E. V. WURTS AND B. S. PERO.

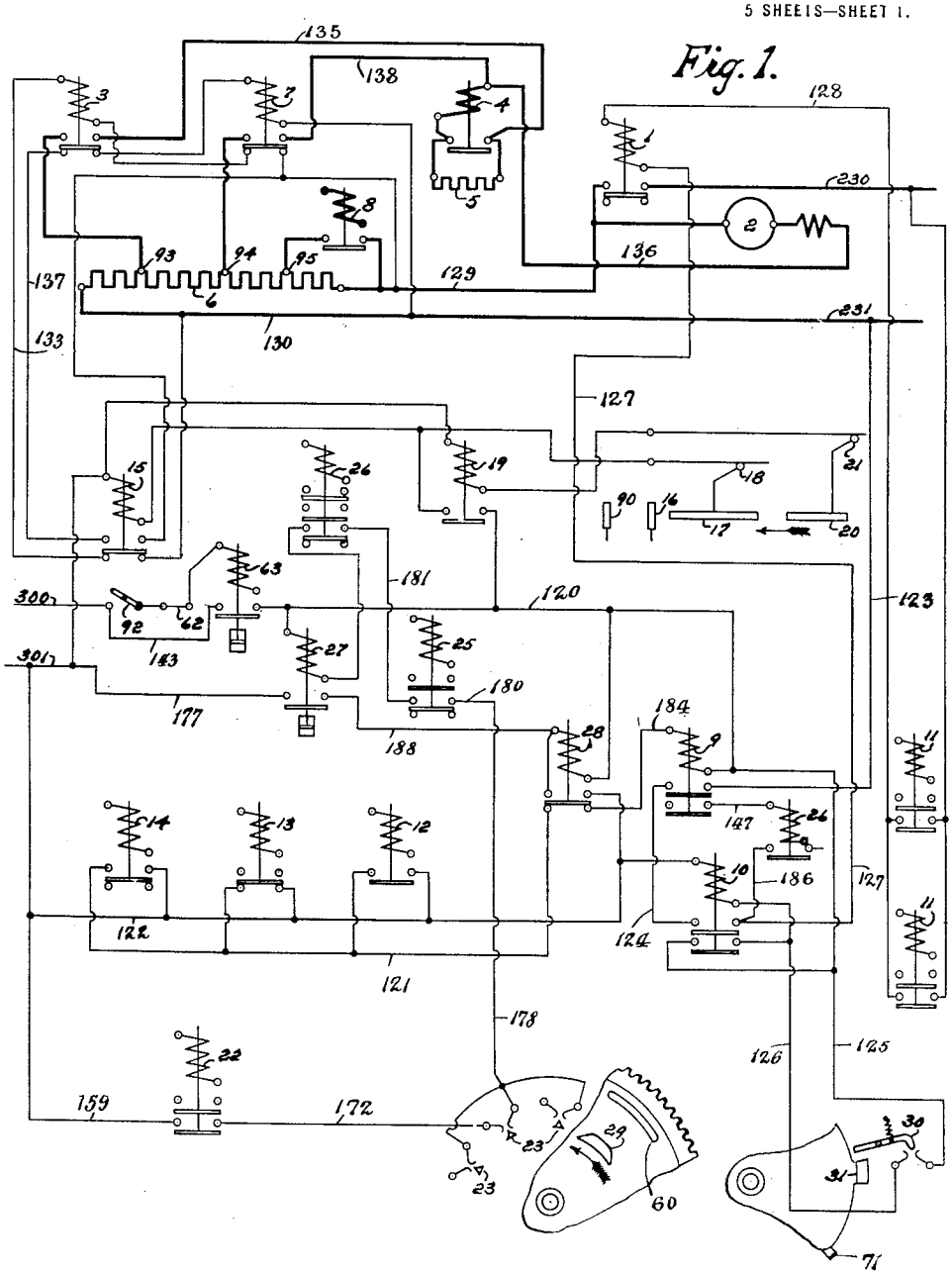
CONTROLLING SYSTEM FOR METAL WORKING MACHINES.

APPLICATION FILED SEPT. 24, 1917.

1,349,995. **Patented Aug. 17, 1920.**

5 SHEETS—SHEET 1.

Fig. 1.



E. V. Wurts INVENTOR

B. S. Pero

by John B. Morgan

ATTORNEYS

E. V. WURTS AND B. S. PERO.

CONTROLLING SYSTEM FOR METAL WORKING MACHINES.

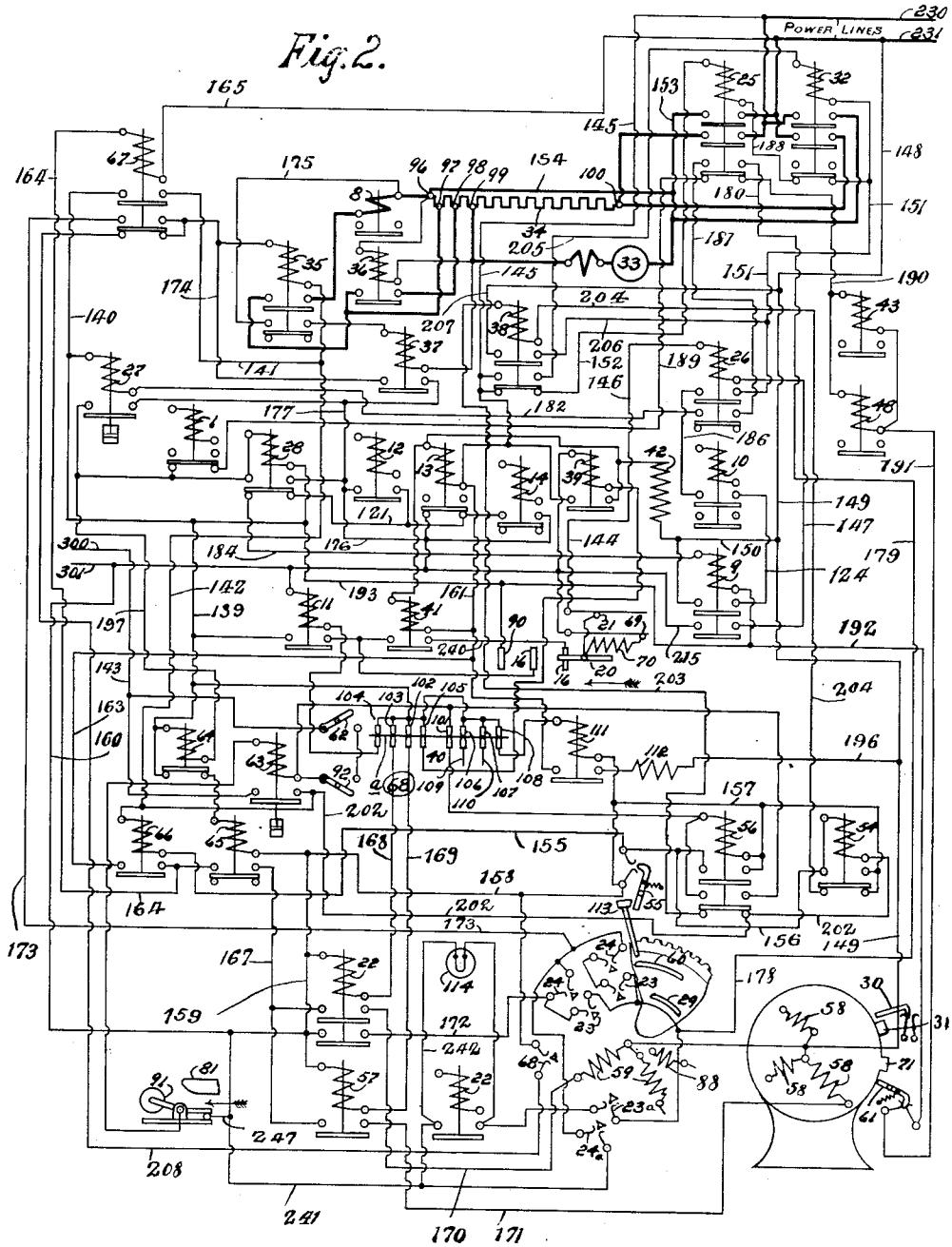
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5 SHEETS—SHEET 2.

Fig. 2.



