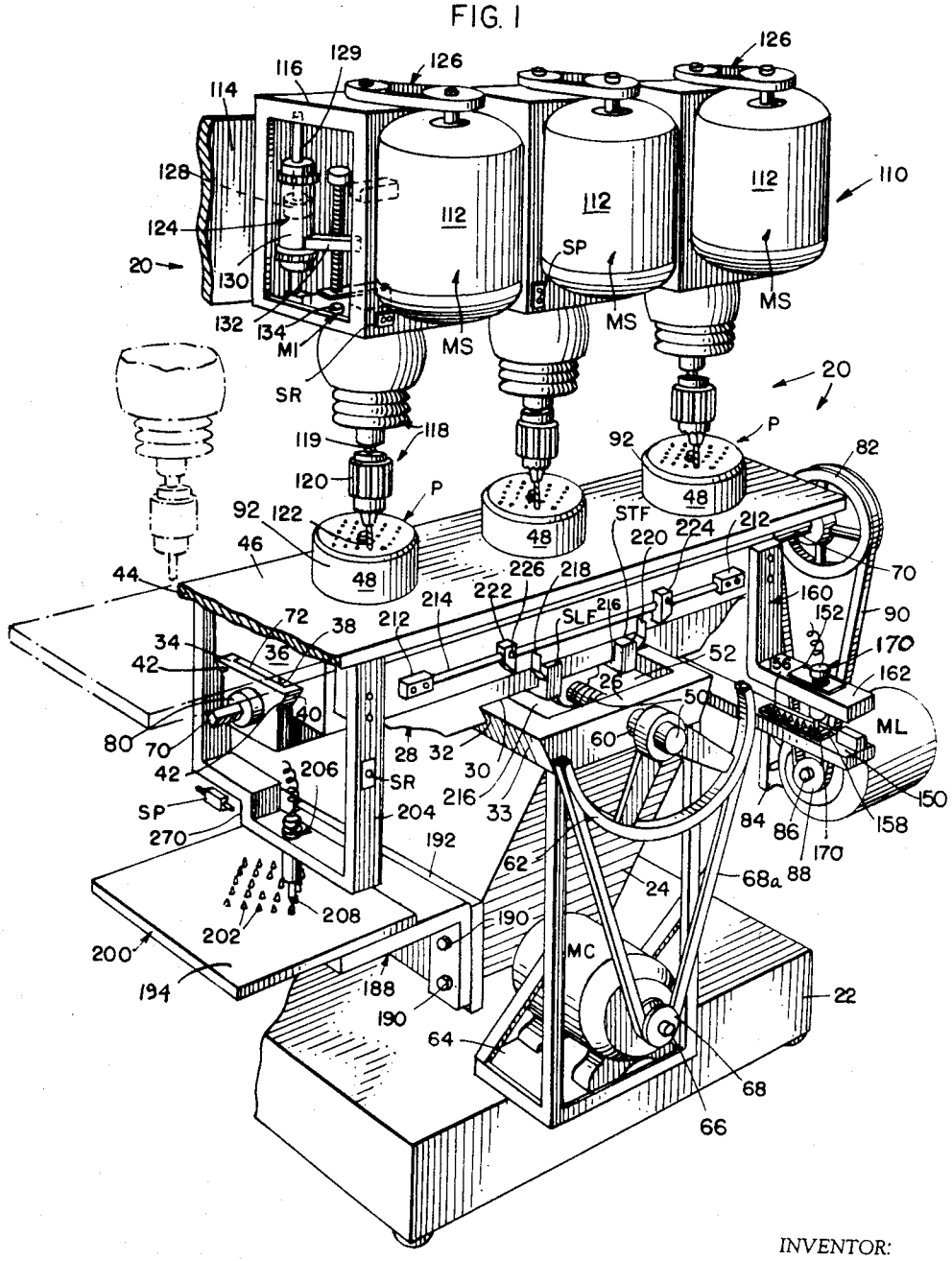
Oct. 11, 1960 C. W. HESS 2,955,490

TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

Filed June 10, 1959 6 Sheets-Sheet 1

FIG. 1



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TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

