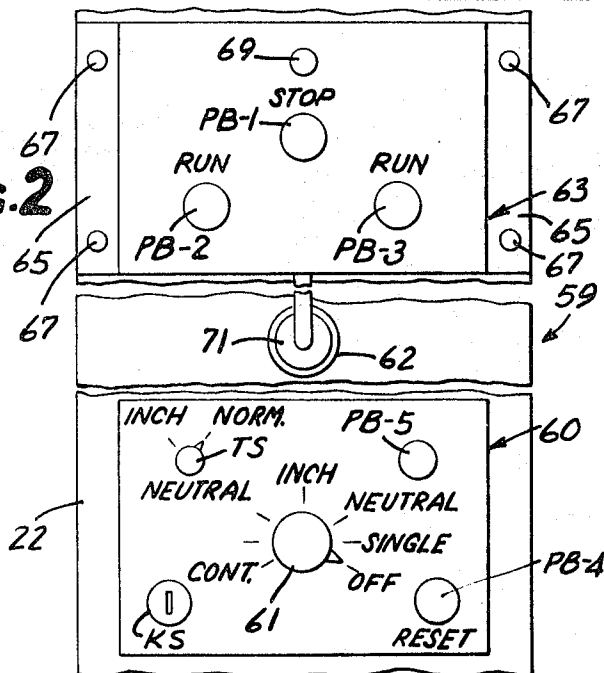


**FIG. 5**

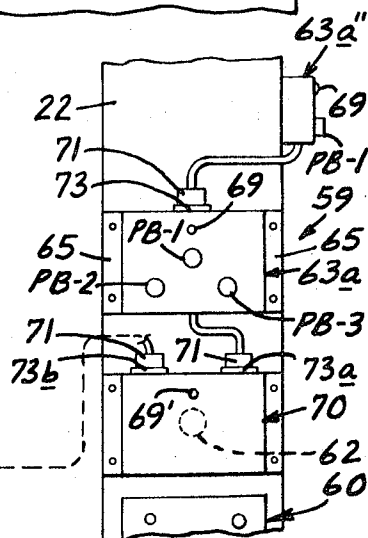
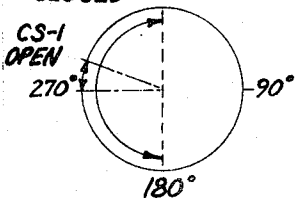


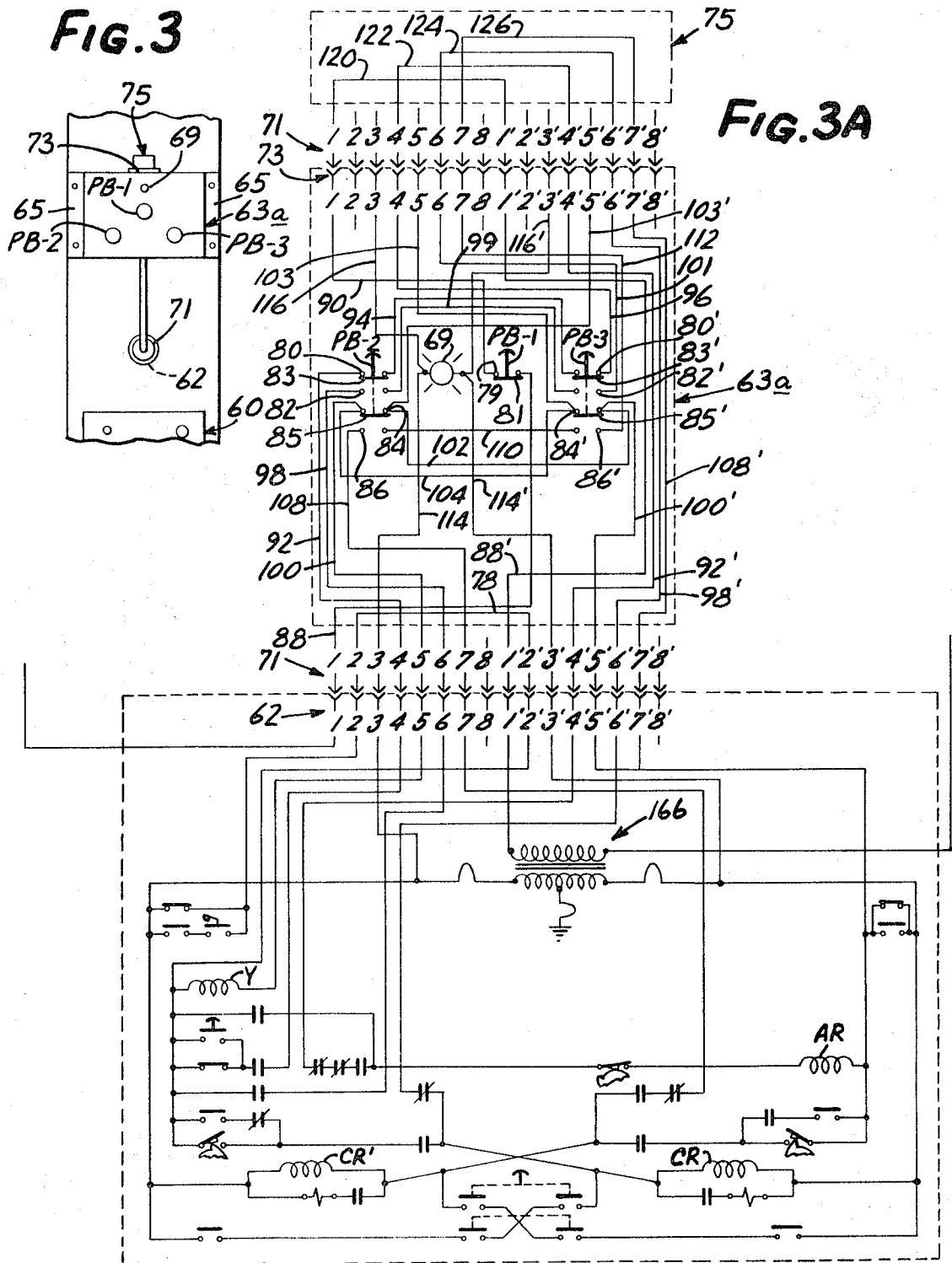
**FIG. 8**

CS-2 AND CS-2'  
CLOSED 0°



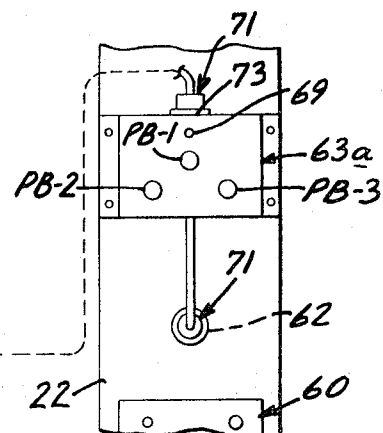
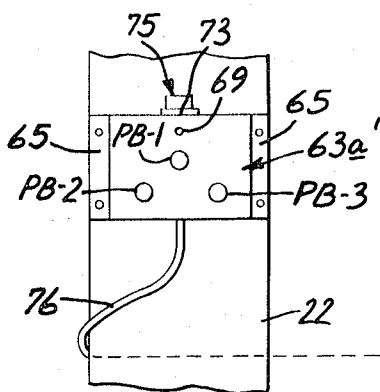
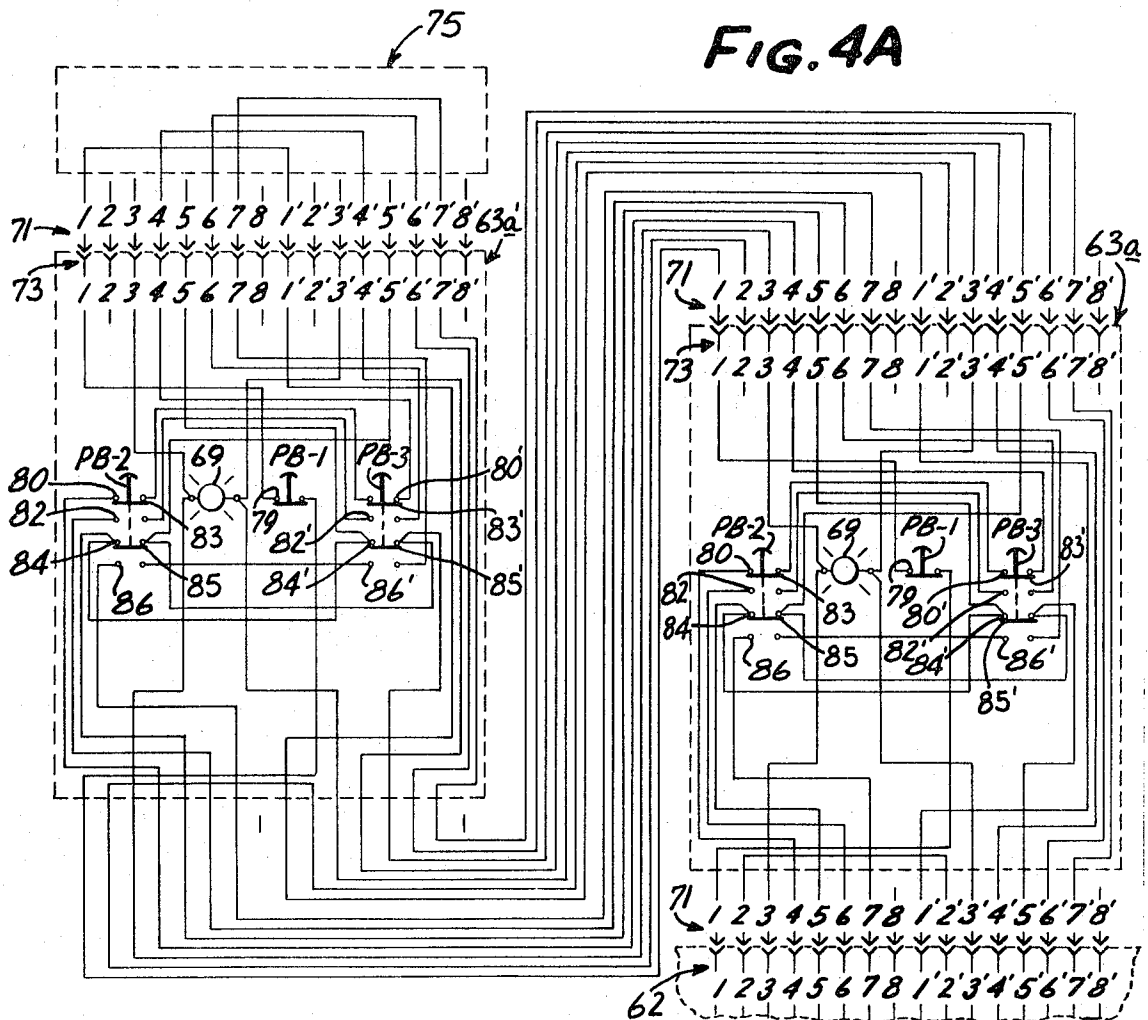
**INVENTOR**  
KURT K. LUENSER