E. V. Wurts INVENTOR

B. S. Pero

BY John R. Morgan

ATTORNEYS

E. V. WURTS AND B. S. PERO.

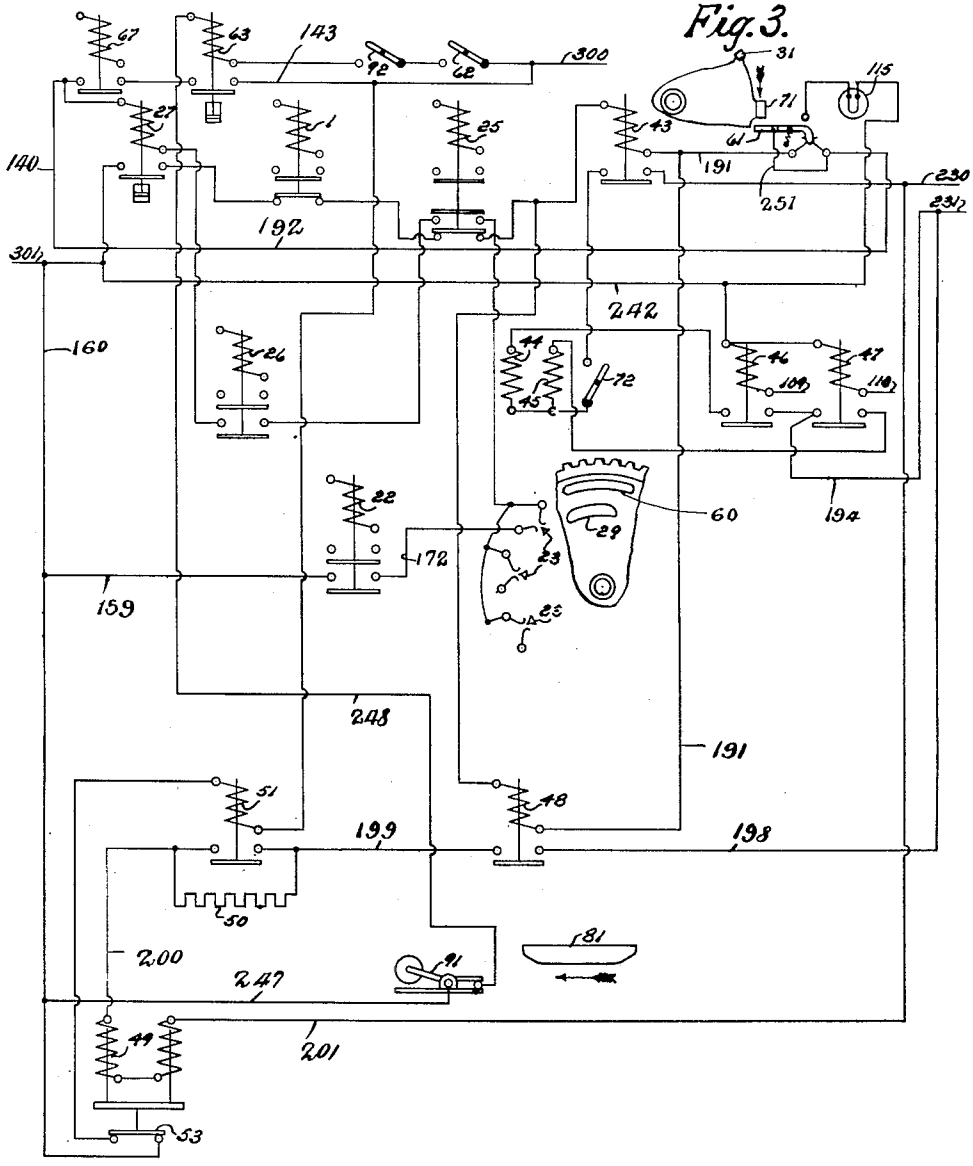
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5 SHEETS—SHEET 3.

Fig. 3.



E. V. Wurts
B. S. Pero
INVENTOR

BY
John D. Morgan
ATTORNEYS

E. V. WURTS AND B. S. PERO.

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5 SHEETS—SHEET 4.

Fig. 4.

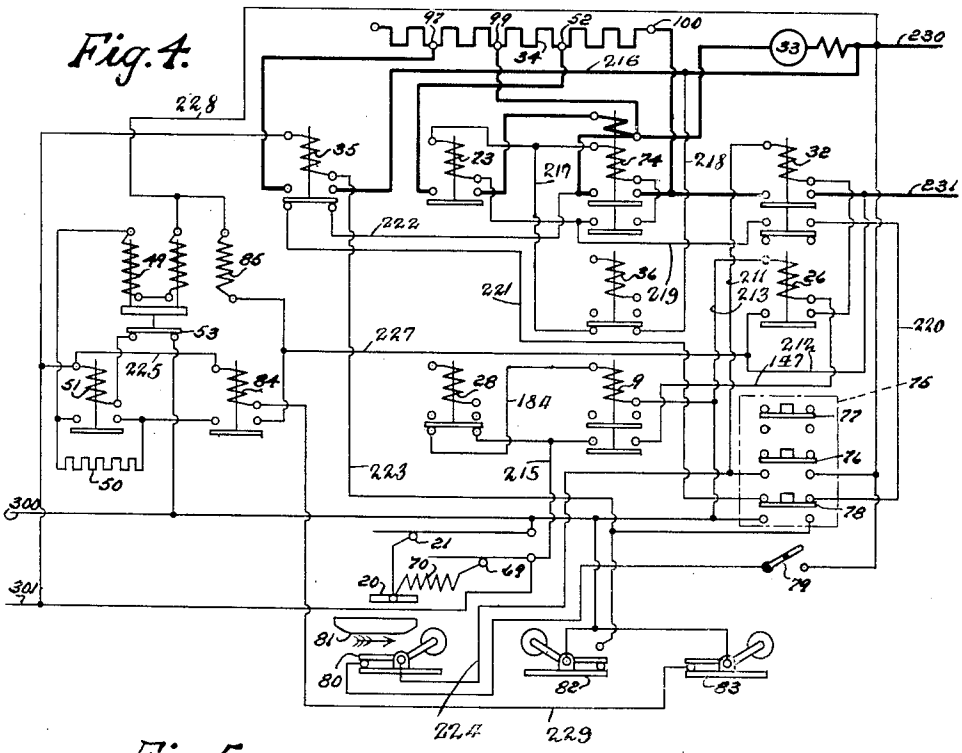
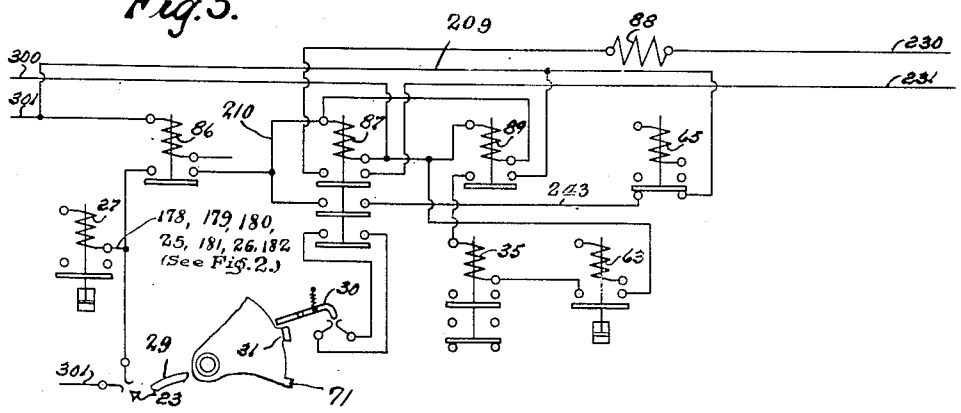


Fig. 5.



E. V. Wurts
B. S. Pero
INVENTOR

John D. Morgan
ATTORNEYS

E. V. WURTS AND B. S. PERO.

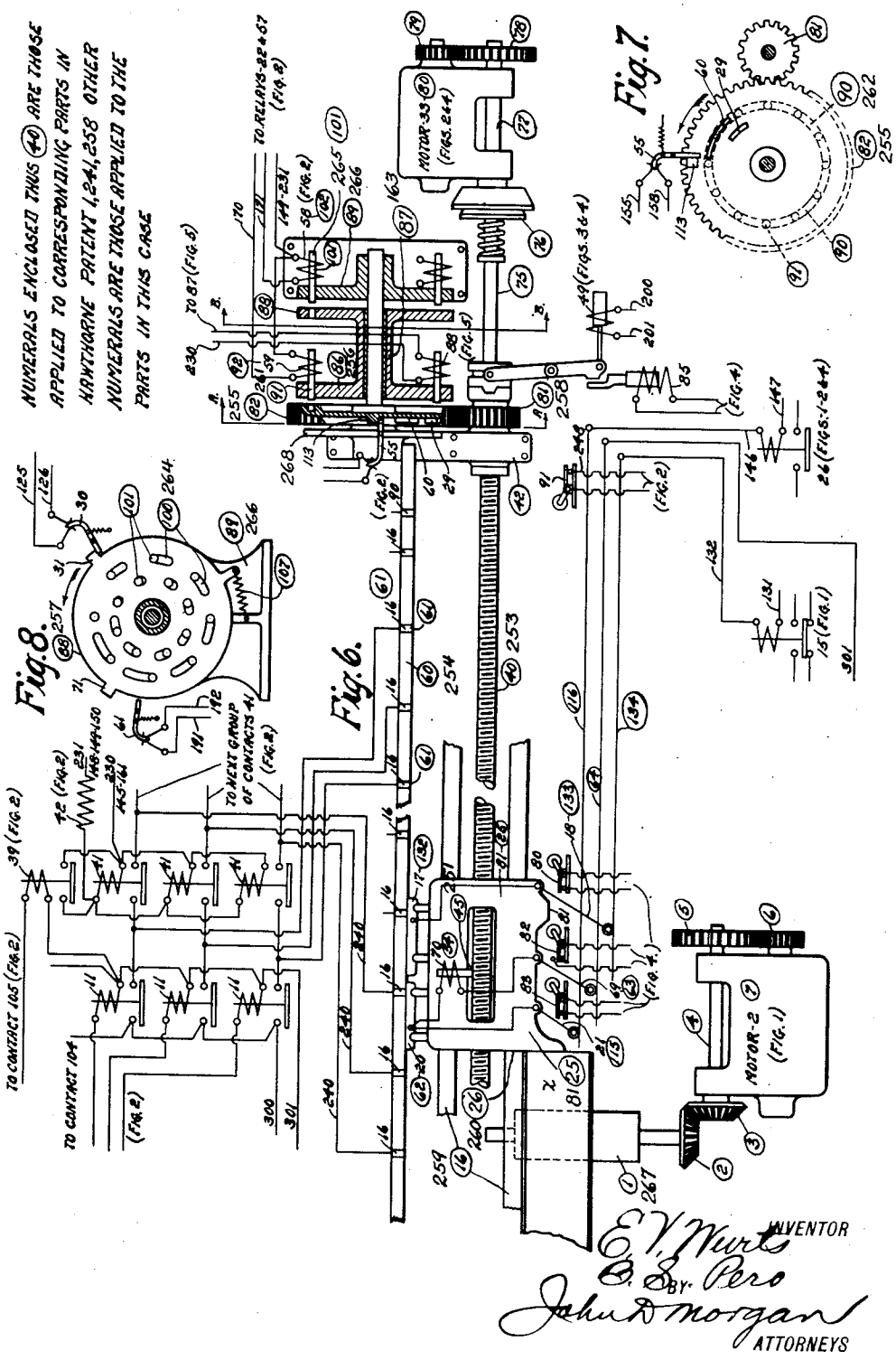
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5 SHEETS—SHEET 5.