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FIG. 7

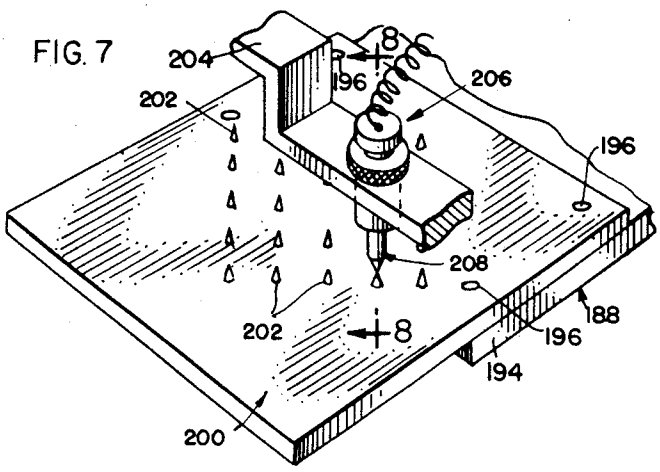


FIG. 8

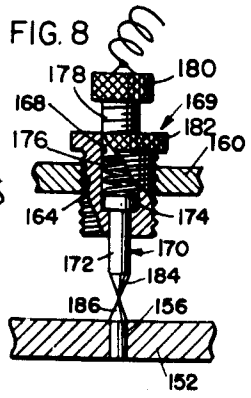


FIG. 2

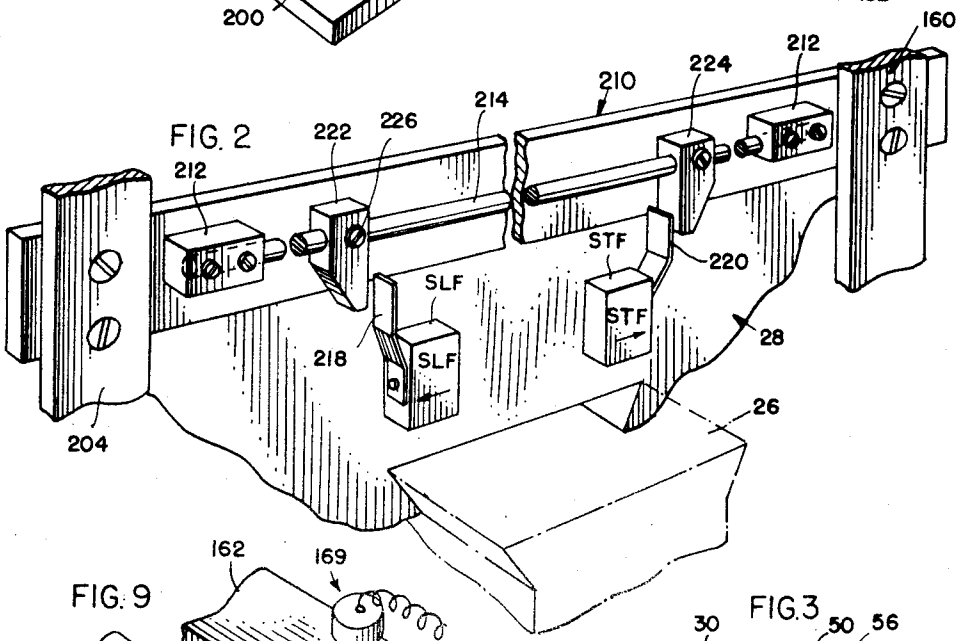


FIG. 9

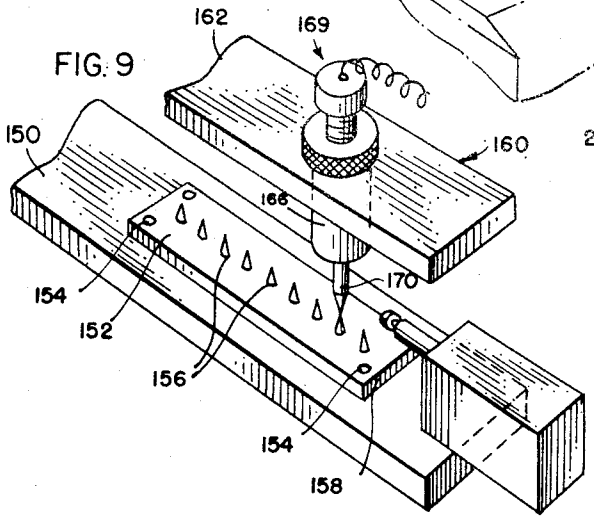
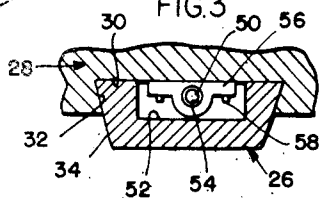


FIG. 3



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TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

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FIG. 5

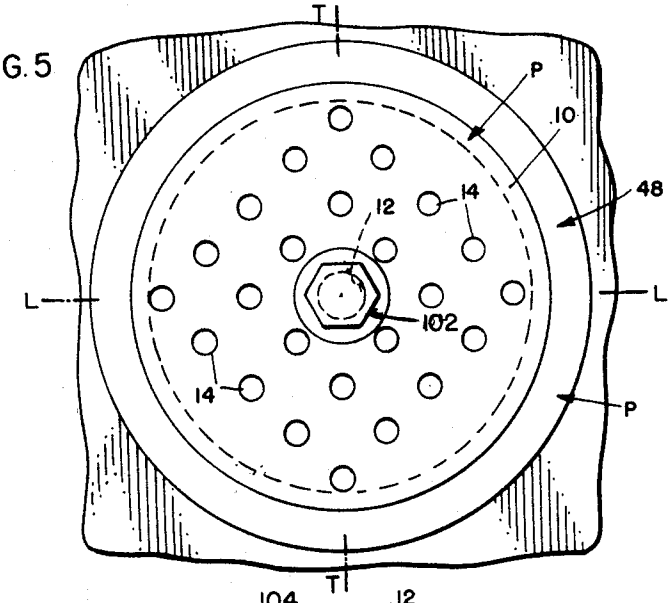


FIG. 6

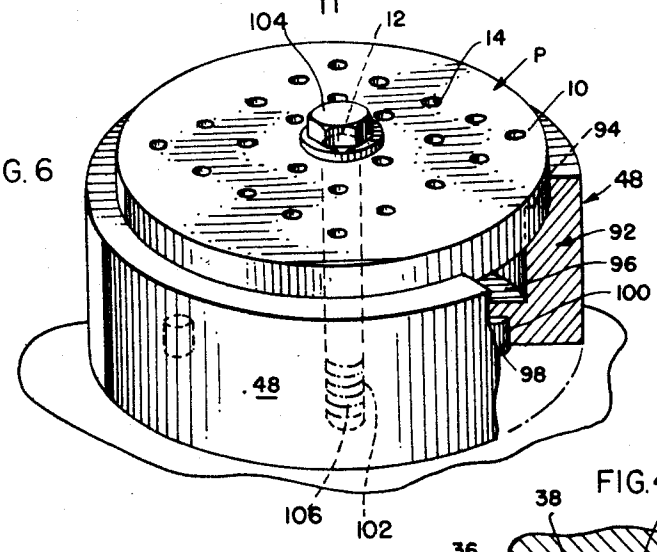
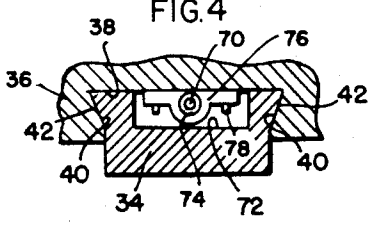