by: Wallenstein, Spangenberg,  
Harris & Strampel **ATTYS.**



**INVENTOR**  
KURT K. LUENSER

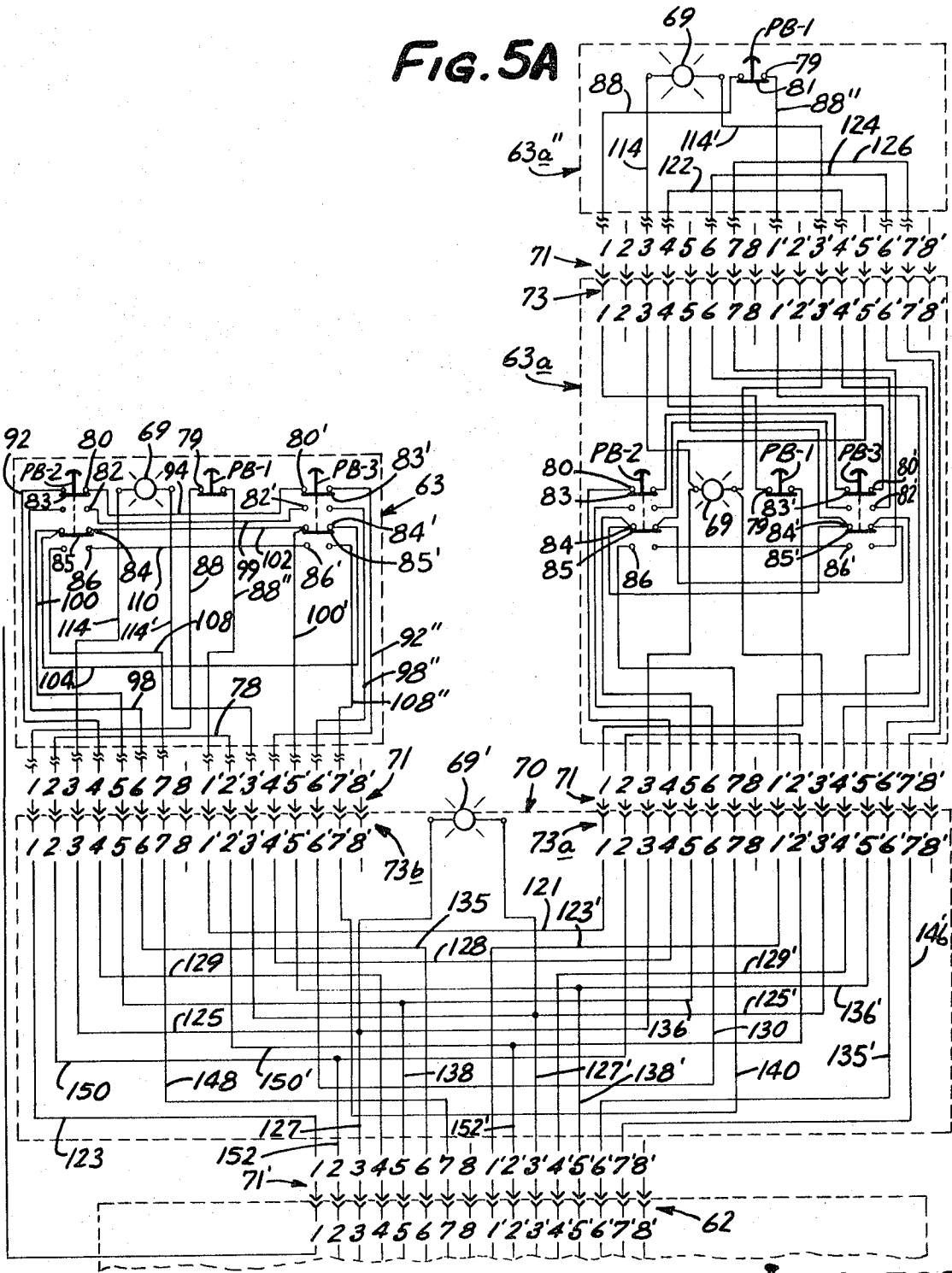
by: Wallenstein, Ghangenberg, Hattis & Strampel  
**ATTYS.**



**INVENTOR**  
KURT K. LUENSER

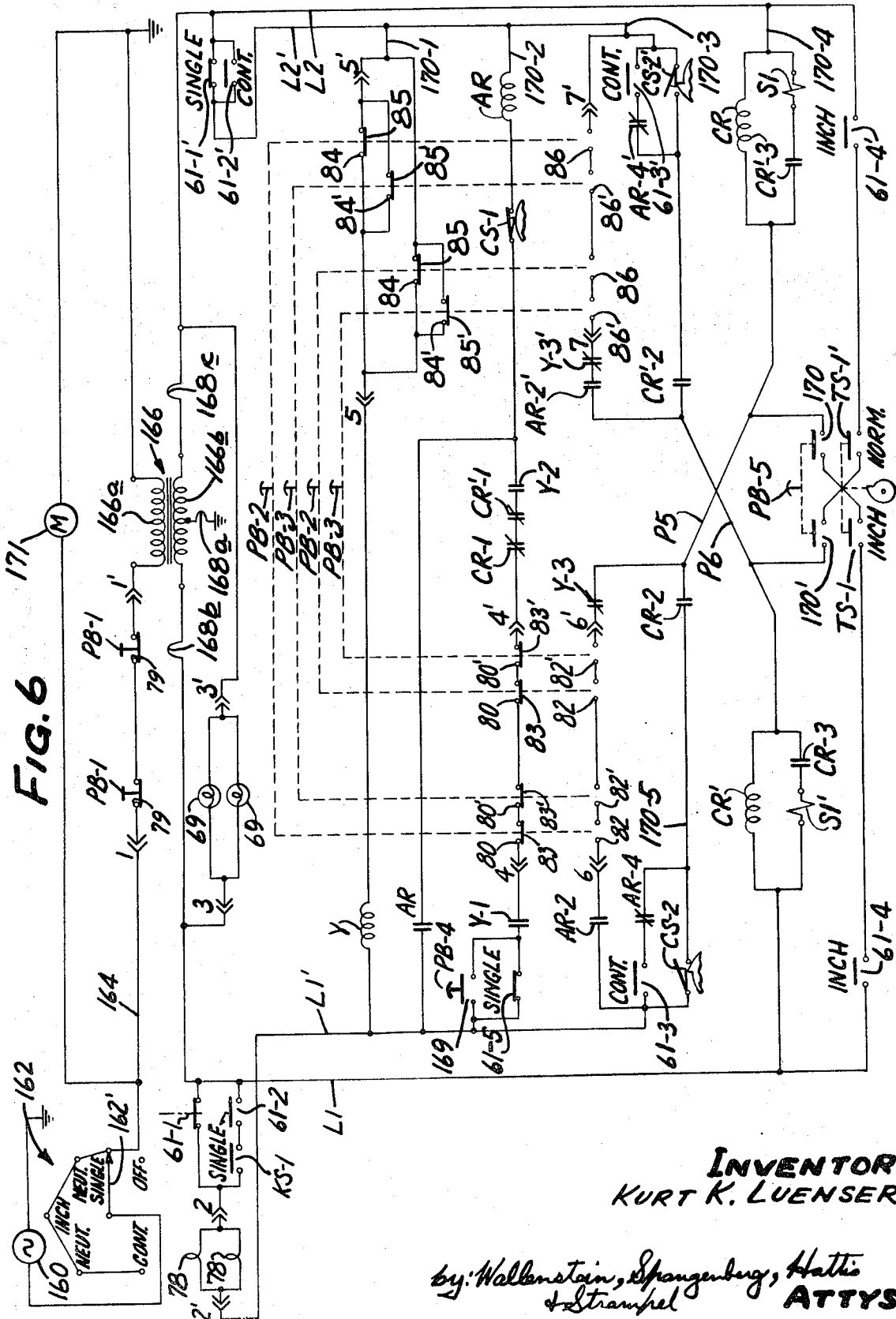
by: Wallenstein, Spangenberg, Hattis  
& Strampel **ATTYS.**

Fig. 5A



INVENTOR  
KURT K. LUENSER

by: Wallenstein, Spangenberg, Hattis & Strampel  
ATTYS.