UNITED STATES PATENT OFFICE.

EDWARD V. WURTS, OF NEWARK, AND BERTRAM S. PERO, OF JERSEY CITY, NEW JERSEY, ASSIGNORS TO STEEL UTILITIES, INCORPORATED, A CORPORATION OF NEW YORK.

CONTROLLING SYSTEM FOR METAL-WORKING MACHINES.

1,349,995. Specification of Letters Patent. Patented Aug. 17, 1920.

Application filed September 24, 1917. Serial No. 193,011.

To all whom it may concern:

Be it known that we, EDWARD V. WURTS and BERTRAM S. PERO, citizens of the United States, and residents of Newark and Jersey City, respectively, in the State of New Jersey, have invented certain new and useful Improvements in Controlling Systems for Metal-Working Machines, of which the following is a specification.

The invention relates to a controlling mechanism or system for a machine for punching structural shapes and like material or objects, although in certain of its aspects the mechanism or system is adaptable for use with other machines.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described; and the objects and advantages thereof will be set forth in part hereinafter, and in part will be obvious herefrom, or may be learned by practice with the invention.

The accompanying drawings referred to herein and constituting a part hereof, illustrate one embodiment of the invention, the same serving in connection with the description to explain the principles thereof; the drawings being diagrammatic in character.

Of the drawings:—

Figure 1 is a diagrammatic representation of the control for the distance determining means, that is, the mechanism for traveling and stopping the shape or other work relatively to the punch or other tool equipped means;

Fig. 2 is a diagrammatic representation of circuits and coöperating devices for the control motor;

Fig. 3 is a similar representation of the safety, non-punch mechanism, and other devices;

Fig. 4 is a similar representation of the circuits and coöperating parts for returning the carriage by the operator; and

Fig. 5 is a similar representation of the circuits and coöperating parts operating and controlling the "inch lock" for advances in the same inch.

Fig. 6, is a view, largely diagrammatic, showing the exemplary application of the controlling circuits shown in the preceding figures to a machine like that shown in Patent No. 1,241,258 to L. A. Hawthorne; and

Figs. 7 and 8 are like views showing the application of certain of the circuits to certain of the parts shown in Fig. 6.

Referring to the accompanying drawings, illustrating by way of example one embodiment of the invention, it is shown applied to a machine for punching structural shapes or like articles or material, such as is shown and described in Patent No. 1,241,258 to Hawthorne, dated Sept. 25, 1917, or in Patent No. 1,311,276 to Hawthorne and Pero dated July 29, 1919. Certain parts of the machines of said two prior patents are shown herein and referred to so as to make clear the application of the present invention to the machines of said patents and its coöperation therewith.

In the accompanying drawings, the motor 2 corresponds to motor 7, which drives the rolls 1 of said Patent No. 1,241,258. The contacts 16 in the present case correspond to the contacts 61 in rail 60 of prior Patent No. 1,241,258; and shoe 20 herein corresponds to shoe 62 of said patent, and shoe 17 herein corresponds to shoe 132 of Patent No. 1,241,258 and trolley 18 herein corresponds to trolley 133 and trolley 21 herein to trolley 115 in said patent. The foregoing are part of the foot and inch measuring mechanism, which controls the projection and retraction of the interponent 46 and of the slow-down mechanism for the work of the Hawthorne machine.

In the present case, 20 represents a traveling contact or shoe corresponding to shoe 62, and the coöperating trolley 21 herein corresponds to trolley 115, and 33 herein represents a control motor corresponding to motor 80 in the Hawthorne patent. Herein numeral 40 represents the bank of contacts and associated parts which coöperate with the distance record sheet *a*, and correspond to 66, 67, 68, 108, 109 and 139 in the Hawthorne patent, the distance record sheet being 68 in the Hawthorne patent.

Herein 41 is a group of contactors for the tens of feet represented by 163 and 164 in Fig. 11 of Patent No. 1,241,258, and herein 44 represents a punch-controlling solenoid corresponding to 140 in the prior Hawthorne said patent. 69 herein is a trolley 63 in the Hawthorne patent, connecting latch solenoid 70 herein and 54 in the Hawthorne patent; these being mounted on a head or carriage 81 herein and 25 in the said patent.

In the present drawings 58 represents a group of solenoids for the sixteenths-of-an-inch stop pins, numbered 102 in the Hawthorne patent, and 59 herein represents a group of solenoids for inch stop pins numbered 92 in the Hawthorne patent.

Referring more particularly to Fig. 1 herein, which shows more especially the controlling system and devices for the motor driving the roll table or work progressing rolls, and provides for the starting and stopping thereof and for high and slow speed and for acceleration and retardation.

The main line contactor or circuit-controlling device for roll-driving motor 2 is indicated by 1, and 3 is a contactor connecting motor 2 to a part of a resistance 6. 4 is a contactor, operating on series current, with magnetic retardation, and it short circuits resistance 5, which is a series starting resistance for motor 2.

Resistance 6 is used for speed regulation of the motor 2. 7 is a contactor connecting resistance 6 to motor 2, for slow speed, and 8 is a series contactor cutting out a part of resistance 6 for slow speed of motor 2. Contactor 8 is energized by series current of distance-determining or control motor 33. 9 is a contactor which connects power line 231 through control circuits to line contactors 1, 25 and 32 which control the power circuits for motors 2 and 33. 10 is a contactor for safety arrangement in the aforesaid control circuit to motors 2 and 33.

11 is a group of contactors which energize the particular unit in the selected group of tens of feet, and 12 is a contactor for the zero tens of feet circuit. 13 is a contactor in the group 41, which represents any ten feet group, as from 0 to 9 feet, for instance. 14 is a relay for the last, or highest foot segment. 15 is a contactor normally making connections for high speed, and when energized, making connections for slow speed of work progressing motor 2.

A few of the foot segments are indicated by 16, and 17 is a contact bar or traveling shoe on a carriage or head traveling with the work, and operating to slow down motor 2. 18 is a trolley on said carriage or head for the circuit made by shoe 17. 19 is a contactor for holding the circuit made by contact bar or shoe 17 after 17 passes out of engagement with a foot segment 16, and 20 is a contact bar or shoe on the carriage, and following shoe 17 for operation of the motor 33. 21 is a trolley on the head or carriage for the circuit made by contact shoe 20.

22 is a group of contactors energizing the inch pin solenoids and the stop contacts 23. 23 is a group of stop contacts, located on the machine, and operated by cam 29, and being generally similar in construction and operation to those shown in application Ser. No. 166,585 of Hawthorne and Pero filed May 5th, 1917. 24 is a group of contacts, for slow speed, located on the machine, and operated by cam 60 (see Fig. 2) and similar in construction and operation to contacts 23 in the Hawthorne and Pero case.

25 is a contactor in main line circuit of motor 33, for forward rotation of the motor. 26 is a contactor connecting the control circuit to the main line contactors of motor 33. 27 is a relay with dash pot retardation, which controls the coil circuit of contactor 28, and other contactors as will be later described. 28 is a contactor which controls the stop circuits of the motors 2 and 33. 29 is a cam on the machine, traveling proportionately with the work, and it operates successively the stop contacts 23.

30 is a limit switch controlling coil circuit of contactor 10, and 31 is a tappet, on the sixteenth-of-an-inch disk or slot plate, and operates limit switch 30.

Referring more particularly to the circuits for the distance determining or control motor, and to the connections for starting, high speed, slow speed, and stopping, 32 is a contactor controlling main line circuit of motor 33 for reverse rotation. The control motor, that is, the motor for the distance determining mechanism, is designated by 33. 34 is a resistance for speed control of motor 33, and 35 is a contactor for slow speed of said motor, while 36 is a contactor for extra slow speed of motor 33. 37 is a contactor making a holding circuit for contactor 35. 38 is a contactor connecting forward or reverse contactors 25 and 32 for motor 33.

39 is a contactor which operates contactor 13 in the tens of feet group. 40 is an automatic keyboard or bank of contacts for distance record sheet *a*. 41 is a group of ten contactors for tens of feet, of which contactor 13 is one, and 42 is a resistance in the coil circuit of contactor group 41. 43 is a contactor in the punch controlling circuits.

Referring more especially to the diagram of connections for safety, non-punch arrangements, shown more particularly in Fig. 3, 44 is a web punch starting solenoid and 45 is a flange punch starting solenoid. 46 is a contactor for the web punch solenoid circuit, and 47 is a contactor for the flange punch solenoid circuit. 48 is a contactor in circuit of clutch solenoid 49 and 50 is the clutch solenoid resistance, which is cut in or cut out by contactor 51. 53 is a mechanical switch on clutch controlling coil circuit of contactor 51. 52 is a tap on speed-control resistance 34. (See Fig. 4.)

54 is a contactor operated by a limit switch 55 (Fig. 2), which limit switch is in turn closed by tappet 113, when the mechanism has come back to zero. 56 is a con-

tactor used to prevent the inch control mechanism from returning to zero, when the next succeeding reading is in the same foot. 57 is a group of sixteen contactors, energizing the sixteenth of-an-inch stop pin solenoids (marked 102 in Patent No. 1,241,258). 58 is a group of sixteen solenoids for the sixteenths-of-an inch stop pins (marked 101 in Patent No. 1,241,258). 59 is a group of eleven solenoids for the inch stop pins (marked 91 in Patent No. 1,241,258).