FIG. 4

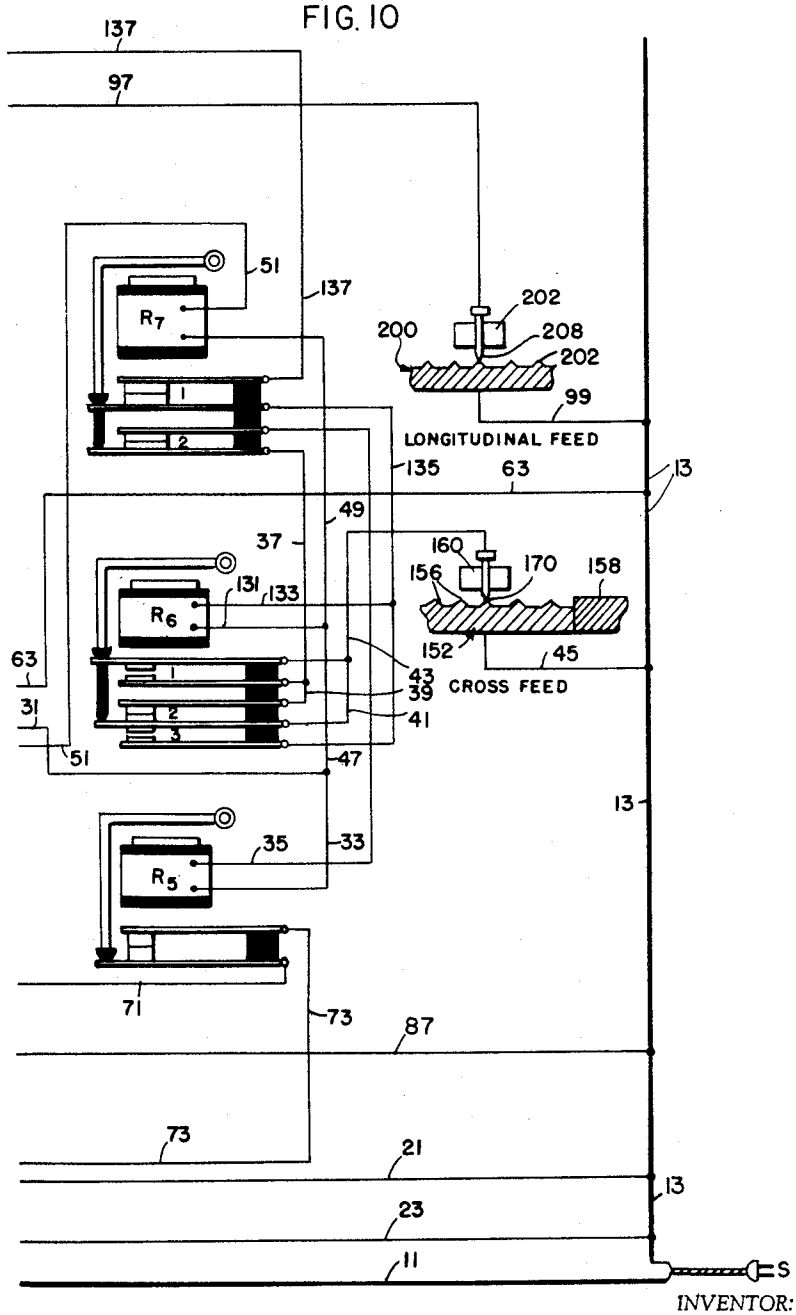


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TEMPLATE CONSTRUCTION FOR AUTOMATIC, DRILLING MACHINE

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FIG. 10



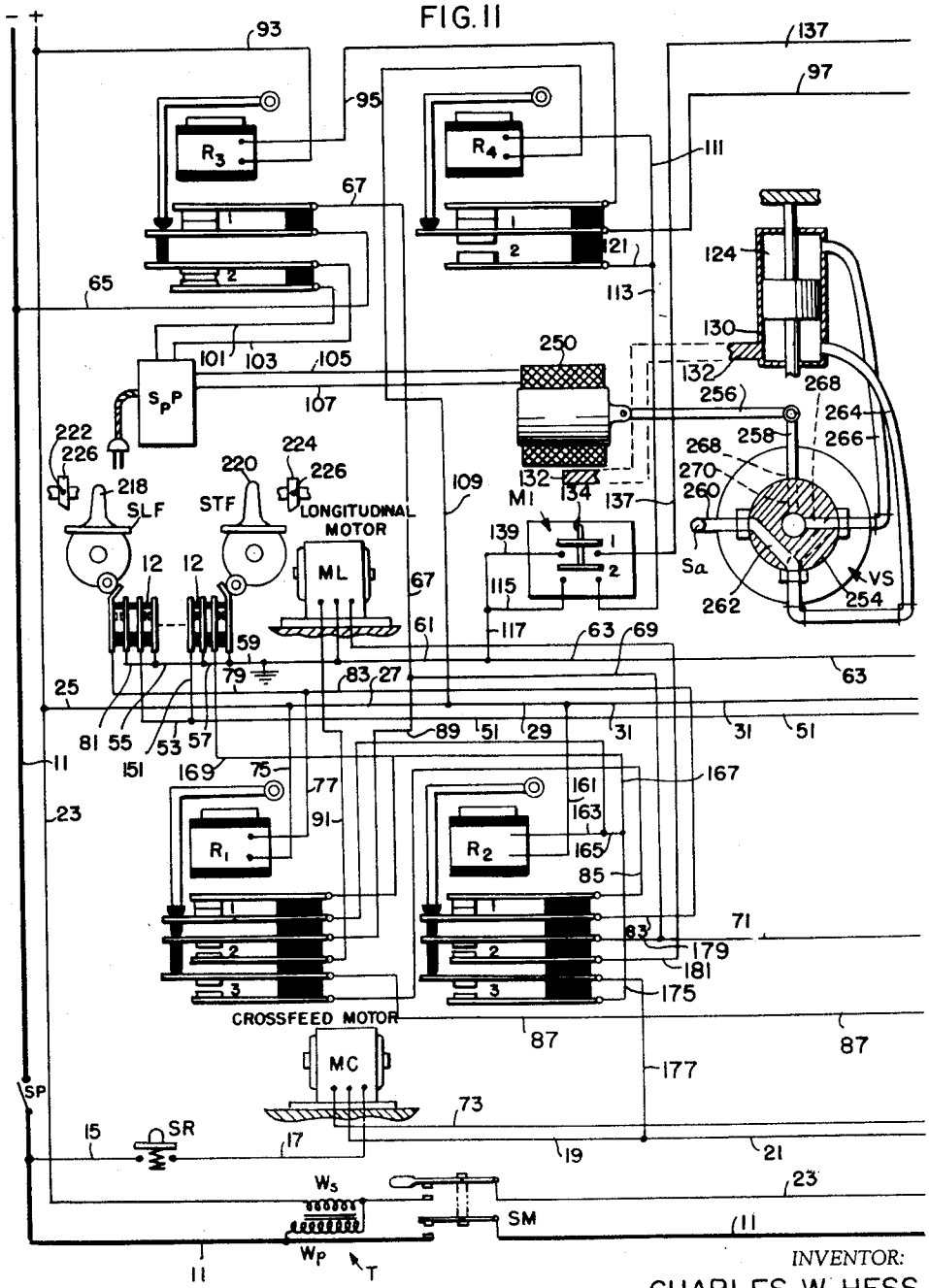
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TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

Filed June 10, 1959 6 Sheets-Sheet 5

FIG. 11



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TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