## PRESS CONTROL APPARATUS

The present invention relates to machine controls, and more particularly to a new and improved control system having the most useful application in metal stamping presses and the like where the presses may be controlled by a number of different operators from individual control stations.

It is customary in metal stamping presses of this type to provide a continuous mode of operation where the press ram is continuously operated, a single cycle mode of operation where the press ram is under manual control only during the down stroke of the ram and the ram automatically comes to rest in the raised position thereof each cycle, and an inch mode of operation where the movement of the press ram is constantly under the control of a press operator at all times. In presses of great tonnage capacity, a number of operators are commonly stationed about the machine and for safety reasons and each operator has his own operator control station with control which, together with "run" controls of the other stations must generally be operated to operate the press when a single cycle or inch mode of operation is desired. Generally, each operator station has a pair of "run" push buttons which must be operated to initiate these modes of operation. For safety reasons, each operator should be able to stop the press by depression of only one "stop" push button.

When a metal stamping press is manufactured and sold to a particular customer, the control circuit for the press has generally been made to accommodate a certain fixed number of operator control stations, some of which may be designed to have only "stop" push buttons and others of which have both "stop" and "run" push buttons. The "stop" push buttons generally operate normally closed switches in the press control circuit which are connected in series so that the depression of any "stop" push button will de-energize the press control circuit immediately to stop the movement of the press ram. Each "run" push button may operate two or more normally open switches and at least one normally closed switch. One group of corresponding normally open switches controlled by the "run" push buttons are generally connected in series circuit relation in the energization circuit of the main control devices which are usually clutch control relays controlling clutch solenoids so that all of the control push buttons must be operated to energize the control device. Similarly, another group of normally closed switches controlled by the "run" push buttons are commonly connected in series circuit relation to de-energize a control relay when any control push button is depressed although in the preferred exemplary form of the invention these switches are connected in parallel.

Operator control stations are sometimes supplied in the form of individual plug-in units which plug into corresponding receptacles in the originally manufactured machine. The contact terminals of the plugs and receptacles involved were generally wired to accommodate the particular type of operator control station unit involved. The metal stamping press sold to a particular customer, therefore, would be initially provided with the proper number of receptacles wired to receive the particular operator control station plug-in units ordered by the customer. If the customer initially desired to have only two operator control station units of particular type, and he subsequently desired to add additional operator control stations it was necessary to rewire the press control circuit and to add additional receptacles to accommodate additional operator control station plug-in units.

The present invention provides a new concept for press controls in that the basic control circuit of the press is wired to only a single main receptacle seemingly to accommodate only a single operator control station having both "run" and "stop" push buttons with the exception that, in the most advantageous form of the invention, an additional pair of contact terminals are provided in the receptacle connected to a part of the press control circuit to be interrupted for stopping the press ram which pair of contact terminals must be bridged by an external jumper connection to permit operation of the press. In accordance with the present invention, a unique combination of different plug-in units or the like are provided

for insertion into the aforementioned main receptacle (to be sometimes referred to as a main electrical connector means) which combination of plug-in units permit the selective use of one or more operator control station plug-in units of the type comprising only "stop" push buttons and associated switches, or of the type comprising both "stop" push buttons and "run" push buttons and their associated switches with a machine having only one receptacle or the like as described. Thus, although the initially manufactured press is seemingly constructed to operate with only one operator control station, it nevertheless has the flexibility of receiving any number of operator control stations of the types referred to without any change in the wiring or number of receptacles of the originally manufactured press.

One of the basic plug-in units insertable into the main receptacle of the press will be referred to as a connector duplicating unit which is a unit which duplicates the main connector means at least one and, in some cases, two or more times. (Such duplicated connector means will be sometimes referred to as output electrical connector means.) In one form of the invention, the connector duplication unit is also an operator control station unit which includes "stop" push buttons only and associated switches or both "stop" and "run" push buttons and associated switches. The one or more output electrical connector means provided in a connector duplicating unit are designed removably to receive the complementary output electrical connector means of one or more units forming what will be referred to as circuit completing means. Without the connection of circuit completing means to an output electrical connector means of a connector duplicating unit, electrical continuity cannot be established between all contact terminals of the input connector means of a connector duplicating unit. The circuit completing means for an output electrical connector means of a connector duplicating unit may be only one other unit referred to as a terminal circuit completing unit which can be an operator control station unit or what will be referred to as a dummy unit including all of the circuit connections for completing the circuit connected to the input electrical connector means thereof, or may constitute another connector duplicating unit requiring other circuit completing means to complete the circuitry involved. When a connector duplicating unit also constitutes an operator control station unit, each of the switches forming a part thereof is connected between corresponding contact terminals of the input and output electrical connector means. When all output electrical connectors of all connector duplicating units have connected thereto the electrical connector means of circuit completing means as described, all corresponding switches of the various operator control station units involved to be connected in series will be so connected between the various pairs of contact terminals of the main electrical connector means of the press described above.

The aforementioned dummy unit and an operator control station unit which is not also a connector duplicating unit and having only "stop" push buttons controlling normally closed switches could create a serious hazard if the input electrical connector means thereof is inserted into the main electrical connector means of the press since such units only have terminal short circuiting switches or jumpers in the absence of the aforesaid additional pair of contact terminals of the main connector means. Such operator control station units and dummy units are not provided with jumpers for interconnecting said additional pair of contact terminals. However, operator control station units having "run" push buttons controlling normally open switches which must be closed in order to complete energization circuits to the control devices of the press control circuit are provided with such jumpers to provide continuity of the press control circuit whenever such a unit is inserted into the system ahead of an operator control station unit or dummy unit devoid of such jumpers.

The flexibility of the press control system as described has resulted in a substantial simplification and lower cost of the basic press control equipment and in greater convenience and

lower cost to the customer who desires to modify the number or type of operation control stations used with a particular press.

The above and other advantages and features of the invention will become apparent upon making reference to the specification to follow, the claims and the drawings wherein:

FIG. 1 is an elevational view of a typical metal stamping press with an exposed receptacle for receiving the input plug-in connector of an operator control station unit;

FIG. 2 is a greatly enlarged view of a portion of the press shown in FIG. 1, showing one form of operator control station unit inserted into the main receptacle thereof;

FIG. 3 is a view of a portion of the press shown in FIG. 1 with a combination connector duplicating and operator control station unit plugged into the main receptacle of FIG. 1 and which combination unit has a circuit completing dummy unit inserted therein;

FIG. 3A is a circuit diagram of the press control circuit for the press of FIG. 1 with the combination connector duplicating and operator control station unit and circuit completing dummy unit shown in FIG. 3 incorporated therein;

FIG. 4 is a view of a portion of the press shown in FIG. 1 with a combination connector duplicating and operator control station unit inserted into the main receptacle of the press shown in FIG. 1 with an additional combination connector duplicating and operator control station unit and dummy unit electrically connected to the output receptacle of the former combination connector duplicating and operator control station unit;

FIG. 4A shown the circuit diagram of the various units shown in FIG. 4;

FIG. 5 is a view of a portion of the press shown in FIG. 1 with a connector duplicating unit inserted into the main receptacle shown in FIG. 1 and having a pair of output receptacles into which are connected different types of operator control station units forming three operator control stations;

FIG. 5A shows the circuit diagram of the various units shown in FIG. 5;

FIG. 6 is an across-the-line diagram of the basic press control circuit common to all of the different forms of the invention illustrated in the preceding figures.

FIG. 7 is a chart indicating the conditions of the various relays shown in FIGS. 3A, 4A, 5A and 6 at various angular positions of the press ram crank arm; and

FIG. 8 is a timing diagram illustrating the operation of machine controlled cam switches shown in the circuit of FIGS. 2A, 3A, 4A, 5A and 6.

Referring now to FIG. 1, a press 20 is shown which is of the type disclosed in the David C. Verson and Albert Clements U.S. Pat. No. 2,286,943 with certain modifications which are dictated by the present invention. The press 20 includes a frame 22 having a crown 24, a bed 26 and a reciprocable ram 28 movable in gibs 30. In the press crown is mounted a motor (not shown), a flywheel 32 driven by the motor and connected through a clutch 34, a clutch and brake assembly 36 and suitable gearing 38, to a pair of large gears 40 which drive an eccentric 42 for pitman 44 connected to the ram 28.

The clutch 34 and clutch brake assembly 36 may be of the pressure fluid operated type (either hydraulic or pneumatic), and, in such case, the supply of fluid thereto is under the control of one or more solenoid operated valves, the solenoid or solenoids of which are incorporated in the control circuit to be described.