60 is a slow down cam traveling with or proportionally to the work, and operating contacts 24. 61 is a limit switch which opens for over-travel of the sixteenths-of-an-inch slot disk (numbered 88 in Patent No. 1,241,258). 62 is a mechanical switch which is opened while distance record sheet is advanced in keyboard or between the contacts. 63 is a contactor, with dash pot retardation, operated by switch 62 (which is a switch 122 in Patent No. 1,241,259, dated Sept. 25, 1917), through hand switch 92. 64 is a normally closed contactor, which controls coil circuit of contactor 65. 65 is a contactor controlling the circuit to solenoids 58 and 59. 66 is a contactor controlling coil circuit of contactor 67. 67 is a contactor, connecting a 30 volt control circuit to the various control mechanisms when the control or distance determining mechanism is connected for forward travel.

68 is a switch, operated by cam 60, and it connects slow speed for return to zero of the screw shaft (marked 40 in Patent No. 1,241,258) or equivalent device. 69 is a trolley on the carriage or head connecting one side of latch solenoid 70 to line 301 (which solenoid is numbered 63 in Patent No. 1,241,258). See also Fig. 4. 71 is a tappet which operates limit switch 61, and is located on disk 88 of Patent No. 1,241,258. 72 (see Fig. 3) is a hand-operated switch for deënergizing punch solenoids 44 and 45.

Referring to the wiring diagram, showing connections for carriage return by hand, and referring especially to Fig. 4, 73 is a contactor, energized by counter E. M. F., used to cut out a section of the starting resistance 34. 74 is a series contactor, with magnetic retardation, and is used to cut out the remainder of starting resistance 34. It has a shunt holding coil.

75 is a push button or other switch control station for the control or distance-determining motor 33. 76 is a push button or other form of switch in control station 75, for reverse motion of motor 33, as hereinafter described. 77 is a push button or other form of switch in control station 75, for forward motion of motor 33, which operates similarly to 76. 78 is a push button or other form of switch in control station 75, for slow speed rotation in either direction of the motor 33. 79 is a knife switch, functioning the same as push button 76. 80 is a limit switch, operated by carriage 81 (corresponding to head 25 in Patent No. 1,241,258) cutting out control motor circuit on the return movement. 82 is a limit switch, closed by carriage 81 on return movement, for slow speed of motor 33. 83 is a limit switch, opened by carriage 81 on return movement, to deënergize clutch solenoid 49 through contactor 84 on return to zero of the carriage. 85 is the clutch latch solenoid.

Referring now to the wiring diagram showing connections for the "inch lock" for advance in the same inch, shown especially in Fig. 5, 86 is a contactor (set from a contact in keyboard or bank of contactors 40), which is in the coil circuit of a contactor 87, controlling through its contacts the inch locking pin solenoid 88. 89 is a contactor, connecting the circuits which give slow speed of motor 33, during the locking operation. 90 is a segment placed beyond the last foot segment, for slowing down the work progressing motor 2, before reaching limit switch 91. See Figs. 1 and 2.

Referring now to certain features and parts, shown in various figures of the drawings:—91 is a limit switch, opened by carriage 81, on over travel thereof, to stop further travel and to stop punching of the work. See Figs. 2 and 3. 92 is a hand-operated switch in coil circuit of contactor 63. See Fig. 2.

Referring now especially to Fig. 1:—93 is a tap on resistance 6, used for high speed, and 94 is a tap on resistance 6, used for slow speed, while 95 is a tap on resistance 6, used for extreme slow speed. Referring more particularly to Fig. 2:—96 is one end of resistance 34, and 97, 98 and 99 are taps on resistance 34, and 100 is the other end of resistance 34.

101 is a contact on keyboard or contact bank 40, for preventing return to zero of the inch mechanism when making a successive reading in the same foot. 102 is one of a group of sixteen contacts, on keyboard or bank 40, for the sixteenths-of-an-inch stop pin solenoids, and 103 is one of a group of eleven contacts on the keyboard or bank 40, for the inch stop pin solenoids. 104 is one of a group of ten contacts on keyboard or bank 40, for foot settings, and 105 is one of a group of contacts on keyboard or bank 40, for tens of feet settings.

106 is a contact on keyboard or bank 40, for the web punch solenoid or other form of starter. See also Fig. 3. 107 is a contact, on the keyboard or bank 40, for the flange punch clutch solenoid or other form of starter. See also Fig. 3. 108 is one of a group of contacts on keyboard or bank 40

for setting the gags for the punches. 109 is a connection from contact 106, Fig. 2, to solenoid 46, Fig. 3. 110 is a connection from contact 107, Fig. 2 to contactor 47, Fig. 3. 111 is a contactor closing circuit of punch gag solenoid 112, see Fig. 2. 113 is a tappet on the inch gear (marked 82, in Patent No. 1,241,258) for closing limit switch 55. 114 is a signal lamp for indicating any failure which might occur in effecting the inch measurement (see Fig. 2), and 115 is a similar signal or indicating lamp for the sixteenth-of-an-inch measurement. See Fig. 3.

230 is one line of the 230 volt source of power, and 231 is the other line thereof. 300 is one line of the 30 volt source of power, and 301 is the other line thereof.

The foot contacts 16 are connected as follows: The group of contactors 11 energize like units in each group of ten feet contacts 16. That is, one contactor energizes foot contacts 16, for instance, for 29 feet, 19 feet and 9 feet, and the other nines in all the groups of ten, and one contactor energizes contacts 16, for 20, 10 and 0 feet, and so on. Each foot unit in each group of ten feet, as for instance 29 feet, 19 feet, 9 feet, is connected through a corresponding group of contactors 41, located, respectively, between each two such units in the successive groups. For example, there is a contactor 41 between 29 feet and 19 feet, another between 19 feet and 9 feet, and so on.

These contacts 16 are connected with contactors 41, so that any group of contactors 41, opening, will deënergize all of their contacts 16 below the numeral value of the group so opening.

The system and mechanism described and referred to hereinbefore, operates substantially as follows:

It will be understood that certain of the operations which are of necessity described sequentially occur simultaneously in the machine or are simultaneous in part.

Assuming the work to be at rest, and to start and bring the work to full speed, and then to slow down and bring the work to rest in the desired or measured position with respect to the punching mechanism or other tool-equipped means, the operation would be:—

To set the inch and sixteenths-of-an-inch stop pins, and to start the work progressing motor 2, and bring the work to full speed.

Upon closing switch 92, with the record sheet placed in the keyboard and the switch 62 closed, line 300 connects through switches 62 and 92 to one side of the coil of contactor 63. The other side of this coil connects through line 248, limit switch 91 and lines 159 and 160 to line 301, contactor 63 is energized. (See description Fig. 2). This connects line 300, through line 120 (Fig. 1) and through lines 143, 142, 141, contacts of contactor 67, lines 140 and 193 (Fig. 2), to one side of the coil of contactor 9. The other side of the coil of contactor 9 connects through line 184 (Fig. 2) and through deenergized position contacts of contactor 28, through line 121 and contactors 12, 13 or 14, through line 122 to line 301, thus completing the circuit of the coil of contactor 9, thereby closing said contactor 9. Contactor 9 in closing connects line 231, through line 123 (Fig. 1) and through lines 148, 149 and 150 (Fig. 2), to one contact of contactor 10 through line 124.

Assume the inch control mechanism to be at zero position. One side of the coil of contactor 66 is connected to line 300 through contactor 63 and line 143. The other side of the coil of contactor 66 connects to line 301 through line 155, switch 55 and lines 158, 159 and 160 (Fig. 2). Switch 55 is closed only when mechanism has returned to zero. Switch 55 in closing, denoting zero position, also connects line 301 through line 160, 159, 158, switch 55 and line 156 to one side of coil of contactor 54; the other side of coil of contactor 54 connects through line 202, contacts of contactor 63 and line 143 to 300, thereby closing contactor 54 which maintains a holding circuit by bridging switch 55, on one side through line 157 and on the other side through line 156. Contactor 54 is closed by limit switch 55 when the mechanism is in zero position, as previously described. The coil of contactor 66 is in parallel with the coil of contactor 54 through line 202 on one side and lines 155 and 156 on the other side, therefore contactor 66 is energized. Contactor 66 in closing connects through lines 145, 161, 162 and 163, and line 230 to one side of the coil of contactor 67 through line 164. The other side of the coil of contactor 67 connects through line 165 to line 231, thus closing contactor 67. Contactor 67 connects line 300, through line 143, through contacts of contactor 63 and lines 142 and 141, to the common contacts of keyboard or contact bank 40, through lines 140, 139, and 166 and also through line 139 and through the contacts of contactor 64, to one side of the coil of contactor 65. The other side of coil of contactor 65 connects through lines 159 and 160 to line 301.

Contactor 65 closes and through lines 145, 161, 162 and 163, connects line 230, through contacts of contactor 66, through line 167, to contacts of contactors 22 and 57. It will be recalled that 22 represents a group of eleven contactors for the inch stop pin solenoids and 57 a group for the sixteenths-of-an-inch. One contactor in each of these groups 22 and 57 is closed from keyboard

contacts 103 and 102, through lines 168 and 169, line 301 being common, through lines 159 and 160, to one side of all of the above contactor coils.

The closing of contactor 22 completes the circuit in lines 230, 145, 161, 162, 163, contacts of contactors 66 and 65, line 167, relay 22, and through 170, to one side of solenoid 59. The other side of solenoid 59 connects through lines 149 and 148 to line 231, setting the inch pin.