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Fig. 12

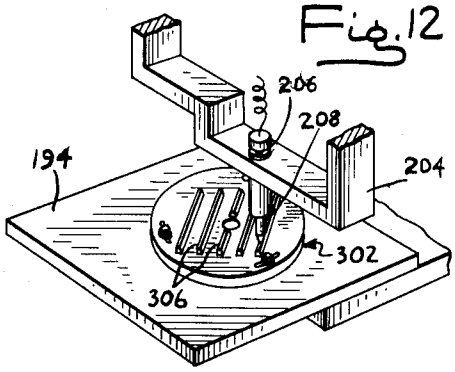


Fig. 13

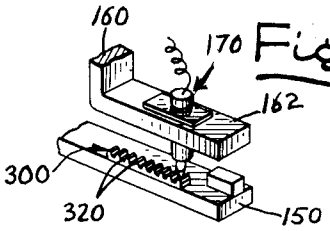


Fig. 14

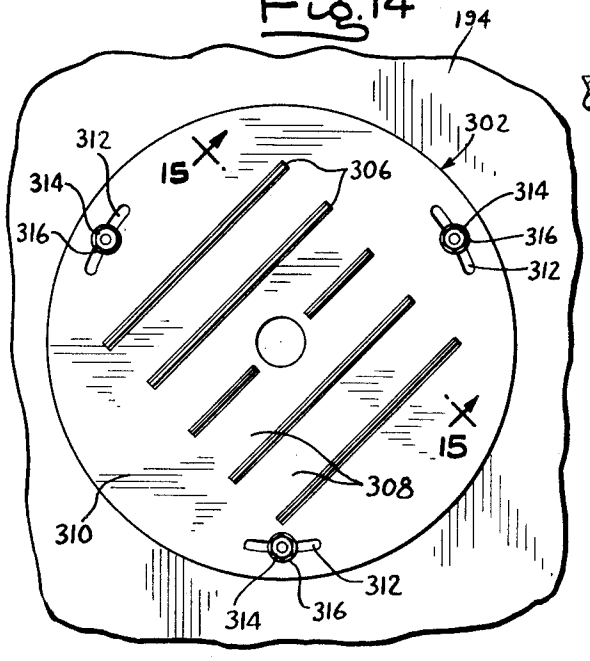


Fig. 15

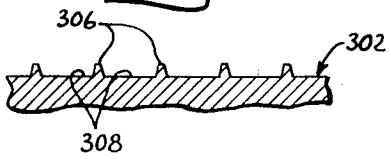


Fig. 16

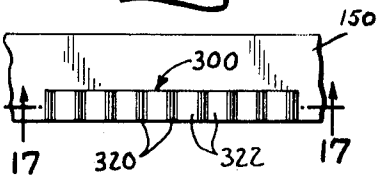
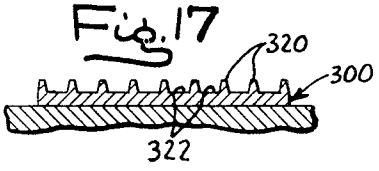


Fig. 17



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United States Patent Office 2,955,490
Patented Oct. 11, 1960

2,955,490

TEMPLATE CONSTRUCTION FOR AUTOMATIC DRILLING MACHINE

Charles W. Hess, Chicago, Ill., assignor to Speco, Inc., Schiller Park, Ill., a corporation of Illinois

Filed June 10, 1959, Ser. No. 819,315

2 Claims. (Cl. 77—32.2)

The present invention relates to automatic drilling machines and more particularly to a fully automatic cyclically operable, machine by which a predetermined pattern of holes may be drilled, one at a time and sequentially in a plate or other object. The drilling machine of the present invention has been designed for use primarily in connection with the drilling of holes in commercial meat grinder shear plates having a relatively large number of holes and wherein the holes are arranged in longitudinal and horizontal rows in such plates. The invention is however capable of other uses and the same may, if desired, with or without suitable modification, be employed for drilling holes in a wide variety of objects other than meat grinder shear plates, whether the holes be arranged in distinguishable rows or otherwise. Irrespective however of the particular use to which the invention may be put, the essential features of the same are at all times preserved.

Heretofore, in the manufacture of meat grinder shear plates, the practice has been to lay out the desired hole pattern on each plate individually, utilizing a template or pattern plate by means of which guided punch holes are initially formed on the upper surface of the plate. Thereafter the punched plate is slidably positioned on the work support of a conventional drill press and the various punch marks are visually brought into register with the rotating drill by sliding the work relative to the drill immediately prior to each successive descent of the drill. Such a manual process is a prolonged and tedious one and requires a certain degree of skill for its successful operation. In connection with the larger size plates having several thousand holes therein, the drilling of a single plate may require the better portion of a day's work on the part of a skilled operator. Needless to say, mistakes in misalignment are costly, particularly when they occur near the completion of drilling operations.

In order to overcome the above noted limitations that are attendant upon conventional manual drilling methods, there has been developed a fully automatic machine utilizing one or more automatic drill units, and by means of which machine the various work pieces undergoing drilling are automatically moved into register with the respective drills associated with the units and are presented to such drills successively in proper positions for drilling the various holes according to a predetermined pattern of holes. Such a machine has been shown and described in my copending application, Serial No. 735,253, filed May 14, 1958, for Automatic Drilling Machine, and of which application the present application is a continuation-in-part. In the above mentioned application there is disclosed a machine including a battery of more or less conventional automatic drill units which are preferably of the pneumatically operable type having conventional control devices for their operation, together with a shiftable work-supporting carriage common to the various units which, under the control of a

sensing system including pattern control templates and electrical control devices actuated thereby, is caused to automatically shift its position periodically to bring the work pieces supported thereby into proper drilling register with the respective drills of the automatic drill units. The electrical control devices not only effect control of the movement of the work-supporting carriage but they also effect automatic operation of the drill units at the proper times in the machine cycle after each drill location on the various plates has been brought into accurate register with its respective rotating drill.

The present invention is concerned with a novel and improved form of template construction designed for use with the machine shown and described in my copending application, above referred to, and by means of which more accurate control of the work, better electrical contact for circuit closing and opening operations, the insurance of positive electrical engagement between the cooperating sensing elements despite possible minor machine frame misalignment, the elimination of the need for individual sensing pin adjustments, and the avoidance of sensing pin wear, may be obtained. Still further, according to the present invention, a template construction is provided which may be manufactured at a fraction of the cost of the template constructions shown in my above mentioned copending application.

The provision of an automatic drilling machine having associated wherewith a template construction possessing the advantages briefly outlined above being among the principal objects of the invention, it is a further object to provide a template which, by varying its angular position on the movable carriage upon which it is mounted, will vary the pattern of holes which are drilled in a given piece of work, thus dispensing with the necessity of having to provide separate templates for producing certain varying work patterns.

Numerous other objects and advantages of the invention, not at this time enumerated, will become more readily apparent as the following description ensues.

In the accompanying six sheets of drawings forming a part of this specification, a preferred embodiment of the invention has been shown.