On the frame 22 is a main or master control station 59 including a control panel 60 which has a manually operable function control means illustrated as a control knob 61 (FIG. 2) which is movable to a number of different active stable positions identified as "off," "single cycle" "inch" and "continuous" positions preferably in the order named. A stable "neutral" position is provided for the control knob 61 between the "single cycle" and "inch position" and between the "inch" and "continuous" positions of the control knob 61. Various switch means or contacts to be described are open

and closed when the control knob 61 is in its various positions to accomplish the aforementioned inch, single cycle and continuous cycle modes of operation. The "neutral" positions are positions which are inoperative positions to minimize the possibility of inadvertent movement of the control knob 61 into an undesired operating position from another operating position when the control knob is moved one position from the operative "single," "inch" or "continuous" positions. Thus, for example, if the control knob 61 were in its "single" position, inadvertent movement of the control switch one position counterclockwise rather than one position clockwise to the "off" position would not result in the system being adjusted for an "inch" mode of operation. As previously indicated, a continuous mode of operation is where the press ram is continuously operated, a single cycle mode of operation is where the press ram is under manual control only during the down stroke of the ram and the ram automatically comes to rest in the raised position thereof each cycle, and an inch mode of operation is where the movement of the press ram is constantly under the control of a press operator at all times. In presses of great tonnage capacity, a number of operators are often stationed about the machine and for safety reasons each operator has his own operator control station run push buttons (like PB-2 and PB-3 in FIG. 2) with controls which, together with the "run" push buttons of the other stations, must be operated to operate the press when a single cycle or continuous mode of operation is desired. Generally, each operator control station has a pair of "run" push buttons so that an accidental pushing of only one "run" push button will have no effect. Also, operation of the press in a continuous mode of operation requires the control knob to be moved into its "continuous" position, the rotation of a key switch by the rotation of a proper key into a member KS on the control panel 60 and the momentary depression of a continuous reset push button PB-4 on the control panel 60 along with operation of all "run" push buttons at all operator control stations for a give period. For the inch mode of operation, the control knob 61 is moved into its "inch" position, and the spring urged control knob TS on the control panel 60 is held in an "inch" position while a push button PB-5 is depressed.

In addition to the control panel 60, the master operator control station 59 will include an operator control station unit like plug-in unit 63, 63a or 63a' shown in FIGS. 2, 3, 4, and 5 including a stop push button PB-1, a pair of the aforesaid "run" push buttons PB-2 and PB-3 and an indicating lamp 69. FIG. 1 shows only a main receptacle 62 above the control panel 60 into which receptacle can be operably inserted the input plug connector 71 (sometimes referred to also as an input electrical connector means) of any of the operator control station plug-in units 63, 63a, 63a' or 63a'', or a plug-in unit 70 shown in FIG. 5 (It should be understood that although the exemplary form of the invention utilizes "plug-in" units meaning that they have input connectors with male contact terminals insertable into the female contact terminals or sockets of receptacles, the present invention is equally applicable to units using input connectors with female contact terminals.)

FIG. 2 illustrates the insertion into the main receptacle of the input plug connector 71 of the plug-in unit 63 which is to be referred to as a terminal operator control station plug-in unit because it acts as a final or terminating circuit completing unit for the circuit into which it is directly connected (unlike the other operator control station units 63a, 63a' and 63a'') which require the insertion into an output receptacle 73 thereof of another plug-in unit to complete the circuitry involved. The illustrated operator control station plug-in unit 63 (as well as the other operator control station plug-in units) have side flanges 65-65 through which may be extended anchoring screws 67 for physically anchoring the same to the frame 22. (Obviously other means of mounting these plug-in units may be provided.) The press control apparatus illustrated in FIG. 2 is provided only with one operator control station, namely the master operator control station 59 from which the entire press is controlled. Only one such operator

control station would be used for relatively small presses where the owner of the press desires to minimize overhead by minimizing the number of operators necessary to operate the press. The energization of an indicating lamp 69 of any plug-in unit informs the operator that operating voltage is applied to the plug-in unit so that operation of the controls thereof should be effective in performing this intended function. The "stop" and "run" push buttons operate pairs of contacts or switches to be described which are respectively operable to terminate movement of the press ram 28 and to initiate movement of the press ram 28. As will be described, the "run" push buttons contact may include both normally open and normally closed pairs of contacts. Corresponding pairs of normally open contacts of the different "run" push buttons in the press control circuit to be described are connected in series so that the inadvertent pressing of only one of the "run" push buttons will not result in the operation of the press ram 28. The provision of a terminal operator control station plug-in unit like the unit 63 just described is not per se novel. One of the important novel aspects of the invention is the provision of special plug-in units like the aforesaid plug-in units 63 or 63a', 63a'' and 70 which enable the addition of any desired number of operator control station plug-in units from the single main receptacle 62.

In accordance with one of the features of the present invention, to enable the connection of any desired number of operator control station to the main receptacle 62, there is provided a connector duplicating unit, such as the combination connector and operator control station plug-in units 63a in FIG. 3 or the plug-in unit 70 shown in FIG. 5. The plug-in unit 63a has an input plug connector 71 insertable into the main receptacle 62, and an output receptacle 73 (sometimes referred to as an output electrical connector means) which duplicates the main receptacle 62 on the press frame 22. The combination connector duplicating and control station plug-in unit 63a has the same basic controls as the terminal operator control station plug-in unit 63 shown in FIG. 2, namely a "stop" push button PB-1 and a pair of "run" push buttons PB-2 and PB-3 in addition to an indicating lamp 69. The push buttons PB-1, PB-2 and PB-3 control contacts or switches of the same type previously referred to in connection with the operator control station plug-in unit 63. As it will be described in more detail hereinafter, the input plug connector 71 and the output receptacle 73 have corresponding contact terminals which are interconnected by conductors and contacts or switches within the plug-in unit 63a. The circuits involved having series connected contacts or switches which require for their completion circuit completing means to be connected to the plug-in unit 63a by a plug connector inserted into the output receptacle 73, such as the input plug connector 71 of a dummy plug-in unit 75 shown in FIG. 3. The dummy plug-in unit 75 contains only jumper interconnections associated with contacts or switches to be connected in series with various pairs of contact terminals of the output receptacle 73.

Refer now to FIG. 4 which illustrates the manner in which additional operator control stations can be added to the single operator control station of FIG. 3. As shown in FIG. 4, the dummy plug-in unit 75 in FIG. 3 is replaced by a combination connector duplicating and operator control station unit 63a' which is identical to the plug-in unit 63a (corresponding parts thereof being similarly numbered), except that the plug connector of 71 thereof plugs into the output receptacle 73 of the plug-in unit 63a connected to a long cable 76 so that the plug-in unit 63a' can be located a substantial distance from the plug-in unit 63a, such as at the opposite side of the press frame 22. The wiring between the contact terminals of the input plug connector 71 and the output receptacle 73 of the plug-in units 63a and 63a' and the input plug connector 71 of the dummy plug-in unit 75 connects the various contacts or switches to be connected in series of the plug-in units 63a and 63a' and the various contacts or switches to be connected in parallel respectively in series and parallel between various pair of contact terminals of the main receptacle. Thus the combination

connector duplicating and operator control station plug-in unit 63a' and the dummy plug-in unit 75 together form a circuit completing means for the combination connector duplicating and control station plug-in unit 63a.

FIG. 5 illustrates another form of the invention wherein the aforementioned connector duplicating unit 70 which plugs directly into the main receptacle 62 performs the function of providing output receptacles 73a and 73b which are duplicates of main receptacle 62 and wiring which connects in series and parallel circuit relating all contacts or switches to be connected respectively in series and parallel of the operator control station plug-in units 63, 63a' and 63a'' to be connected to the output receptacle 73a and 73b. The input plug connector 71 of the previously described combination connector duplicating and control station plug-in unit 63a located on the right side of the frame 22 is shown removably inserted within the output receptacle 73a of the connector duplicating unit 70 and the input plug connector 71 of the terminal operator control station plug-in unit 63a' located on the left side of the frame 22 is removably inserted into the output receptacle 73b of the connector duplicating unit 70. A third operator station is provided by the operator control station plug-in unit 63a'' located to the rear of the right side of the frame 22. The operator control station plug-in unit 63a'' has only a "stop" push button for stopping the press ram, and, like the terminal operator control station plug-in unit 63, acts as a terminal circuit completing unit since it has no output receptacle. In addition to the contacts or switches controlled by the "stop" push button PB-1 of the operator control station plug-in unit 63a'', the plug-in unit 63a'' has jumpers interconnecting the various contact terminals of the output receptacle 73 of the plug-in unit 63a associated with contacts or switches of the plug-in unit 63a to be connected in series.