The closing of contactor 57 completes the circuit through line 171 to solenoid 58, the other side of said solenoid being common with solenoid 59, setting the sixteenths-of-an-inch pin. Switch 30 is closed, connecting line 300 through contactor 63, and lines 120, 125 and 126, to one side of the coil of contactor 10. The other side of the coil of contactor 10 is connected, through line 122, to line 301. This energizes contactor 10, which closes, and thus completes the circuit from line 231, through line 123, through contactor 9, through lines 124 and 127, to one side of the coil of contactor 1. The other side of the coil of contactor 1 is connected to line 230 through line 128 and contacts of contactor 11, as later described. The closing of the contactor 1 connects line 230 to one side of roll driving motor 2, and also through line 129 to one end of the resistance 6. The other end of resistance 6 is connected through line 130 to line 231.

Assume an energized foot contact 16 to be connected to line 300 (as will be described later) one side of coil of contactor 15 is connected through line 131 to line 301. The other side of coil of contactor 15 is connected through line 132 to contact bar or shoe 17 through trolley 18. As contact bar 17 has not yet advanced to engage the energized foot segment 16 (which has been selectively energized from the distance record sheet *a*) contactor 15 will be in deënergized position, and will connect line 231 through line 130 to one side of coil or contactor 3, through line 133. The other side of coil of contactor 3 connects through deënergized position contacts of contactor 7 and lines 134 and 129 to line 230. Contactor 3 is thereby energized, and in closing, connects tap 93 of resistance 6, through line 135, through resistance 5 and through series coil of contactor 4, and through line 136, to the other side of table motor 2, thereby starting the motor and progressing the work. As the motor accelerates, contactor 4 which is magnetically retarded closes, thereby short circuiting resistance 5, and bringing the motor 2 to high speed.

To energize the selected segment for the required feet of travel, and to slow down motor 2.

When contact bar or shoe 17 engages the energized segment 16, line 300 is connected through trolley 18 and line 132 to one side of the coil of contactor 15, thereby closing said contactor. Contactor 15 in closing opens the coil circuit of contactor 3 in line 133, and connects line 230 through lines 129 and 134, through line 137 and deënergized position contacts of contactor 3, to one side of the coil of contactor 7. The other side of the coil of contactor 7 is connected to line 231, thereby closing contactor 7. Contactor 7 in closing connects tap 94 of resistance 6 through lines 138 and 136 to one side of motor 2. The other side of motor 2 is connected to line 230 through contacts of contactor 1 and to one end of resistance 6, and line 129. Motor 2 now runs at slow speed.

When contact bar 17 leaves energized segment 16, contact bar or shoe 20 will next engage said segment 16, thereby energizing coil of contactor 19 through trolley 21. Contactor 19 holds the connection of line 300 to one side of the coil of contactor 15 through line 132, thus holding slow speed. For extremely slow speed, contactor 8 is energized by the series current of motor 33 (Fig. 2). Contactor 8, in closing, short circuits the resistance between tap 95 and the end of resistance 6 thereby further slowing down the speed of motor 2.

When the inch travel is completed, relay 27 is energized through contactor 67 by the closing of switch 61 on the forward movement of the machine at the beginning of the travel for the sixteenths of an inch. The closing of relay 27 closes line 301, through lines 176, 177, and 183 (Fig. 2), to one side of the coil of contactor 28. The other side of the coil of contactor 28 is connected, through line 120 (Fig. 1) and lines 140, 141, 142, contacts of contactor 63 and line 143 (Fig. 2), to line 300. The energizing of contactor 28 opens the coil circuit of contactor 9, which through its contacts opens the coil circuit of contactor 1, through lines 124 and 127, thereby shutting down motor 2. Contactor 28, in closing, makes a holding circuit for its own coil.

To energize latch solenoid 70, setting the carriage latch, and to start motor 33 of the distance determining mechanism.

Referring now to the control for the motor 33 of the distance determining mechanism, continuing from the point in the previous description, when contact bar or shoe 17 (see Fig. 2) passes from engagement with energized segment 16, and contact bar or shoe 20 engages said segment 16.

The selected segment 16 in the group of units of feet is connected through line 240, contacts of contactor 41, contacts of contactor 11 (which contactors are closed by being energized from the contacts 40, closed by distance record sheet *a*) through lines

166, 139 and 140, contacts of contactor 67 (which is closed through contacts of contactor 66 for forward running of the work), through lines 141 and 142, contacts of contactor 63 and line 143, to line 300.

The engagement of contact bar or shoe 20 with said energized segment 16 connects line 300, through lines 143, 142, 141, 140, 139, 240 and contacts of contactors 63, 67, 11 and 41, to one side of solenoid 70. The other side of solenoid 70, connecting through trolley 69 to line 301, energizes solenoid 70 and thereby sets the carriage latch (which latch is numbered 46 in Patent No. 1,241,258). Contact bar 20 also connects line 300, through trolley 21, and line 146, to one side of the coil of contactor 26. The other side of coil of contactor 26 connects to line 301, through line 147 and contacts of contactor 9, which closes contactor 26. Contactor 26 in closing, through lines 148, 149 and 150, connects line 231, through contacts of contactors 9 and 10, through lines 124 and 186, respectively, and through line 151, deënergized position contacts of contactor 32 and line 188, to one side of the coil of contactor 25.

The other side of the coil of contactor 25 connects to line 230, through line 152, deenergized position contacts of contactor 38 and line 145. This closes contactor 25, which connects line 230 to the end 100 of resistance 34, and connects line 231 through line 153 to one side of the control motor 33 and through line 154 to end 96 of resistance 34. The other side of motor 33 connects to tap 99 of resistance 34. The control motor 33 starts at high speed.

To slow down motor 33 and further slow down motor 2.

Contactor 22 in closing as described has connected line 301 through line 172 to contacts 23 and 24. When slow-down cam 60 closes the energized contact 24, it connects line 301 through contacts of contactor 22 and through lines 160, 159 and 172 and through contacts of contactor 67 and line 173 to one side of the coil of contactor 35.

The other side of the coil of contactor 35 connects to line 300 through line 142, contactor 63 and line 143.

The closing of contactor 35 short circuits the resistance between taps 96 and 97 of resistance 34, through the series coil of contactor 8. Contactor 36 has its coil connected across armature of motor 33, operating on counter E. M. F. If motor 33 has been running high speed long enough to get up to speed, contactor 36 will close, and will short circuit, through its contacts, between taps 97 and 98 of resistance 34, thereby causing a slower speed of the motor.

The control motor 33 slows down, and the closing of contactor 8 further slows down the table motor 2.

Contactor 35 in closing, connects through lines 175 and 154 the coil of contactor 37 across armature of motor 33. The contacts of contactor 37, through lines 176 and 177, connect line 301, through line 174, to the same side of the coil of contactor 35 as contacts 24 through contacts of contactor 67, line 173, contacts 24, line 172, relay 22, lines 159 and 160 to line 301. This makes a holding circuit for contactor 35.

To stop motor 33.

When cam 29 closes energized contact 23, line 301 is connected through lines 160 and 159 and contacts of contactor 22, and through lines 172, 178, 179 and 180, through contacts of contactor 25, through line 181, contacts of contactor 26, and line 182 to one side of the coil of relay 27. The other side of the coil of relay 27 connects through line 140 through contacts of contactor 67, lines 141 and 142, contacts of contactor 63, and line 143, to line 300, thereby energizing relay 27, which closes after a retardation which allows the sixteenths-of-an-inch distance to be traveled.

The closing of relay 27 (as just described) through line 183 connects line 301 through lines 176 and 177 to one side of the coil of contactor 28. The other side of the coil of contactor 28 is connected to line 300 through line 140, contacts of contactor 67, lines 141 and 142 and through contacts of contactor 63 and line 143, thereby closing contactor 28, which makes its own holding circuit by connecting line 301 through line 176 to upper contacts of contactor 28.

Contactor 28 thus closing, opens line 184 in the coil circuit of contactor 9, which contactor through its contacts opens the coil circuits of contactor 26, through line 147, and contactor 25, through lines 121, 186, 151 and 188, thus stopping motor 33 of the distance control.

Relay 27 in closing also connects line 301, through line 183 and deënergized position contacts of contactor 1 and line 189 and deenergized position contacts of contactor 25 and line 190, to one side of the coils of contactors 43 and 48. The other side of coils of contactors 43 and 48 connects through line 191, through limit switch 61 and through lines 192 and 193, and 140 and contacts of contactor 67, and lines 141 and 142, and contacts of contactor 63 and line 143 to line 300, thus closing contactors 43 and 48.

The closing of contactor 43 connects line 230—see Fig. 3—through switch 72 to one side of the coils 44 and 45. The other side of coil 44 connects through contacts of contactor 46 and line 194 to line 231. The other side of selenoid coil 45 connects through line 242 through contacts of contactor 47 and line 194 to line 231. One side of the coils of contactors 46 and 47 connects to line 301.

The other side of coil of contactor 46 is shown as wire 109. The other side of the coil of contactor 47 is shown as wire 110.

Referring again to Fig. 2: Wire 109, through keyboard or bank contact 106, connects through lines 166, 139 and 140, contacts of contactor 67, lines 141 and 142, and contacts of contactor 63 and line 143 to line 300. Wire 110, through keyboard contact 107 and similarly through contacts of contactors 67 and 63, connects to line 300. This releases the punching mechanism.

The correct punches have been previously set from the keyboard or bank contacts, through the distance record sheet, by having their respective gags placed in operative position.

The gag solenoid 112 (Fig. 2) is connected, through lines 196, 149 and 148 to line 231 on one side, and on the other side, through contacts of contactor 111, through lines 161 and 145 to line 230. One side of the coil of contactor 111 is connected, through lines 158, 159 and 160, to line 301. The other side of coil of contactor 111 is connected to line 300, through keyboard contact 108 and through the contacts of contactors 67 and 63 through the circuit previously described.