In these drawings:

Fig. 1 is a front perspective view, partly in section, of an automatic drilling machine constructed in accordance with the principles of the present invention;

Fig. 2 is an enlarged fragmentary front perspective view of a portion of the machine shown in Fig. 1 and illustrating the location and operation of a pair of limit switches employed in connection with the invention;

Fig. 3 is an enlarged sectional view taken substantially centrally and longitudinally through the machine in the vicinity of a transverse feed screw employed in connection with the invention;

Fig. 4 is an enlarged sectional view taken substantially centrally and transversely through the machine in the vicinity of a longitudinal feed screw employed in connection with the invention;

Fig. 5 is a top plan view of one of a plurality of work holders employed in connection with the invention and showing the same operatively mounted on a positionable carriage support forming a part of the machine;

Fig. 6 is a front perspective view of the structure shown in Fig. 5;

Fig. 7 is a fragmentary perspective view of a pattern sensing mechanism employed in connection with the invention and under the control of which the work supporting carriage is caused to shift its position longitudinally of the machine;

Fig. 8 is a sectional view taken substantially along the plane indicated by the line 8—8 of Fig. 7;

Fig. 9 is a fragmentary perspective view similar to Fig. 7 of a pattern sensing mechanism under the control of which the work supporting carriage is caused to shift its position transversely of the machine; and

Figs 10 and 11, when placed in edge-to-edge relationship, constitute an electric circuit diagram showing the operation of the various electrical control devices associated with the machine.

Fig. 12 is a fragmentary perspective view of a portion of the drilling machine of Fig. 1 showing a novel form of pattern sensing mechanism under the control of which the work supporting carriage may be shifted longitudinally.

Fig. 13 is a fragmentary perspective view similar to Fig. 11 showing a novel form of pattern sensing mechanism under the control of which the work supporting carriage may be shifted transversely.

Fig. 14 is a plan view of a longitudinal feed control template constructed in accordance with the principles of the present invention.

Fig. 15 is a sectional view taken substantially along the line **15—15** of Fig. 14.

Fig. 16 is a plan view of a transverse feed control template constructed in accordance with the principles of the invention, and

Fig. 17 is a sectional view taken substantially along the line **17—17** of Fig. 16.

Referring now to the drawings in detail, and in particular to Fig. 1, there is illustrated an exemplary embodiment of an automatic drilling machine to which the present template construction may be applied and by means of which the perforations or holes associated with a plurality of circular shear plates may be simultaneously drilled in the plates in a progressive manner. Shear plates of the type with which the present invention is concerned, and which have been designated herein at P are designed for use in connection with meat grinders of the feed screw type. A grinder of this sort is comprised generally of a casing providing a cylindrical feed channel for the meat product to be ground and in which there is disposed a rotatable feed screw. One end of the feed channel is open while the other end has interposed thereacross one of the perforated shear plates P. The end of the feed screw is rotatably journalled in a central opening provided in the plate and a cutter assembly including a series of radially disposed rotary knife blades operates on the inside face of the plate to shear the material as it enters the various shear openings provided in the plate. Shear plates of this character vary widely both as regards their size and the number of holes provided therein. Where commercial grinders are concerned the extremely large plates may have as many as four thousand one-sixteenth inch holes while the small plates may have fewer than one hundred one-quarter inch holes. The holes in commercial shear plates of this character are variously formed in the plates, some plate utilizing holes which extend along radial lines or rows, other utilizing concentric equally spaced circumferentially arranged holes, and still other plates having holes which are spaced at random. However, to facilitate manual drilling operations, most commercial plates have holes which are arranged in longitudinal and transverse rows. The drilling operations performed by the machine of the present invention are predicated upon this latter type of circular shear plate and, as best seen in Figs. 5 and 6, wherein one of the shear plates P has been illustrated after drilling operations are complete, the plate is shown as being provided with twenty-four holes therein arranged in a square checker-board pattern with each row in two directions containing five holes, except for the two medial intersecting rows which contain only four holes due to the omission of a central shear hole. In the diagonal direction of the square pattern of holes, the holes are arranged in nine rows and, when the undrilled plate P is mounted in the machine for drilling purposes, there will be nine rows of hole locations extending both longitudinally and transversely of the machine as will be described in detail presently. Considering either the transverse direction indicated by the axis T—T in Fig. 5, or the longitudinal direction as indicated by the line L—L of Fig. 5, there is a single hole in the first row, two holes in the second row, three holes in the third row, four holes in the fourth row, four holes in the fifth row, four holes in the sixth row, three holes in the seventh row, two holes in the eighth row, and one hole in the last row. The arrangement of holes shown in Fig. 5 is purely exemplary and it will be understood that a greater or lesser number of holes may be employed and that these holes may be arranged in longitudinal and transverse rows in the direction of the axes T—T and L—L with any desired spacing or number of holes in the various rows.

The various plates P are identical in construction and each comprises a flat relatively thick circular steel plate or body **10** having a relatively large central feed screw opening **12** formed therein with the various shear holes **14** being arranged in a pattern about the central opening **12** in the manner previously outlined above.

The plates P are purely conventional and no claim is made herein to any novelty associated with the same.

Referring again to Fig. 1, the automatic drilling machine of the present invention is designated in its entirety at **20** and the same involves in its general organization a baseplate or block **22** on which there is supported a supporting structure or base framework **24**, the upper end of which carries a transversely extending dovetail guide block **26** which constitutes a stationary portion of the machine framework and on which guide block there is slidably supported for transverse movement relative to the framework a carriage assembly **28** hereinafter referred to as the transverse carriage. The underneath side of the transverse carriage **28** is formed with a transversely extending dovetail slot **30** presenting inclined side walls **32** designed for cooperation with the inclined side surfaces **33** of the dovetail guide block **26**. The body portion of the transverse carriage **28** is of elongated design and has its axis extending longitudinally of the framework of the machine. The carriage **28** is provided with a dovetail block section **34** on which section there is longitudinally slidable a carriage assembly **36** hereinafter referred to as the longitudinal carriage. The carriage **36** is provided with a dovetail slot **38** having side faces **40** designed to straddle the inclined side faces **42** of the dovetail guide block **34**. From the above description it will be seen that inasmuch as the transverse carriage **28** is transversely slidable upon the stationary guide block **34** and, inasmuch as the longitudinal carriage **36** is longitudinally slidable on the guide block **34**, this latter carriage is capable of universal shifting movement in a horizontal plane so that it may be brought to any desired position of adjustment either longitudinally or transversely of the machine framework for purposes that will be made clear presently.

The carriage **36** is provided on the upper side thereof with a work-supporting bed plate **44** presenting an upwardly facing horizontal table surface **46** on which there are adapted to be mounted a plurality of work supports proper **48** (see also Figs. 5 and 6). The nature and function of these work supporting assemblies **48** will be set forth in detail subsequently.