Refer now FIG. 3A which shown a schematic diagram of the circuit formed by the combination connector duplicating and control station plug-in unit 63a, the dummy unit 75 and the basic press control circuit which is connected to the main receptacle 62 of the press. As shown in FIG. 3A, the input plug connector 71 has 16 male contact terminals which are insertable within 16 female or socket contact terminals of the main receptacle 62 or other similar receptacles. The output receptacle 73 of the plug-in unit 63a has sixteen female contact terminals. For the purpose of simplifying the training of the circuits, the sixteen contact terminals of each input plug connector and the output receptacle has been divided into two groups of eight contact terminals each respectively numbered as contact terminals Nos. 1 through 8 and 1' through 8'. Each pair of correspondingly numbered terminal contact pairs 1-1', 2-2', or 3-3', etc. in a contact terminal pair associated with the same circuit portion and across which contacts or switches, lamps or a jumper are to be connected. Contact terminal pairs 1-1', 2-2', etc., of main receptacle 62 extend to respective pairs of juncture points in the main press control circuit to be described, which juncture points are to be interconnected or disconnected to effect various relay control functions to be described. In a connector duplicating unit like the combination connector duplicating and operator control station plug-in unit 63a, contact or switches which are to be connected in series across a pair of juncture points in the press control circuit are shown connected in series between one of the correspondingly numbered contact terminals of the input plug connector 71 and the output receptacle 73. A conductor extends between the other correspondingly numbered and primed contact terminals of the input plug connector and output receptacle involved, so that continuity between a correspondingly numbered pair of contact terminals of the main receptacle 62 associated with contacts or switches to be connected in series cannot be effected unless circuit completing means, like the dummy plug-in unit 75 or other terminal plug-in unit, is inserted or coupled to each output receptacle 73 involved. (Contacts or switches or lamps connected in parallel do not need circuit completing means to effect switch continuity.)

All input plug connectors 71 and output receptacles 73 of the various units described are respectively identical and each plug connector 71 is insertable into an output receptacle 73 or the main receptacle 62 in only one position where the corresponding contact terminals are in engagement.

As previously indicated, any terminal circuit completing unit like dummy plug unit 75 containing only jumper connections or operator control station plug-in unit 63a' containing only jumper and normally closed contacts or switches completing continuity of circuits having series connected contacts or switches could create a dangerous condition if such a plug-in unit were inadvertently plugged directly into the main receptacle 62, since then all circuits would have continuity which are necessary to initiate operation of the press ram. To prevent such a dangerous condition, the press control circuit to be described is provided with a pair of juncture points which must be connected by continuous jumper in order to effect operation of the press ram, these juncture points extend to contact terminals 2 and 2' of the main receptacle 62. Any operator control station plug-in unit which has normally opened contacts or switches is provided with a jumper 78 which provides continuity between the Nos. 2 and 2' contact terminals of the input plug connector thereof, and any terminal plug-in circuit completing unit like the dummy plug-in unit 75 and operator control station plug-in unit 63a' devoid of any normally open contact or switches has no connections between its Nos. 2 and 2' contact terminals of the input plug connector 71 thereof.

As shown in FIG. 3A, the "stop" push button of combination connector duplicating and operator control station plug-in unit 63a operate a movable contact 81 which normally bridges a pair of normally-closed contact 79. A conductor 88 extends between the right contact of the pair of contacts 79 and the No. 1 contact terminal of the input plug connector 71, and a conductor 90 extends between the left contact of the pair of contacts 79 and the No. 1 contact terminal of the output receptacle 73. A conductor 88' extends between the No. 1' contact terminal of the output receptacle 73 and the No. 1' contact terminal of the input plug connector 71. Contact terminals 1 and 1' of the output receptacle 73 thus must be bridged by circuit completing connections making external connection with the output receptacle 73 to the normally-closed contacts 79 effective. The depression of the "stop" push button PB-1 will then disconnect normally-closed contacts 79 to interrupt the press control circuit to stop the press ram. Any of the other operator control station plug-in unit connected to the the output receptacle 73 will connect corresponding normally-closed stop contacts 79 in series with the contacts 79 of the plug-in unit 63a.

The "run" push button PB-2 of the plug-in unit 63a has a movable contact 83 which normally interconnects a normally-closed pair of contacts 80, and the "run" push button PB-3 has a movable contact 83' which normally interconnects a normally-closed pair of contacts 80'. The contacts 80 and 80' are connected in series between the No. 4 contact terminals of the input plug connector 71 and the output receptacle 73 by conductor 92 extending between the No. 4 contact terminal of the input plug connector 71 and the left hand terminal of the pair of contact 80, a conductor 94 extending between the right hand contact of the pair of contacts 80 and the left hand contact of the pair of contacts 80', and a conductor 96 extending between the right contact of the pair of contacts 80' and the No. 4 contact terminal of the output receptacle 73. A conductor 92' extends between the No. 4' contact terminals of the output receptacle 73 and the input plug connector 71.

Depression of the "run" push buttons PB-2 and PB-3 respectfully result in the disconnection of the pair of contacts 80 and 80' and the interconnection of a pair of normally-open contact 82 and 82' respectively by the movable contacts 83 and 83'. The normally-open pairs of contacts 82 and 82' are connected in series between the Nos. 6 contact terminals of the input plug connector 71 and the output receptacle 73 by a conductor 98 connected between the No. 6 contact terminal

of the input plug connector 71 and the left contacts of the pair of contacts 82, a conductor 99 extending between the right contact of the pair of contacts 82 and the left contact of the pair of contacts 82', and a conductor 101 extending between the right contact of the pair of contacts 82' and the No. 6 contact terminal of the output receptacle 73. A conductor 98' extends between the Nos. 6' contact terminals of the output receptacle 73 and the input plug connector 71.

The "run" push buttons PB-2 and PB-3 have respectively movable contacts 85 and 85' which normally interconnect normally-closed pair of contact 84 and 84' respectively. These pair of normally-closed contacts 84 and 84' are connected in parallel with one another. A conductor 102 extends between the right contact of the pair of contacts 84 and the right contact of the pair of contacts 84', and a conductor 104 extends between the left contact of the pair of contacts 84 and the left contact of the pair of contacts 84'. The parallel connected pairs of contacts 84' and 84 are connected directly across the Nos. 5 and 5' contact terminal of the input connector 71 by conductor 100 extending between the No. 5 contact terminal of the input plug connector 71 and the left contact of the pair of contacts 84, and a conductor 100' extending between the right contact of the pair of contacts 84' and the No. 5' contact terminal of the input plug connector 71. The parallel connected pairs of contacts 84 and 84' are respectively connected across the Nos. 5 and 5' contact terminals of the output receptacle 73 by conductor 103' extending between the right contact of the pair of contacts 84 and the No. 5' contact terminal of the output receptacle 73, and be a conductor 103 extending from the left contact of the pair of contacts 84' and the No. 5 contact of the output receptacle 73.

When the push buttons PB-2 and PB-3 are depressed, the movable contacts 85 and 85' leave the pairs of normally-closed contacts 84 and 84' and make connection across pairs of normally-open contacts 86 and 86'. The pairs of normally-open contacts 86 and 86' are connected in series between the No. 7 contact terminals of the input plug connector 71 and the output receptacle 73 by a conductor 108 extending between the No. 7 contact terminal of the input plug connector 71 and the left contact of the pair of contacts 86, a conductor 110 extending between the right contact of the pair of contacts 86 and the left contact of the pair of contacts 86', and a conductor 112 extending between the right contact of the pair of contacts 86' and the No. 7 contact terminal of the output receptacle 73. A conductor 108' extends between the No. 7' contact terminals of the output receptacle 73 and the input plug connector 71.

The indicating lamp 69 is connected across the Nos. 3 and 3' contact terminals of the input plug connector 71 by a pair of connectors 114 and 114' respectively, and the lamp 69 is connected to the Nos. 3 and 3' contact terminals of the output receptacle 73 receptacle 73 by conductors 116 and 116', respectively.

The dummy plug unit 75 contains jumpers 120, 122, 124, 126 respectively connected between the contact pairs 1-1', 4-4', 6-6', and 7-7' of the input plug connector 71 of the dummy plug-in unit 75 and thus establish final connections between the various pairs of series connected pairs of push button contacts. As previously explained, pairs of contacts, lamps or jumpers in the other plug-in units to be connected in parallel do not have any jumpers in the dummy plug-in unit 75 to complete connections between the same.

As previously indicated, in FIG. 4 there is shown an additional combination connector duplicating and operator control station unit 63a' having an input plug connector 71 which extends into the output receptacle 73 of the other combination connector duplicating and operator control station plug-in unit 63a connected directly to the output receptacle 62. These plug-in units 63a and 63a' are identical and so a further description on the wiring of the plug-in unit 63a' need not be given. It is apparent that the insertion of the input plug connector 71 of the plug-in unit 63a' into the output receptacle 73 of the plug-in unit 63a connects the normally-closed con-

tacts 80' and 80 of both of these plug-in units in series between the No. 4 contact terminals of the main receptacle 62 and the output receptacle 73 of the plug-in unit 63a', connects the pairs of normally-open terminal 82 and 82' of the plug-in units 63a and 63a' in series between the No. 6 contact terminals of the main receptacle 62 and the output receptacle 73 of the plug-in unit 63a', connects the normally-closed pairs of contacts 84 and 84' of the plug-in units 63a and 63a' in parallel across the Nos. 5 and 5' contact terminals of the main receptacle 62, connects the normally-open pairs of contacts 86 and 86' of the plug-in units 63a and 63a' between the No. 7 contact terminals of the main receptacle 62 and the output receptacle 73 of the plug-in unit 63a', connects the normally-closed pairs of contacts 79 of the plug-in units 63a and 63a' between the No. 1 contact terminals of the main receptacle 62 and the output receptacle 73 of the plug-in unit 63a', connects the indicating lamps 69 of the plug-in units 63a' and 63a'' in parallel with the indicating lamp 69 of plug-in unit 63a, and connects the normally-closed pair of contacts 84 and 84' of the plug-in unit 63a' in parallel with the correspondingly numbered contacts of the plug-in unit 63a. The jumper connections made by the dummy plug-in unit 75 plugged into the output receptacle 73 of the plug-in unit 63a' effect the same circuit connections as the dummy plug-in unit 75 in the embodiment of FIG. 3.