Motor 2 stops at the same time as motor 33, by the closing of relay 27, and through the connections previously described.

To release latch and inch and sixteenths-of-an-inch stop pins.

Relay 27 in closing, also connects line 301 through line 197 to one side of the coil of contactor 64. The other side of the coil of contactor 64 is connected through lines 139, 140 and contacts of contactors 67 and 63 to line 300, thus energizing contactor 64. The energizing of contactor 64 opens the coil circuit of contactor 65, deënergizing the inch and sixteenths-of-an-inch, solenoids 58 and 59 in line 167 and lines 170 and 171. This takes place at the same time as the closing of contactor 48 which has just been described.

Contactor 48 in closing—see Fig. 3—connects line 231, through lines 198 and 199, through contacts of contactor 51 and line 200, to one side of solenoids 49. The other side of solenoids 49 connects through line 201 to line 230. When solenoid coils 49 are energized, switch 53 is open, deënergizing contactor 51 and connecting resistance 50 in circuit to reduce the current in coils 49. The energizing of solenoid coils 49 opens the clutch and releases the stop pins, the solenoids coils of which have been deënergized by the deënergizing of contactors 22 and 57 as described.

After this the mechanical switch 62 is opened, which disconnects line 300, (Figs 1, 2 and 3) while the distance record sheet is advancing for a new reading.

Assume the next reading to be in the next foot. Limit switch 55 (Fig. 2) is open, due to the advance of the mechanism. Line 300 connects to one side of the coil of contactor 63 when switch 62 is closed. This closes contactor 63 and through line 143 connects line 300 through line 202, deënergized position contacts of contactor 56 and line 203 to one side of the coil of contactor 38. The other side of the coil of contactor 38 connects, through line 204, deënergized position contacts of contactor 54, and through lines 157, 158, 159 and 160, to line 301, thus closing contactor 38. Contactors 54 and 66 cannot close, due to limit switch 55 and contactor switch 56 being open; therefore contactor 67 cannot close.

Contactor 38 in closing connects line 230 through line 145 to one side of coil of contactor 32 through line 205. The other side of coil of contactor 32 connects to line 231 through lines 151 and 206, and contacts of contactor 38 and lines 207 and 148. This closes contactor 32, which connects motor 33 and resistance 34 to line 230 and line 231, as described above for contactor 25, except for reverse rotation.

Contactor 67 being deënergized, one side of coil of contactor 35 is connected, through deënergized position contacts of contactor 67 and through line 208 and slow-down contact 68 and lines 158, 159 and 160 to line 301, when cam 60 closes contact 68 on the return movement. The other side of coil of contactor 35 is connected through line 142, contact of contactor 63 and line 143 to line 300. This allows contactor 35 to close at a predetermined point, before the mechanism reaches the zero point. When the mechanism reaches the zero position, tappet 113, closes limit switch 55, which connects line 301, lines 160, 159 and 158 through line 156, to one side of coil of contactor 54.

The other side of the coil of contactor 54 is connected through line 202 through contact of contactor 63 and through line 143 to line 300. Contactor 54 closes, and deenergizes, through its contacts, the coil of contactor 38, in line 204, which in turn deenergizes the coil of contactor 32 through lines 206 and 151. Contactor 38, through its deënergized position contacts and line 152, energizes the coil of contactor 25, for forward rotation of control or distance determining mechanism motor 33.

The closing of switch 55 and contactor 54, the latter making a holding circuit for itself and a short circuit around switch 55, completes the circuit from line 301 to contactor 66, which in turn closes contactors 67, 65, etc., as described above.

Referring now to the locking arrangement for advance or feed of the work in the same inch for the next punching or like operation (see Fig. 5):—

To obtain a second reading in the same inch, the inch locking pin must be set in the previous reading, to prevent the return of disk 86 to zero or initial position. One side of the coil of contactor 86 is connected to a keyboard or bank contact, which connects to line 300, through one contact of group 40, line 166, line 139, line 140, upper contacts of relay 67, line 141, line 142, contacts of relay 63, and line 143. The other side of the coil of contactor 86 connects to line 301. This energizes the coil of contactor 86 in the previous reading.

When the energized stop contact 23 closes, line 301 is connected through contacts of contactor 86, through line 210, to one side of coils of contactors 87 and 89. The other side of coils of contactors 87 and 89 is connected to line 300. When the inch slot moves into engagement with the set inch pin, and energized contact 23 is closed by cam 29, contactors 87 and 89 are energized.

Contactor 87 connects line 231 to locking pin solenoid 88. The other side of solenoid coil 88 is connected to line 230. Contactor 87 in closing also makes its own holding circuit through line 209, a normally closed interlock on contactor 65 and lines 243 and 210.

By referring to Fig. 2, it will be seen that contactor 65 is deënergized by the closing of relay 27 and contactor 64, before contactor 86 opens. Such prior opening of contactor 65 is effected by contactor 27, which in closing energizes relay 64, which in turn deënergizes coil of relay 65, thereby opening the relay. Relay 86 gets its current through the keyboard or distance record sheet, and through contacts of relay 63, which relay is controlled by the mechanical switch 62. Switch 62 is operated from the main shaft of the punch, which has been set in motion by the closing of relay 27. There is therefore an appreciable lag or pause before relay 86 can be opened. Therefore, the holding circuit of contactor 87 is held by its own contacts, through the deenergized position contacts of contactor 65, and line 209 back to line 301. This holds locking pin solenoid 88 closed while the distance record sheet is advancing to the next setting.

Contactor 87 in closing also bridges contacts of limit switch 30 as explained later herein. Limit switch 30 must be closed, or bridged, before the control or distance determining mechanism can go ahead, that is, it insures that the inch determining mechanism has returned to zero or initial position. When, however, the inch lock pin 88 is used, the limit switch cannot close, and is bridged by the lower contacts of relay 87, and the machine starts forward from its last position (see Fig. 5). The coil of the contactor 89, being connected in parallel with the coil of contactor 87, also holds closed as long as 87 is held. Contactor 89 connects line 301 and line 209 to one side of the coil of contactor 35, making positive the closing of contactor 35, (after contactor 63 has closed) which connects slow speed on motor 33, even though cam 60 has moved past the energized slow contact 24.

After the distance record sheet has advanced, and contactor 63 closes, contactors 65, 22 and 67 are energized, connecting the same inch solenoid as was set in the preceding reading, and at the same time deënergizing the locking pin solenoid 88 by opening the coil circuit of contactor 87, and the mechanism completes its travel as before.

Referring now to the safety features for guarding against failure of feet or tens of feet to function (see Fig. 1;)

If contactors 12, 13, 14 or 11 fail to function, due to keyboard or bank contacts failing, or the relay coil circuit failing, the work progressing motor 2 cannot start.

The failure of contactor 12, 13 (which contactor is normally closed) or 14 prevents contactor 9 from closing. In case contactor 9 should close, and the unit contactor 11 fails, the coil circuit for table motor control, (which is contactor 1,) would be broken through contacts of contactor 11.

Contactors 12, 13 and 14 failing and preventing contactor 9 from closing, also hold up contactor 26, see Fig. 2—preventing the completion of the circuit to coil of contactor 25, and the control motor 33 likewise cannot start. The failure of contactor 11 to close also prevents contactor 26 from closing, and motor 33 from starting, by reason of foot segment 16, not being energized except when one of the contactors of group 11 is closed.

Should an inch stop pin stick or fail to release.

Referring again to Fig. 1: If limit switch 30 is not closed by tappet 31, after a reading has been made, which would happen should an inch stop pin stick or fail to release, contactor 10 could not close, which would hold open the circuit of contactor 1, preventing the starting of work progressing motor 2.

In Fig. 2, the failure of contactor 10 will hold open the circuit of contactor 25 thus preventing the start of control motor 33. If the motors 2 and 33 have started, and the inch stop pin fails to engage its slot, the control or distance determining mechanism advances until cam 60 closes the eleven inch contact 24^a, thus slowing down the control motor 33. As the eleven inch contact 23^a is energized only when the eleven inch contactor 22 is closed, the motors will

continue to run at slow speed. The engagement of the eleven inch stop pin in its slot arrests the mechanism.

The dash pot retardation of relay 27 prevents the relay from closing while cam 29 is passing over the energized contact 23^a for the set inch. When cam 29 closes contact 23 for eleven inches, a lower inch contact being energized, a circuit is made from line 301, through lines 160, 159, 241 and 242, through indicating or signal lamp 114, through contact 23^a through lines 178, 179 and 180 and contactor 25, through line 181, and contact of contactor 26, through line 182 and coil of relay 27, through line 140 and contact of contactor 67 and through line 141 and 142 through contact of contactor 63 and line 143, to line 300, causing the indicating lamp 114 to glow. The current taken by the lamp is of a value that will not cause relay 27 to operate.

Should a sixteenth-of-an-inch stop pin stick or fail to release.

Referring to Fig. 3: The failure of relay 27 to close prevents contactors 43 and 48 from operating and so holds open the circuit of punch solenoids 44 and 45.

Should a sixteenth-of-an-inch stop pin fail, tappet 71 will open limit switch 61, which opens circuit in line 191 as above to coils of contactors 43 and 48. Limit switch 61, in opening, makes a circuit from line 300 through line 143, through contacts of contactor 63, and contacts of contactor 67 through lines 140, 192 and 251, to one side of indicating or signal lamp 115. The other side of the lamp is connected to line 301 through line 242, causing lamp to glow.

Should the latch fail to engage the screw shaft.

Should work progressing motor 2 start and the latch fail to engage the screw shaft, the head or carriage will be pushed along until contact bar or shoe 17 (Fig. 1) engages segment 90. Referring to Fig. 2, segment 90 connects through lines 193 and 140 and contacts of contactors 67 and 63 to line 300. Motor 2 will then slow down as described above.