In order to effect transverse movements of the carriage assembly **28**, a transversely extending feed screw **50** (Figs. 1 and 3) is rotatably journalled substantially centrally in the dovetail guide block **34** and has its medial regions exposed within a rectangular socket or well portion **52** and in threaded engagement with a threaded bore **54** provided in a block member **56** which is secured by means of cap screws or the like **58** to the underneath surface of the carriage **28** within the dovetail slot **30**. The front

and rear ends of the feed screw **50** are rotatably journalled as at **60** in the front and rear portions of the block respectively and the forward end of the feed screw projects forwardly of the block **34** and has fixedly secured thereto a relatively large driven pulley **62**. An electric motor MC operatively mounted on a platform **64** supported on the block **22** is provided with a motor shaft **66** on which there is mounted a pulley **68**. A belt **68***a* passes around the pulleys **62** and **68** and completes the driving connection between the motor MC and feed screw **50**. The motor MC is of the reversible type and therefore it will be seen that upon energization of the motor MC for rotation of the shaft **66** in either direction, traversing of the carriage **28** across the machine framework **in one direction or the other,** as the case may be, will **be effected.**

As best seen in Figs. 3 and 4, longitudinal shifting of the carriage **36** relative to the carriage **28** is effected by a feed screw and electric motor drive mechanism similar to that described in connection with the carriage **28**. Accordingly, a longitudinally extending feed screw **70** is rotatably journalled in the dovetail block portion **34** of the carriage **28** and has its central threaded region exposed within a rectangular recess or socket **72** and in threaded engagement with a threaded bore **74** provided in a block **76** secured by means of cap screws **78** within the dovetail slot **38**. The opposite ends of the feed screw **70** are journalled as at **80** in the ends of the block **34** and the right hand end of the shaft **70**, as seen in Fig. 1, projects beyond the face of the block and carries a pulley **82**. An electric motor ML is operatively mounted on a bracket **84** suitably suspended from the carriage **36** and is provided with a motor shaft **86** on which there is mounted a pulley **88**. A belt **90** passes around the pulleys **82** and **88** and completes the driving connection between the motor ML and the feed screw **70**. The motor ML is of the reversible type and thus it will be seen that upon energization of the motor for rotation of its drive shaft **80** in either direction, shifting movement of the carriage **36** relative to the carriage **28** in one direction or the other, as the case may be, will take place.

Referring now to Figs. 1, 5 and 6, the various work supports are positioned on the table surface **46** in a longitudinally extending row. In Fig. 1, three such supports have been illustrated but it will be understood that a greater or lesser number of such supports may be employed if desired, depending upon the number of plates P which are to be simultaneously drilled during each cycle of machine operation, or in other words, upon the unit capacity of the machine. Each work support is in the form of a cylindrical cup-shaped member or body **92**, the upstanding cylindrical wall of which is provided with an internal annular shoulder **94** providing, in effect, a ledge upon which the peripheral regions of one of the plates P is adapted to be supported. The bottom wall **96** of the member **92** is provided with a plurality of sockets **98** therein designed for reception therein of a plurality of locating pins **100** which project upwardly from the table surface **46**. In order to firmly secure the plate P in position on the shoulder or ledge **94**, a clamping bolt **102** having a flanged bolt head **104** projects through the central opening **12** in the plate P and has its lower regions threaded as at **106** in the bottom wall **96**.

Referring now to Fig. 1, a battery **110** of individual drill press assemblies **112** is suitably mounted on a supporting surface **114** so as to overlie the table surface **46** with each drill press assembly **112** being operatively aligned vertically with one of the work supports **48**. The various drill press units **112** are identical in design and construction and each unit is of a more or less conventional comercial type of unit capable of being purchased on the open market, and which has been modified slightly as to its control characteristics to adapt the same for use in performing the drilling method of the present machine, all in a manner that will be clearly set forth in detail subsequently. It is deemed sufficient for purposes of description herein to state that each unit **112** includes a mounting and control cabinet **116** having associated therewith a spindle assembly **118**, the vertically reciprocal spindle **119** of which carries the usual chuck **120** for supporting a drill **122**. A fluid actuated cylinder assembly or motor **124** is operatively connected to the spindle assembly **118** for controlling the vertical raising and lowering movements of the latter while a spindle motor MS is operatively connected by a belt and pulley driving connection **126** to the spindle **119** in a manner that is well known in the art. The piston and cylinder assembly **124** is of the stationary-piston, movable-cylinder type, the piston **128** thereof being provided with a piston rod **129** secured to the top wall of the cabinet **116**, and the movable cylinder **130** being provided with an arm **132** adapted to engage an actuating finger **134** associated with a microswitch MI (see also Fig. 10) mounted within the cabinet **116** in the path of movement of the arm **132**, and the electrical function of which switch will be described when the nature of the electrical control instrumentalities of the present invention is described. It is deemed sufficient for the present to state that upon engagement of the finger **134** by the arm **132** when the spindle **119** is adjacent the bottom of its stroke and has completed its drilling operation, certain relay mechanism is set into operation by means of which a solenoid valve VS is actuated in such a manner as to supply air to the upper side of the cylinder **130** and thus drive the cylinder upwardly within the casing **116** to return the spindle **119** to its normally elevated position. Initial movement of the cylinder **130** and the spindle **119** downward at the commencement of any drilling stroke is also effected under the control of the solenoid valve VS which, for such purposes, is caused to admit air to the lower regions of the cylinder **130** under the control of the electrical instrumentalities associated with the present invention, all in a manner that will be set forth subsequently.

Various types of drill press units are capable of being used in connection with the present automatic drilling machine. One such unit which has been found suitable for use is known as the Dumore, Series 24 Automatic Drill Unit, manufactured and sold by Dumore Precision Tools Co., of Racine, Wisconsin.

Referring now to Figs. 1 and 9 wherein certain electrical sensing instrumentalities by means of which control of transverse shifting movement of the carriage **28** across the framework of the machine is best illustrated, a supporting bracket **150** is mounted on the support **24**, is electrically connected thereto, and is adapted to removably receive thereon an electrical template or sensing plate **152** hereinafter referred to as the transverse feed template. The template **152** is in the form of an elongated flat plate formed of copper or other material having good electrical conductive qualities and the same is secured to the bracket **150** by means of anchoring screws **154**. The plate **152** is provided with a series of upstanding sensing pins **156** arranged in a straight row extending transversely of the machine and the number of such pins correspond in number to the number of longitudinally extending, transversely arranged, rows of shear holes **14** provided in the various plates P undergoing drilling by the present machine as previously described. With the square checkerboard pattern of holes **14** provided in the plate P shown in Figs. 5 and 6, there are nine such diagonally extending, laterally spaced, rows of such holes. As a consequence the plate **152** is provided with nine of the sensing pins **156** and the distance between each pair of adjacent pins corresponds exactly to the distance between the adjacent transversely spaced rows in the plate P.