Referring now to FIG. 5A which shows the circuit diagram for the arrangement of plug-in units shown in FIG. 5, which includes the same combination connector duplicating and operator control station unit 63a shown in FIG. 4 and so a further description of the wiring of this unit will not now be given. The operator control station unit 63a'' which plugs into the output receptacle 73 of the plug-in 63a includes only an indicating lamp 69, and a single "stop" push button PB-1 and related normally-closed switch contacts and wiring and jumpers to be described for completing various circuits having contacts connected in series of one another. Accordingly, the "stop" push button PB-1 operates a movable contact 81 which normally interconnects a pair of normally-closed contacts 79 which are respectively connected by conductors 88 and 88'' between the No. 1 and No. 1' contact terminals of the input plug connector 71 of the plug-in unit 63a''. The indicating lamp 69 is connected by conductors 114 and 114' respectively between the Nos. 3 and 3' contact terminals of the input plug connector 71. Jumpers 122, 124, and 125 respectively interconnect the Nos. 4 and 4', 6 and 6', and 7 and 7' contact terminals of the input connector 71 in the same manner and for the same purpose served by correspondingly numbered jumpers of the dummy plug-in unit 75 previously described. As in the case of dummy plug-in unit 75 which only has circuit element or circuits dealing with normally-energized circuits, the plug-in unit 63a'' is devoid of any jumpers between the Nos. 2 and 2' contact terminals of the input connector 71 thereof.

It is thus apparent that the indicating lamps 69 of the plug-in unit 63a and 63a'' are connected in parallel across the Nos. 3 and 3' contact terminals of the input plug connector 71 of the plug-in unit 63a and that the pair of normally-closed contacts 79 of the plug-in units 63a'' and 63a' are connected in series across from Nos. 1 and 1' contact terminals of the input plug connector 71 of the plug-in unit 63a. Also, the other normally-open and normally-closed pairs of contacts associated with the "run" push buttons PB-2 and PB-3 of the plug-in unit 63a are connected in the same manner across the various associated contact terminals of the input plug connector 71 of the plug-in unit 63a as in the case of the plug-in unit 63a described in connection with FIG. 3A.

As previously indicated, the input connector 71 of the plug-in unit 63a is inserted into the output receptacle 73a of the connector duplicating plug-in unit 70, and the input plug connector 71 of the terminal operator control station plug-in unit 63 is inserted into the output receptacle 73b of the connector duplicating plug-in unit 70. The plug-in unit 70 connects all corresponding circuit elements to be connected in parallel, like lamp 69 and contacts 84 and 84', in parallel circuit rela-

tion, and all corresponding contacts to be connected in series, like contacts 80 and 80' 82 and 82', and 86 and 86', in series circuit relation across the associated similarly numbered pairs of contact terminals of the input plug connector 71 of the plug-in unit 70. To this end, a conductor 121 extends between the No. 1 contact terminal of the output receptacle 73a and the No. 1' contact terminal of the output receptacle 73b of the plug-in unit 70. The No. 1' contact terminal of the output receptacle 73b is connected by a conductor 88'' to a right terminal of a pair of normally-closed contacts 79 associated with the "stop" push button PB-1 of the plug-in unit 63. The left contact of the pair of contacts 79 is connected by a conductor 88 to the No. 1 contact terminal of the input plug connector 71 of the plug-in unit 63. A conductor 123 extend between the No. 1 contact terminal of the output receptacle of the plug-in unit 70 and the No. 1 contact terminal of the input plug connector 71' thereof. Similarly, a conductor 123' extends between the No. 1' contact terminal of the output receptacle 73a and the No. 1' contact terminal of the input plug connector 71' of the plug-in unit 70, thereby to connect the various normally-closed contacts of the various plug-in units in series circuit relation between the Nos. 1 and 1' contact terminals of the input plug connector 71'.

A conductor 125 extends between the No. 3 contact terminals of the output receptacles 73a and 73b, and a conductor 125' extends between the No. 3' contact terminals of the output receptacles 73a and 73b thus to connect the terminals associated with the various indicating lamps 69 in parallel. Conductors 127 and 127' respectively extend between the Nos. 3 and 3' contact terminals of the input plug connector 71' and said conductors 125 and 125', respectively, and also to the opposite terminals of an indicating lamp 69' for the plug-in unit 70. The terminal operator control station plug-in unit 63 has an indicating lamp 69 connected by conductors 114 and 114' to the Nos. 3 and 3' contact terminals of the input plug connector 71 thereof, so that the last mentioned indicating lamp 69 is connected in parallel with all the other indicating lamps 69 and 69' across the Nos. 3 and 3' contact terminals of the input plug connector 71' of the plug-in unit 70.

A conductor 128 extends between the No. 4 contact terminal of the output receptacle 73a and the No. 4' contact terminal of the output receptacle 73b. A conductor 92'' extends between the No. 4' contact terminal of the input connector 71 of the plug-in unit 63 and the right contact of the normally-closed pair of contacts 80' associated with the "run" push button PB-3 of the plug-in unit 63. The pair of contacts 80' are connected in series with the other corresponding pair of normally-closed contacts 80 associated with the other "run" push button PB-2 by conductor 94 extending between the left contact of the pair of contacts 80' and the right contact of the pair of contacts 80. A conductor 92 extends between the left contact of the pair of contacts 80 and the No. 4 contact terminal of the associated input plug connector 71. A conductor 129 extends between the No. 4 contact terminal of the output receptacle 73b and the No. 4 contact terminal of the input plug connector 71'. Similarly, a conductor 129' extends between the No. 4' contact terminals of the output receptacle 73a and the input plug connector 71'. Thus, contacts 80 and 80' associated with the various "run" push buttons PB-2 and PB-3 of all the various operator control station plug-in units are connected in series across the Nos. 4 and 4' contact terminals of the input plug connector 71'.

A conductor 100 extends between the No. 5 contact terminal of the input plug connector 71 and the left contact of a pair of normally-closed contacts 84 initially interconnected by the movable contact 85 operated by the "run" push button PB-2. A conductor 102 extends between the right contact of the pair of contacts 84 and the left contact of the pair of contacts 84' interconnected by the movable contact 85' operated by the "run" push button PB-3. A conductor 100' connects the left contact of the pair of contacts 84 to the No. 5' contact terminal of the input plug connector 71, thereby to connect the pairs of contacts 84 across the Nos. 5 and 5' contact ter-

minals of the input plug connector 71. A conductor 104 connects the right contact of the pair of contacts 84' to the left contact of the pair of contacts 84 thereby to connect the pair of contacts 84' in parallel with the pair of contacts 84.

A conductor 130 extends between the No. 6 contact terminal of the output receptacle 73a and the No. 6' contact terminal of the output receptacle 73b. A conductor 98'' extends between the No. 6' contact terminal of the input plug connector 71 of the plug-in unit 63 and the right contact of the pair of normally-open contacts 82' associated with the "run" push button PB-3 of the plug-in unit 63. A conductor 99 connects the normally-open contacts 82' and a pair of contacts 82 of the "run" push button PB-2 in series with one another, and a conductor 98 connects the pair of normally-open contacts 82 to the No. 6 contact terminal of the input plug connector 71. A conductor 135 extends between the No. 6 contact of the output receptacle 73b and the No. 6 contact terminal of the input plug connector 71'. Similarly, a conductor 135' extends between the No. 6' contact terminal of output receptacle 73a and the No. 6' contact terminal of the plug connector 71', thereby to connect all of the various normally-open pairs of "run" push button contacts 82 and 82' of the various plug-in units 63, 63a and 63a'' in series across the Nos. 6 and 6' contact terminals of the input plug connector 71' of the plug-in unit 70.

Conductors 136 and 136' respectively extend between the Nos. 5 and 5' contact terminals of the output receptacles 73a and 73b and conductors 138 and 138' respectively extend between the conductors 136 and 136' to the Nos. 5 and 5' contact terminals of the input plug connector 71', thereby connecting all of the various normally-closed "run" push button contacts 84 and 84' in parallel across the Nos. 5 and 5' contact terminals of the input plug connector 71'.

A conductor 140 extends between the No. 7 contact terminal of the output receptacle 73a and the No. 7' contact terminal of the output receptacle 73b of the plug-in unit 70. A conductor 108'' extends between the No. 7' contact terminal of the input plug connector 71 of the plug-in unit 63 and the right contact of the pair of normally-open contacts 86' associated with "run" push button PB-3. A conductor 110 connects the pair of contacts 86' in series with a pair of normally-open contacts 86 of the "run" push button PB-2. A conductor 108 connects the left contact of the pair of contacts 86 with the No. 7 contact terminal of the associated input plug connector 71. A conductor 148 connects the No. 7 contact terminal of the output receptacle 73b to the No. 7 contact terminal of the input plug connector 71' of the plug-in unit 70. A conductor 146' extends between the No. 7' contact terminal of the output receptacle 73a and the No. 7' contact terminal of the input plug connector 71', to connect the various normally-open contacts 86 and 86' of the various plug-in units 63 and 63a between the Nos. 7 and 7' contact terminals of the input plug connector 71'.