Referring to Figs. 2 and 3, carriage 81 will operate limit switch 91, opening line 248 in the coil circuit of contactor 63, and disconnecting the control circuit from the motors.

Referring now more especially to the carriage return by hand (Fig. 4):—

When button 76 of switch station 75 is operated, it connects line 230 through line 211 to one side of coil of contactor 32. The other side of coil of contactor 32 is connected through contacts of contactor 26 and line 212 to line 231. Contactor 26 is in closed position. One side of its coil is connected to line 300, through line 213, and the other side of the coil to line 301, through line 147, contacts of contactor 9 and line 215. Contactor 9 is in closed position. One side of its coil is connected to line 300 through line 213 and the other side of the coil is connected, through line 184 and the deënergized position contacts of contactor 28 and line 215, to line 301. Contactor 28 is deënergized. Contactor 32 closes, connecting line 231 through end 100 of resistance 34 and line 216 to one side of motor 33, and to one side of series coil of contactor 74.

The other side of motor 33 connects to line 230. The coil of contactor 73 is connected across armature of motor 33, one side through line 217, the deënergized position contacts of contactor 36 and line 218, and the other side through line 219, contacts of contactor 32, line 220, through up or normal position of switch 78, through line 221, and through deënergized position contacts of contactor 35 and line 222.

Contactor 73 operates on counter E. M. F. and will therefore close at a predetermined point, connecting through its contacts, line 231, through contacts of contactor 32, through end 100 of resistance 34, through tap 52, and through series coil of contactor 74, to one side of control motor 33. Resistance between taps 99 and 52 on resistance 34 has been cut out. Current is now flowing through series coil of contactor 74, and this contactor will close, after a magnetic retardation, connecting line 231 directly to one side of control motor 33. When contactor 74 closes, it short circuits its series coil, and connects its shunt holding coil in parallel with coil of contactor 73.

When button 78 of station 75 is operated; it connects line 300, through line 223, to one side of the coil of contactor 35, and opens the coil circuits of contactors 73 and 74 in lines 219 and 220. The other side of the coil of contactor 35 is connected to line 301. This closes contactor 35, which makes the following connections:—

One side of motor 33, and line 230 are connected to tap 97 of resistance 34. The other side of motor 33 is connected to tap 99 of resistance 34, and line 231 is connected to end 100 of resistance 34, giving slow speed. To return the carriage or head to the zero position, switch 79 is closed, preferably by hand, closing contactor 32, which connects motor 33 in the reverse direction. Push button 76 in station 75 functions the same as switch 79, except that it is independent of limit switch 80.

When the carriage 81 reaches limit switch 80, contactor 32 is deënergized in lines 224 and 211, dropping out contactors 73 and 74, and cutting power off from the motor 33. The motor drifts until carriage or head 81

engages the limit switch 82. Limit switch 82 is in parallel with the lower contacts of button 78, and contactor 35 is energized for slow speed. At the instant that limit switch 82 operates, carriage 81 passes off from limit switch 80, allowing the switch to close, and throw the motor on the line with the above-described slow-speed connections.

When switches are thrown for hand return of carriage, latch solenoid 70 is connected through trolley 69 to line 301, and through trolley 21 to line 300, setting the latch.

One side of the coil of contactor 84 is connected through line 225 to line 301, and the other side through line 226 and limit switch 83 to line 300, closing contactor 84 (Fig. 4). The coil of contactor 51 is connected to line 301, and through switch 53 to line 300, energizing contactor 51, which short circuits resistance 50. This connects one side of solenoids 49, through contacts of contactor 51, through contacts of contactor 84 and lines 227 and 212, to line 231. The other side of solenoids 49 and one side of solenoid 85 are connected through line 228 to line 230. The other side of solenoid 85 is connected through lines 227 and 212 to line 231. Solenoids 49 and 85 are thereby energized, and solenoids 49, in operating the screw shaft clutch, to disengage the distance determining mechanism therefrom, open switch 53, which opens the coil circuit of contactor 51, cutting resistance 50 in circuit, and reducing the current through solenoids 49.

Solenoid 85 operates the clutch latch or other releasing mechanism. This clutch latch is a device for permitting the easing of the main clutch, operated by solenoid 49. Thus the pressure is eased off the inch and sixteen stop pins, while preventing the clutch disconnecting and thereby destroying the relation between the screw shaft 40 (Fig. 6) and the inch determining mechanism. When solenoid 85 is energized, the clutch can be disengaged. When solenoid 85 is not energized, the clutch can be only partly disengaged, giving back lash or lost motion, for the easy release of the previously set stop pins.

When carriage 81 reaches the zero feet position, limit switch 83 is engaged, opening line 229 in the coil circuit of contactor 84, which deënergizes solenoids 49, allowing the clutch to drop into engaging position. The machine now stands ready to start with a new distance record sheet, on a new beam.

Speed controls.

The work progressing means has a high speed, which is effected through speed regulation of the motor 2, and an intermediate or slow speed which is harmonized with the high speed of the screw shaft, or equivalent device, to provide for the engagement of the latch with the screw shaft and the subsequent travel together thereof, until such time as the screw shaft slows down, when the work progressing means again slows down (to what may be termed a slow or very slow speed) to harmonize with the slower speed of the screw shaft, and of the motor 33. Thus the movements and operations of the work progressing means and the distance determining means are coördinated and harmonized, and in the present embodiment this is effected by resistances and automatic controls therefor in circuit with the two motors 2 and 33, and the work is thus handled at the most efficient speed and in the best or most advisable way.

Undesirable acceleration of the work when the feed or travel between successive punchings or other operations is very short, as for instance, within the same foot or inch, is prevented, as already pointed out in detail. This is effected, as embodied, by the contactor and coöperating devices which hold the slow-down circuit after the shoe has passed out of contact with the energized foot contact, which contactor is energized by the second or following shoe.

The acceleration device or mechanism is prevented from operating when the retardation device has begun to operate first due to electrical interlocks between the contactors, operated preferably by the contactors themselves, and one contactor cannot close until the other is open, as already explained in detail.

In connection with the exemplary showing of Figs. 6, 7 and 8 of the application of the control system to a machine like that of the Hawthorne Patent No. 1,241,258, previously referred to, the operation of the mechanism for a typical distance reading or setting for a desired travel of the structural shape or other work, is substantially as follows:—

(The reference numerals used in parentheses herein correspond to the numerals applied to the same parts in the Hawthorne Patent No. 1,241,258, and where the corresponding parts are previously described in this case, the reference numerals therefor are used in conjunction with the numerals in parentheses from the Hawthorne patent. This is believed to be the briefest and clearest way of connecting up the two devices by description.)

For the purpose of generally correlating Figs. 6, 7 and 8, with the Hawthorne patent, it may be stated that the head or carriage 81 (25) is pushed forward by the beam, plate or other work x, which is driven by rollers 267 (1) from motor 2 (7). Latch or engaging member 251 (45), when its solenoid winding 70 (54) is energized from the distance record sheet a (68), engages with

screw shaft 253 (40). This determines the number of feet of travel, and the subsequent rotation of screw shaft 253 (40) determines the travel for inches and fractions thereof. (This is taken as a typical example of operation, but the machine will feed for successive inches or fractions of an inch within the same foot by the latch reëngaging the screw shaft after the required hole is punched). The solenoid 70 (54) is energized from the live foot contact 16 (61) carried on bar 254 (60). Shoe 20 (62) and shoe 17 (132) slide along contacts 16 (61).

A group of the units of feet contacts 11 and a group of the tens of feet contacts 41 are shown in the upper part of Fig. 6, which will serve to connect this part of the figure to the diagrams of the preceding figures. The trolley 18 (133) is shown with circuit connections to contactor 15 for slow-down of motor 2 (7); and trolley 21 (115) is shown with connections to contactor 26 for starting screw shaft motor 33 (80), the details thereof being already described in this case.

Pinion 258 (81) on screw shaft 253 (40) meshes with gear 255 (82) of the inch-determining mechanism. Stop pin disk 256 (86) carries the inch solenoids and stop pins, shown as 59 (92) and 58 (102) as identified in the present case. Disk 257 (88) coöperates with the sixteenths-of-an-inch stop pins, the solenoids for which are identified herein as 58 (102).

Referring to Fig. 6, the mechanical operation of the machine is as follows:—

The beam x is impelled forward by the rolls 267 (1), driven by the work progressing motor 2 (7). As the beam or other work advances, it pushes against the bearing surface 260 (26) of the carriage or head 81 (25), which is thereby moved along its guideway, arranged along the path of travel of the work. A screw shaft 253 (40) is carried between guideway members 259 (16) closely adjacent to carriage 81 (25).

An engaging latch 251 (45), controlled through solenoid 70 (54), engages the shaft 253 (40) to arrest the travel of the carriage or head 81 (25), and thereby of the work x, at the completion of the integral number of feet of travel, as designated or selected by the distance record sheet a (68).

For fractions of a foot, or inches, and sixteenths-of-an-inch (or other fractional parts) of travel, the rotation of screw shaft 253 (40), when driven by motor 33 (80) of the distance determining mechanism, is effected through electrical connections of contact bars or shoes 17 (132), and 20 (62), with selected segment 16 (61), carried in insulating bar 254 (60), and energized from the distance record sheet a (68).

These connections, as particularly described later, slow down the work progressing motor 2 (7), and start motor 33 (80), causing the screw shaft 263 (40), to rotate, thereby permitting a further advance of the carriage or head 81 (25) and the work x. Gear wheel 255 (82), in mesh with pinion 258 (81) on the screw shaft 253 (40), rotates in front of a set of twelve inch stop pins 261 (91), which are selectively set by solenoids 59 (92) from the distance record sheet a (68). These pins are mounted in a disk or housing 256 (86), and engage in a slot 262 (90), in the inner face or gear wheel 255 (82) for any desired inch of travel of the work x.