Still referring to Figs. 1 and 9, the universally movable carriage **36** has affixed thereto an L-shaped bracket **160** having a horizontal leg **162** overlying the template **152**. The leg **162** is formed with a threaded hole **164**

therethrough in which there is threadedly received a tubular sleeve **166** (see also Fig. 8) formed of a suitable insulating material. The sleeve **166** is formed with a socket **168** therein and a sensing pin **170** having a shank portion **172** and an enlarged head **174**, extends through the bottom wall of the socket. A spring **176** disposed within the socket **168** bears at its lower end against the head **174** and at its upper end against the lower end of an adjusting screw **178** having a knurled head **180** and by means of which the tension applied to the sensing pin **170** may be regulated. The sleeve **166** is formed with a knurled head **182** by means of which the elevation of the entire sensing finger assembly may be adjusted relative to the various sensing pins **156**. As shown in Fig. 8, the lower end of the sensing finger **172** and the upper ends of the various sensing pins **156** are tapered to substantial points as indicated at **184** and **186** respectively and the elevation of the sensing finger assembly is such that when the work supporting carriage **36** is brought to a position wherein the axis of the sensing finger **172** is in alignment with the axis of one of the sensing pins **186**, the pin and finger meet and make electrical contact in end-to-end relationship.

Referring now to Figs. 1 and 7, a second L-shaped bracket **188** is secured by means of screws **190** to a plate **192** secured to the left hand side of the support **24** and is provided with a horizontally extending leg or platform portion **194**. Suitably secured, as by screws **196** to the platform **194** is an electrical template or sensing plate **200**, hereinafter referred to as the longitudinal feed template. The template **200** is similar to its construction to the transverse feed template **152** and it is provided with a series of upstanding sensing pins **202** arranged in longitudinally and transversely extending rows and disposed in a checkerboard pattern corresponding exactly to the checkerboard pattern of the holes **14** provided in the various plates P, both as regards the spacing of the longitudinal and transverse rows and as regards spacing between adjacent pins in each row. A generally U-shaped bracket **204** carries a sensing finger assembly **206** which may be substantially identical with the sensing finger assembly **169** and which, as a consequence, requires no detailed description. The assembly **206** is provided with a sensing finger proper **208** designed from cooperation with the various sensing pins **202** in the manner previously described in connection with the sensing pins **186** and sensing finger **172**. The position of the longitudinal feed template **200** on the platform **188** is such that when the sensing finger **170** is in register with one of the sensing pins **156**, the sensing finger **170** will be in longitudinal coincidence or alignment with one of the longitudinal rows of sensing pins **202**.

Referring now to Figs. 1 and 2, a longitudinal bar **210** extends between the bracket **204** and **160** and has mounted thereon a pair of supporting blocks **212**, between which blocks there extends a guide rod **214**. A pair of limit switch assemblies SLF and STF (see also Fig. 10), hereinafter referred to as the longitudinal feed switch and the transverse feed switch respectively, are mounted on plates **216** secured to the side of the dovetail block **34** in spaced relationship and are provided with actuating fingers **218** and **220** respectively. The actuating fingers **218** and **220** are positioned in the respective paths of movement of a pair of longitudinally shiftable switch-operating blocks **222** and **224** respectively which are capable of being anchored in any desired position of longitudinal adjustment therealong by means of set screws **226**.

Briefly, in the operation of the automatic drilling machine of the present invention thus far described, the undrilled shear plate blanks P are positioned in the work supports **48** and are tightened in position by means of the clamping bolt **102**. By electrical means subsequently to be described, the reversible motor MC is energized in a manner to bring the transverse carriage **28** to an initial or starting position wherein the sensing finger **170** makes electrical contact with the elevated land portion **158** of the cross feed template **152**. Without regard to the electrical instrumentalities whereby the machine's movements are controlled, initial machine operations involve movement of the carriage **28** rearwardly of the machine so that the sensing finger **170** leaves the elevated land portion **158** and proceeds toward the first sensing pin **156** in the series of pins on the template **152**. As soon as the sensing finger **170** engages the first sensing pin **156** in the series, the motor MC is deenergized so that further rearward movement of the carriage **28** is terminated. At this point in the machine cycle the longitudinal feed motor ML is energized whereupon the longitudinal carriage **28** will commence movement to the left as viewed in Fig. 1 along the dovetail guide block **34**. It will be understood of course that prior to initial machine operations the carriage **36** will assume its extreme right hand position in the machine framework wherein the sensing finger **208** is positioned on the right side of the sensing pin **202** in the first longitudinal row of pins and in longitudinal alignment with such row. Movement of the carriage **36** to the left continues until such time as the sensing finger **208** engages the pin **202** in the first row and, at such time, the motor ML is deenergized to discontinue further longitudinal movement of the carriage **36**. The sensing finger **208** remains momentarily in contact with the pin **202** and, at that time, the various rotating spindles **119** are driven downwardly under the influence of the pneumatic cylinder and piston assembly **124** in the cabinets **116**. During such downward movement of the spindles **119**, the drills **122** pass through the plates P and effect their drilling operations. After drilling operations are complete, the spindles **119** are bottomed and, under the influence of the micro switch MI they are immediately restored to their elevated positions whereupon the motor ML is again energized and the carriage **36** caused to proceed longitudinally of the machine to the left until such time as the block **224** carried on the rod **214** engages the switch STF. Actuation of the switch STF terminates the operation of the motor ML and causes energization of the motor MC in a direction to advance the carriage **28** rearwardly so that the sensing finger **170** leaves the first sensing pin **156** in the single row of pins and proceeds toward the second sensing pin in such row. Upon engagement of the sensing finger **170** with the second pin in the row of pins **156** the motor MC is deenergized to stop further rearward movement of the carriage **28** while the motor ML is energized in a reverse direction from the direction of its previous energization so that the longitudinally movable carriage **36** is now caused to proceed along the dovetail guide block **34** to the right as viewed in Fig. 1, thus bringing the sensing finger **208** into electrical engagement with the first sensing pin **202** in the second transverse row of pins at the left of the row. As soon as contact between the sensing finger **208** and sensing pin **202** is made, drilling operations are carried out as previously described and upon restoration of the various spindles **119** to their elevated positions, the motor ML is again energized and caused to move to the right until the second pin in the second transverse row of pins **202** is engaged by the sensing finger **208**. Upon such engagement of the second pin **202** by the sensing finger **208** drilling operations are again effected and the carriage **36** moves to the right until such time as the block **222** engages the actuating finger **218** of the switch SLF whereupon movement of the carriage **36** is terminated and the carriage **28** is again caused to move rearwardly until such time as the sensing finger **170** moves into contact with the third sensing pin **156** in the single row of pins on the template **152**. At this point a complete machine cycle involving an initial movement of the carriage **36** to the left as viewed in Fig. 1 with the sensing finger **208** sensing the first longitudinal

row of pins 202 in the series, a movement of the carriage 28 rearwardly, and a movement of the carriage 36 to the right with the finger 208 sensing the second longitudinal row of pins 202 in the series is completed. This cycle of machine operations is repeated with the sensing finger 208 periodically traversing the succeeding longitudinal rows of pins 202, first to the left and then to the right, alternately, and with the sensing finger 170 controlling the necessary rearward movement of the carriage 28, until such time as the last pin in the rearmost row of pins 202 has been engaged by the sensing finger 208, at which time a switch SP is actuated and machine operations are terminated.