As in the case of the other plug-in units having normally-open switches therein, a jumper 78 extends between the Nos. 2 and 2' contact terminals of the input plug connector 71 of the plug-in unit 63. Conductors 150 and 150' respectively extend between the Nos. 2 and 2' contact terminals of the output receptacles 73a and 73b, and conductors 152 and 152' respectively extend between the Nos. 2 and 2' contact terminals of the input plug connector 71' and the aforementioned conductors 150 and 150', thereby to connect the various jumpers of the plug-in units in parallel with the Nos. 2 and 2' contact terminals of the input plug connectors 71'.

Refer now to FIG. 6 which shown an across-the-line diagram showing the press control circuit in which the various contacts and indicating lamps of the two operator control station plug-in units 63 and 63a of FIGS. 4 and 4A. The contact terminals of the main receptacle 62 are also identified in FIG. 6. A source 160 of AC voltage is provided having one terminal grounded and another terminal connected to the movable wiper 162' of a six position switch 162 operated by the function switch control knob 61. The wiper 162' couples the

source of AC voltage to a conductor 164 in all but the "off" position of the control knob 61. The conductor 164 is coupled through the normally-closed "stop" push button contacts 79 to one end of the primary winding 166a of a transformer 166.

The other end of the winding 166a is grounded. The transformer 166 has a center tapped secondary winding 166b. Short circuit current-responsive switch means 168a is connected between the center tap point of the secondary winding 166b and ground. Similar short circuit current-responsive switch means 168b and 168c are positioned respectively in the connections between the ends of the secondary winding 166b and the power buses L1 and L2. The short circuit current-responsive switch means 168a, 168b and 168c are designed so that when any of these switch means receives a short circuit current or a current above a given desired limit, that switch means and all the other short circuit current-responsive switch means will automatically open. (Such a ganged relationship of switch means is well known in the art and thus a description of the construction of same will not here be given.) The presence of any ground connection within the various circuit branches to be described results in the flow of short circuit current in either the left or right half of the secondary winding 166b, resulting in the complete de-coupling of the power buses L1 and L2 from the ground or any source of voltage.

Power bus L1 is connected to a parallel circuit of a switch 61-1 (which is closed when function control knob 61 is in its "single cycle" position) and continuous operation switches 61-2 and KS-1 which are closed respectively when the function control knob 61 and key operated member KS are operated to their "continuous" mode operating positions. Switches 61-1' and 61-2' corresponding to switches 61-1 and 61-2 are connected in parallel positioned between main power buses L2 and secondary power bus L2'. The switches 61-1, KS-1 and 61-2 are connected through the aforesaid jumpers 78 and secondary power bus L1'. Various branches are connected between opposite power buses which include an anti-repeat relay AR a manual controlled relay Y and a pair of clutch relays CR and CR'.

The manual controlled relay Y has normally-closed contacts Y-3 and Y-3' in circuit branches 170-3 and 170-4 so that the clutch relays CR and CR' can be initially energized only when relay Y is de-energized, and normally-open contacts Y-1 and Y-2 in a circuit branch 170-2 to control the initial energization of the anti-repeat relay AR so that the anti-repeat relay AR cannot be reset to an initially energized condition at the end of each press cycle unless the manual controlled relay is energized. (Contacts of relays are identified by the same designation as the relay controlling the same and the normal condition thereof is the condition when the associated relay is de-energized.)

The series connected normally-closed "run" push button contacts 84 and 84' are connected in parallel with one another and in series with the manual controlled relay Y in circuit branch 170-1 so that all the run control push buttons PB-2 and PB-3 must be depressed to de-energize the manual controlled relay Y.

A portion of the circuit branch 170-2 which controls the initial energization of the anti-repeat relay AR includes a series circuit of switch 169 (closed by depression of the continuous reset push button PB-4) in parallel with switch 61-5 (closed by depression of function control knob 61), normally-open contacts Y-1 of the manual controlled relay Y, the series connected normally-closed run push button contacts 80 and 80', normally-closed contacts CR-1 of the clutch relay CR and normally-open contacts Y-2 of the manual controlled relay Y. A set of normally-open holding contacts AR-1 of the anti-repeat relay AR are connected between the bus L1' and the terminal of the contacts Y-2 remote from the bus L1'. The latter terminal of the contacts Y-2 is connected through a normally-closed cam controlled switch CS-1 to one terminal of the anti-repeat relay AR whose opposite terminal is connected to the bus L2'. The cam switch CS-1, as shown in the timing diagram of FIG. 8, is opened momentarily when the arm driving the

press ram is in a position, such as a 270° position, where the ram is nearing the return to its initial starting position. It is assumed that a crank arm drives the press ram between its starting and work producing positions and that, when the ram is at the top of its path of travel the crank arm is in a 0° position. The crank arm rotates in a clockwise direction as viewed in FIG. 8, to first bring the press ram down to its bottommost position, which is the 180° position of the crank arm, and then rotates back to its initial starting position as it moves between the 180° and 360° positions.

Thus, when the manual controlled relay Y is energized and the press ram is in its uppermost position, an energization path for the anti-repeat relay AR is established provided none of the run control push buttons PB-2, PB-3, PB-2' and PB-3' are depressed, whereupon the relay will lock-in through the normally-open holding contacts AR-1 of the anti-repeat relay.

The portion of the circuit branch 170-3 which effects initial energization of the clutch relay CR includes, in the order named, normally-open contacts AR-2 of the anti-repeat relay AR connected to bus L1', the series connected normally-open run push button contacts 82 and 82' and normally-closed contact Y-3 of the manual controlled relay Y connected to relay Y which is connected to main bus L2. It is thus apparent that upon depression of all of the run control push buttons PB-2 and PB-3 and the continued energization of the anti-repeat relay AR the manual controlled relay Y is de-energized and the clutch relay CR will be energized through the circuit branch 170-3. The portion of the circuit branch 170-4 which effects initial energization of the clutch relay CR' includes, in the order named, the normally-open run push button contacts 86 and 86' connected to the bus L2', normally-closed contacts Y-3' of the manual controlled relay Y, normally-open contacts AR-2' of the anti-repeat relay AR connected to the relay CR'. The clutch relays CR and CR' connected to bus L1 becomes de-energized when any of the run control push buttons PB-2 or PB-3 are released before the ram reaches its lower most position, to stop the movement of the press ram. However, once the crank arm of the press ram moves into an angular position between 180° and 360° where a dangerous condition to the worker no longer exists, machine controlled cam switches CS-2 and CS-2' connected respectively in series with the normally-opened contacts CR-2 and CR-2' of the clutch relays CR and CR' close to establish holding circuits which energizes the clutch relays CR and CR' independently of the position of the aforementioned run control push button contacts until the cam switches CS-2 or CS-2' open when the press ram returns to its uppermost position. The cam switches CS-2 and CS-2' are respectively shunted by series circuits of the continuous function switch contacts 61-3 and 61-3', and normally-closed contacts AR-4 and AR-4' of the anti-repeat relay AR so that the holding circuits of relays CR and CR' remain energized for the continuous mode of operation.

Thus, when the function control knob 61 is moved to its "continuous" position to effect a continuous cycle mode of operation of the press, to complete the initiation of a continuous cycle of operation all of the run control push buttons PB-2 and PB-3 must be continuously depressed until the ram reached its lowermost position where the cam switches CS-2 and CS-2' close to energize the holding circuits of the relays CR and CR'. The continuous cycle function switch contacts 61-3 do not become effective to energize the clutch relay continuously until the anti-repeat relay is de-energized to close the normally-closed contact AR-4 and AR-4' respectively in series with the contacts 61-3 and 61-3'. The clutch relays CR and CR' becomes de-energized near the end of an operating cycle when the cam switch CS-1 opens whereupon clutch relays CR and CR' will be locked-in an energized state which maintains the normally-closed contacts CR-1 open to keep the anti-repeat relay AR continuously in its de-energized state.

The press ram operation is controlled by solenoid S1 and S1' both of which must be energized to operate the press ram. Solenoid S1 is connected in series with normally-open contacts CR-3 of clutch relay CR' across clutch relay CR, and

solenoid S1' is connected in series with normally-open contacts CR-3 of clutch relay CR across relay CR'. A motor 171 continuously drives an input shaft of clutch 34 (FIG. 1) and is operative to drive the press ram when the clutch is engaged by the simultaneous energization of solenoids S1 and S1' upon energization of both clutch relays CR and CR'.

The side of the clutch relay CR' remote from the main bus L1 is connected to the main bus L2 during the inch mode of operation by a branch including normally-open contacts 170' which are closed by the push button PB-5, normally-open contacts TS-1' which are closed when the control knob TS is turned to its "inch" position, and the contacts 61-4' which are closed only when the function control knob 61 is in the "inch" position. Similarly, the side of the clutch relay CR remote from the bus L2 is connected to the bus L1 through a branch including normally-open contacts 169 which are closed by depression of the push button PB-5, normally-open contacts TS-1 which are closed when the control knob TS is turned to its "inch" position, and contacts 61-4 which are closed when the knob 61 is in its "inch" position. Thus, an inching operation can be obtained independently of whether the motor 169 is rotated simply by moving the function control knob 61 to the "inch" position thereof and simultaneously depressing the push buttons PB-5 and turning the control knob TS to the "inch" position. (The purpose of the control knob TS and the associated contacts TS-1', TS-2 is to prevent the inadvertent operation of the press ram when the function switch control knob is in its "inch" position if somebody should inadvertently, without knowing it, lean against the "inch" push button PB-5.)