Disk 257 (88) is connected with housing or disk 256 (86) through sleeve 263 (87) and rotates therewith. In disk 257 (88) is a set of sixteen slots 264 (100) of graduated length, for the sixteenths-of-an-inch of travel of the work x. Sixteen stop pins 265 (101) are mounted in a fixed housing 266 (89), and are selectively set by solenoids 58 (102) from the distance record sheet a (68).

As the latch or engaging member 251 (45) engages the screw shaft 253 (40), and the work progressing motor 2 (7) is brought to slow speed, and the motor 33 (80) of the distance determining mechanism starts, thereby starting the screw shaft 253 (40), pinion 258 (81) and gear wheel 255 (82) will rotate, permitting the work or beam x to push the carriage or head 81 (25) along as permitted by the screw 253 (40). When the slot 262 (90) in gear wheel 255 (82) engages the set stop pin 261 (91) for the selected inch of travel, housing or disk 256 (86) and disk 257 (88) rotate with gear wheel 255 (82), the work x still advancing, until set stop pin 265 (101) for the selected sixteenths-of-an-inch of travel, meets the end of its particular slot 264 (100) in disk 257 (88). This finally arrests the mechanism and effects the stop of the beam x at the selected foot, inch, and sixteenths-of-an-inch of travel.

To avoid the shock and strain of a sudden stop, the motors 2 (7) and 33 (80) are previously brought to slow speed by connections made through slow-down contacts 24 (Fig. 2). These contacts 24 are mounted on the face of a fixed plate or disk 268 (Fig. 6) in such manner as to be closed consecutively by a cam 60 (Figs. 1, 2, 3 and 7) mounted on the adjacent face of the gear wheel 255 (82). Contacts 23 (Figs. 1, 2 and 5), similarly mounted, and operated in like manner by cam 29 (Figs. 1, 2, 3, 5 and 7) on the gear wheel 255 (82) make the connections for opening the power circuits and stopping the motors 2 (7) and 33 (80). The circuits for these motors are opened at the completion of the inches of travel, the contactors operating with retardation which

allows the sixteenths-of-an-inch travel to be completed before the motors drift to rest with the work in the desired position.

It will be understood that the present embodiment is an exemplification of the invention and that changes may be made in the various details as shown and described without departing from the invention and without sacrificing its chief advantages.

What we claim as our invention is:—

1. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate, retard and stop said motor in accordance with the reading of the distance record sheet.

2. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate and stop said motor in accordance with the reading of the distance record sheet.

3. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, retard and stop said motor in accordance with the reading of the distance record sheet.

4. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices including a variable resistance, operating to start, accelerate, retard and stop said motor in accordance with the reading of the distance record sheet.

5. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices including an automatically operated variable resistance, operating to start, accelerate, retard and stop said motor in accordance with the reading of the distance record sheet.

6. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate and stop said motor in accordance with the reading of the distance record sheet, said devices including a resistance device operating to retard and called into operation by the work approaching the stopping point.

7. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, retard and stop said motor in accordance with the reading of the distance record sheet, said devices including a resistance device operating to retard and called into operation by the work approaching the stopping point; the retarding action being controlled by the work approaching the stopping point.

8. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices including a resistance in circuit with said controlling devices operating to start, retard and stop said motor in accordance with the reading of the distance record sheet, and taps on the resistance rendered operative by the advancing work.

9. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices including a resistance in circuit with said controlling devices operating to start, retard and stop said motor in accordance with the reading of the distance record sheet, and taps on the resistance and contacts therefor which are rendered operative by the advancing work.

10. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate and stop said motor in accordance with the reading of the distance record sheet and means preventing acceleration when the travel of the work between successive stops is short.

11. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate and stop said motor in accordance with the reading of the distance record sheet, and means preventing acceleration of the work until the work progressing motor has attained a predetermined speed.

12. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate and stop said motor in accordance with the reading of the distance record sheet and controlling means for the acceleration device operating by counter E. M. F.

13. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, accelerate, retard and stop said motor in accordance with the reading of the distance record sheet, and means for preventing the acceleration device operating when the retardation device has begun to operate first.

14. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, circuit controlling devices coöperating with a distance record sheet and devices in circuit with said controlling devices operating to start, retard and stop said motor in accordance with the reading of the distance record sheet, said devices including a resistance device operating to retard and carried into operation by the work approaching the stopping point, the retarding action being controlled by the work approaching the stopping point, and means for preventing the acceleration devices operating when the retardation device has begun to operate first.

15. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, a distance record sheet for determining the variable travel of the work, and controlling devices operating to start and to retard said motor, the retarding action being controlled by the work approaching the stopping point.

16. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, a distance record sheet for determining the variable travel of the work, and electrically operated controlling devices operating to start and to retard said motor, the retarding action being controlled by the work approaching the stopping point, and thereby closing a circuit of the controlling device.

17. A controlling and operating mechanism for a metal punching machine including in combination a work progressing motor, a distance record sheet for determining the variable travel of the work, and controlling devices, including an electric circuit and a resistance, operating to start and to retard said motor, the retarding action being controlled by the work approaching the stopping point, and a resistance tap operated by the progressing work.

18. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while determining a desired distance, and means which start and stop said motor.

19. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start, accelerate, retard and stop said motor.

20. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start, accelerate and stop said motor.

21. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which retard and stop said motor.

22. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which operate electrically and automatically to start and stop said motor.

23. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which operate electrically and automatically to vary the speed of and to start and stop said motor.

24. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, means which retard and stop said motor and means for calling said retarding device into operation by the work approaching the distance for which the distance determining device is set.

25. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work

for the punch, and means for calling said retarding device into operation by the work approaching the distance for which the distance determining device is set.

26. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which operate electrically to start and stop, retard said motor, and means for calling said retarding device into operation by the work closing a circuit at a point in definite relation to the distance for which the distance determining device is set.

27. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor and electrically operating means controlled by a distance record sheet for governing said motor.

28. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor and means controlled by a distance record sheet for governing said motor.

29. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor and restore the distance determining device.

30. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start, accelerate, retard, stop said motor and restore the distance determining device.

31. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which operate electrically to start, stop said motor and restore the distance determining device.

32. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor, said devices including a series of electrical circuits representing distances of travel of the work and means whereby said circuits are rendered selectively operative by a distance record sheet.

33. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start, accelerate, retard and stop said motor, said devices including a series of electrical circuits representing distances of travel of the work and means whereby said circuits are rendered selectively operative by a distance record sheet.

34. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which retard and stop said motor, said devices including a series of electrical circuits representing distances of travel of the work and means whereby said circuits are rendered selectively operative by a distance record sheet.

35. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor, said stopping means including an automatically variable resistance.

36. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop said motor, said stopping means including an automatically variable resistance, and taps for said resistance controlled by the advancing work.

37. A controlling and operating mechanism for a metal punching machine including in combination a distance determining device, a motor operating the distance determining device while positioning the work for the punch, and means which start and stop the motor, and means for preventing progression of the work while the distance determining means is being restored.

38. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means preventing the punch operating on the work should the work fail to stop at the point for which the distance determining means is set.

39. A controlling and operating mechanism for a metal punching machine includ-

ing in combination distance determining means and means preventing the punch operating on the work should the work fail to stop at the point for which the distance determining means is set, and signal means for indicating such a failure.

40. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means for controlling the progress of the work including a plurality of electrical devices, including means for modifying the action of the distance determining means dependent on whether the next succeeding measurement is in the same foot or unit or not.

41. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means for preventing the punching of the work if the fraction of a unit distance mechanism fails.

42. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means for preventing the punching of the work if the fraction of a unit distance mechanism fails, and signal means for indicating such failure.

43. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means preventing the punch operating on the work should the work fail to stop at the point for which the distance determining means is set and means for arresting the progress of the work.

44. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, and means for controlling the progress of the work including a plurality of electrical devices including means for modifying the action of the distance determining means dependent on whether the next succeeding measurement is in the same foot or unit or not, and means for preventing intermediate restoring of the device.

45. A controlling and operating mechanism for a metal punching machine including in combination a motor operating a distance determining device, and means which start and stop said motor, said means including a plurality of contacts representing distance values and controlling the motor circuit.

46. A controlling and operating mechanism for a metal punching machine including in combination a motor operating a distance determining device, and means which start and stop said motor, said means including a plurality of contacts representing a unit of distance value in the succession of groups of tens of units of distance values.

47. A controlling and operating mechanism for a metal punching machine including in combination a motor and connections therefor controlling work progressing means, distance determining means and a motor therefor, and means preventing the punching means operating unless both said motors are functioning.

48. A controlling and operating mechanism for a metal punching machine including in combination a motor and connections therefor controlling work progressing means, distance determining means and a motor therefor, and means for stopping both said motors just at the time of punching.

49. A controlling and operating mechanism for a metal punching machine including in combination a motor driving the work progressing means, a motor operating a distance determining device, and connections controlled by a distance record device for harmoniously controlling the two motors.

50. A controlling and operating mechanism for a metal punching machine including in combination distance determining means, a distance record device controlling same, means for stopping the work controlled by the distance determining means, and means for starting the punch when the work is stopped at the determined distance.

51. A controlling and operating mechanism for a metal punching machine including in combination distance determining means for stopping the work at a selected and predetermined distance, a distance record sheet controlling the distance determining means, and means preventing the operation of the distance determining means while the distance record sheet is being fed forward for a new reading.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses.

EDWARD V. WURTS.
BERTRAM S. PERO.

Witnesses:
JOHN D. MORGAN,
MAYBELLE C. SMITH.