The press control circuit shown in FIG. 6 and just described may be incorporated with additional safety features, if desired, like those shown in FIG. 15 in copending application Ser. No. 876,672 filed Nov. 14, 1969. The application also disclosed exemplary means by which the simultaneous energization of solenoid S1 and S1' are effective in operating the clutch 34.

It should be understood that the particular details of the press control circuit shown in FIG. 6 form no part of the present invention and thus can be vary widely from the circuit shown in FIG. 6. As previously indicated, the present invention deals with the wiring of the main receptacle 62 and the construction and wiring of the various plug-in units described above insertable into or coupled to the main press receptacle which gives it flexibility in the number and type of operator control station useable with a simplified basic control system.

I claim:

1. In a machine which has a work producing portion movable by an operating drive means from a remote starting position, where an operator is relatively safe, to a work producing position where it can injure an operator in the vicinity thereof, and is then movable back to said starting position, said machine including main electrical connector means including at least a first pair of contact terminals to be interconnected by manually operable switch means of an operator control station, the opening or closing of the circuit across said pair of contact terminals resulting in either the energization of de-energization of said operating drive means, the improvement comprising: a first connector duplication unit for enabling selectively the installation of one or more operator control stations including manually operable switch means to be connected in series between said first pair of contact terminals of said main connector means, said first connector duplicating unit including first electrical connector means complementary and removably connected to said main electrical connector means of the machine, and second electrical connector means for removably receiving complementary electrical connector means of circuit completing means; a first operator control station having manually operable switch means; and circuit completing means including first electrical connector means complementary and removably connected to said second electrical connector means of said first connector duplication unit; said first connector duplicating unit and said circuit completing means including circuit forming means for connecting said

manually operable switch means of said first operator control station and any similar manually operable switch means which may be present in said circuit completing means in series between said first pair of contact terminals of said main electrical connector means.

2. The machine of claim 1 wherein at least part of said circuit completing means includes a second operator station with manually operable switch means connected in series with said manually operable switch means of said first operator control station.

3. The machine of claim 1 wherein said first connector duplicating unit includes, as an integral part thereof, said first operator control station including said manually operable switch means.

4. The machine of claims 1 wherein said first circuit completing means is a terminal circuit completing unit providing a continuous circuit connected in series with said manually operable switch means of said operator control station.

5. The machine of claim 1 wherein said first connector duplicating unit includes third electrical connector means for removably receiving complementary electrical connector means of a circuit completing means, said first operator control station forming a separate unit having first electrical connector means complementary and removably connected to said third electrical connector means of said first connector duplicating unit, said manually operable switch means of said first operator control station being electrically connected through said first electrical connector means thereof to said circuit-forming means of said first connector duplicating unit.

6. The machine of claim 2 wherein said second operator control station form part of said circuit completing means and constitutes a connector duplicating unit by including second electrical connector means for removably receiving complementary electrical connector means associated with a terminal circuit completing unit and a terminal circuit completing unit forming part of said circuit completing means and having associated electrical connector means complementary and removably connected to said second electrical connector means of said second operator control station, and circuit forming means in said terminal circuit completing unit and second operator control station completing connections which connect said manually operable switch means of said first and second operator control stations in series between said pair or contact terminals of said main electrical connector means.

7. In a machine which has a work producing portion movable by an operating drive means from a remote starting position, where an operator is relatively safe, to a work producing position where it can injure an operator in the vicinity thereof, and is then movable back to said starting position, said machine including main electrical connector means for removably receiving complementary connector means of an external circuit completing means and including at least a first pair of contact terminals to be interconnected by manually operable switch means of an operator control station, the opening or closing of a circuit across said pair of contact terminals resulting in the energization or de-energization of said operating drive means, the improvement comprising: a first connector duplicating unit for enabling selectively the installation of a number of operator control stations respectively including manually operable switch means to be connected in series between said first pair of contact terminals of said main electrical connector means, said first connector duplicating unit including first electrical connector means removably connected to said main electrical connector means and having a first pair of contact terminal engaging said first pair of contact terminals of said main electrical connector means, and second electrical connector means for removably receiving complementary electrical connector means of circuit completing means which provides a continuous interconnection between said first pair of contact terminals of said second electrical connector means of the first connector duplicating unit or an operator control which has manually operable switch means

to be connected between said first pair of contact terminals of said second electrical connector means of said first connector duplicating unit; a first operator control station including manually operable switch means having one terminal connected to one of said first electrical connector means of said first connector duplicating unit, means connecting the other terminal of said manually operable switch means of said first operator control station to one of said pair of contact terminals of said second electrical connector means of said first connector duplicating unit, means within said first connector duplicating unit which connects the other of said pair of contact terminals of said second electrical connector means of said first connector duplicating unit to the other contact terminal of said first pair of contact terminals of said first electrical connector means of said first connector duplicating unit; and circuit completing means having electrical connector means with a pair of contact terminals removably connected to said pair of contact terminals of said second electrical connector means of said first connector duplicating unit and circuit completing means connected to said pair of contact terminals of said electrical connector means thereof for completing a circuit which connects said manually operable switch means of said first operator control station across said first pair of terminals of said main electrical connector means.

8. In a machine which has a work producing portion movable by drive means from a remote starting position, where an operator is relatively safe, to a work producing position where it can injure an operator in the vicinity thereof; and is then movable back to said starting position, said machine including main connector means for removably receiving complementary connector means of an external circuit completing means and including at least a first pair of contact terminals to be interconnected by normally closed manually operable switch means of an operator control station, a second pair of contact terminals to be interconnected by normally open manually operable switch means of an operator control station, and a third pair of contact terminals to be continuously interconnected to permit energization of said drive means, the opening of the circuit across said first pair of contact terminals resulting in the de-energization of said drive means and the closing of the circuit across said second pair of contact terminals resulting in the energization of said operating drive means, the improvement comprising: a combination connector duplicating and operator control station unit having input connector means with a first, second and a third pair of contact terminals which can be respectively removably connected across said first, second and third pair of contact terminals of said main connector means, and output connector means with a first, second and third pair of contact terminals for respectively making connection to the contact terminals of an input connector means associated with circuit completing means to be connected thereto, at least one normally closed manually operable switch means and circuit connecting means connecting the corresponding first and second pair of contact terminals of said input and output connector means together with said normally closed manually operable switch means connected in series between one of the corresponding contact terminals of said first pair of contact terminals of said input and output connector means and said normally open manually operable switch means connected in series between one of the corresponding contact terminals of said second pair of contact terminals of said input and output connector means, and means short circuiting said third pair of contact terminals of said input connector means; a terminal circuit completing unit having input connector means with contact terminals which can be mistakenly removably connected with said main connector means and is removably connectable to contact terminals of said output connector means of said combination connector duplicating and operator control station unit, and means for respectively electrically short circuiting only said first and second pair of contact terminals of said output connector means of said combination connector duplicating and operating control station unit so said third pair of contact ter-

minals of said main connector means will remain unconnected if said circuit completing unit is mistakenly directly connected to said main connector means, and circuit-forming means connected to the contact terminals of the last mentioned input connector necessary for completing a circuit where said normally open and normally closed manually operable switch means are respectively electrically connected across said first and second contact terminals of said main connector means.

9. The machine of claim 8 wherein said terminal circuit completing unit is a dummy unit devoid of any manually operable switch means and containing only means electrically short circuiting said first and second pair of contact terminals of said output connector means of said combination connector duplicating and operating control station unit.

10. The machine of claim 8 wherein said terminal circuit completing unit constitutes a second operator control station unit having a normally closed manually operable switch means coupled across said first pair of contact terminals of said output connector means of said combination connector duplicating and operator control station unit.

11. The machine of claim 8 herewith said input connector means of said combination connector duplicating and operator control station unit is directly physically and electrically removably connected to said main connector means.

12. The machine of claim 8 wherein there is provided between said main connector means and said combination connector duplicating and operator control station unit an intervening connector duplicating unit having input connector means having is first, second and third pair of contact ter-

minals respectively connected to said first, second and third pair of contact terminals of said main connector means respectively having a first, second and third pair of contact terminals: the input connector means of said combination connector duplicating and operator control station unit having its first, second and third pair of contact terminals respectively removably connected with said first, second and third pair of contact terminal means of said first output connector means of said intervening connector duplicating unit, and a second operator control station unit having input connector means with first, second and third pair of contact terminals respectively removably making contact with said first, second and third pair of contact terminals of said second output connector means of said intervening connector duplicating unit, and at least normally closed manually operable switch means coupled across said first pair of contact terminals of said input connector means of the second operator control station unit circuit-forming means in said intervening connector duplicating unit which connect said first and second pair of contact terminals of said first and second output connector means of said intervening connector duplicating unit respectively between said first and second pair of contact terminals of said main connector means, and said third pair of contact terminals of said first and second output connector means of said intervening connector duplicating unit respectively in parallel with one another and with said third pair of contact terminals of said main connector means.

\* \* \* \* \*

30

35

40

45

50

55

60

65

70

75