Referring now to Figs. 10 and 11 which, when placed in edge-to-edge relation, constitute an electrical circuit diagram for the present automatic drilling machine, it will be seen that current is supplied to the main lines 11 and 13 from a suitable source S which may be a commercial 110 volt, 60 cycle source, on closure of the main line or master switch SM. Upon closure of the switch SM current is made available for operation of the cross feed motor MC but is not yet made available for operation of the various other machine instrumentalities due to the presence of the manual shut-off switch SP which is interposed in the line 11 in series with the switch SM. The reversing switch SR for the cross feed motor MC is connected to the line 11 in advance of the switch SP so that it is possible to cause energization of the motor MC without necessitating closure of the shut-off switch SP. The reversing circuit for the motor MC extends from the source S, through line 11, lead 15, switch SR, lead 17, motor MC, leads 19, 21 and line 13 back to the source S. As previously explained, the circuit just described is employed for returning the transverse carriage 28 to its initial starting position.

The machine depends for its operational control upon a number of relay devices the nature of which will be set forth presently. These relay devices are, in turn, dependent for their operation upon a supply of low voltage current which may be obtained from a step-down transformer T, having a primary winding W*p* and a secondary winding W*s*. The primary winding has its terminals connected to the line 11 and to a low voltage line 23 which utilizes the line 13 as its counterpart. The switch SM has one pole thereof interposed in the line 11 and the other pole thereof in the line 23. Upon closure of the switch SP, both high and low voltage current is made available for machine operation from the lines 11 and 23 respectively.

Immediately upon closure of the switch SP, a circuit will be established through a relay magnet R5 having a single pair of normally closed contacts associated therewith. This circuit extends from the line 23, through leads 25, 27, 29, 31, 33, magnet R5, lead 35, normally closed #2 contacts of relay magnet R7, leads 37, 39, normally closed #2 contacts of relay magnet R6, leads 41, 43, sensing finger 170, land portion 158 of the cross feed sensing plate 152, and lead 45 to the line 13. Energization of the magnet R5 will cause its normally closed pair of contacts to become open and further machine functioning will not take place until manual operation of the longitudinal feed switch SLF.

To effect initial movement of the carriage 28 rearwardly, the switch SLF is closed manually whereupon the normally open #1 and #2 contacts thereof will become closed, thus establishing a circuit through the relay magnet R7. This circuit extends from the line 23, through leads 25, 27, 29, 31, 47, 49, magnet R7, leads 51, 53, #2 contacts of the switch SLF, and leads 55, 57, 59, 61, 63, to the line 13. Energization of the magnet R7 will cause the previously mentioned normally closed #2 contacts thereof to become open, thus opening the previously described circuit through the relay magnet R5 and deenergizing the latter so as to cause closing of the contacts associated therewith.

The contacts of the magnet R5 are disposed in the circuit for the cross feed motor MC, this circuit extending from the high voltage line 11, through lead 65, normally closed #1 contacts of the relay magnet R3, leads 67, 69, 71, contacts of the magnet R5 (now closed), lead 73, motor MC, and leads 19, 21 to the line 13. With the motor MC thus energized, the sensing finger 170 moves off of the elevated land portion 158 of the sensing plate 152 and proceeds toward the first sensing pin 156 and, upon engagement with such pin, the magnet R5 is again energized through the previously described circuit extending through the #1 contacts of the magnet R3, the #2 contacts of the magnet R6 and the #2 contacts of the magnet R7, whereupon the circuit for the motor CM, previously described, will become open and the movement of the cross feed carriage 28 will be terminated.

Upon initial manual closure of the switch SLF, a circuit for the relay magnet R1 will be established, this circuit extending from the low voltage line 23, through leads 25, 75, magnet R1, leads 77, 79, #1 contacts of the switch SLF, and leads 81, 55, 57, 59, 61, 63 to the line 13. The #3 contacts of the magnet R1 constitutes a pair of holding contacts for this magnet, the holding circuit extending from the line 23, through leads 25, 75, magnet R1, leads 77, 83, normally closed #1 contacts of relay magnet R2, lead 85, #3 holding contacts of magnet R1 (now closed), and lead 87 to the line 13.

Energization of the magnet R1 as described above causes its #2 contacts to close, whereupon a circuit will exist through the longitudinal feed motor ML. This motor circuit extends from the high voltage line 11, through lead 65, normally closed #1 contacts of the magnet R3, and leads 67, 89, #2 contacts of the magnet R1 (now closed), lead 91, motor ML, and leads 61, 63 to the line 13. The motor ML will continue to run and the longitudinal carriage 36 will travel to the left as viewed in Fig. 1 until such time as the sensing finger 208 engages the first pin 202 in the first transverse row of pins on the longitudinal sensing plate 200. At this time, a circuit will be established from the low voltage line 23, through lead 93, magnet R3, lead 95, normally closed #1 contact of the magnet R4, lead 97, sensing finger 208, sensing pin 202 and lead 99 to the line 13. Energization of the magnet R3 will cause the #1 contacts to open, thus deenergizing the previously described circuit through the motor ML and causing the longitudinally moving carriage 36 to terminate its movement. At this instant in the machine cycle, the position of the various work supports 48 will be such that the plates P carried thereby will be in proper position for drilling operations to create the first holes 14 therein.

Drilling operations are initiated by closure of the normally open #2 contacts of the magnet R3 at its time of energization as described above. These contacts are connected through leads 101 and 103 to a relay control device S*p*R, hereinafter referred to as the spindle relay, by means of which the winding 250 of the spindle solenoid valve VS is energized. The details of the relay device S*p*R have not been illustrated herein as much as the device constitutes an element of the commercially available automatic drill unit identified above. It is deemed sufficient to state herein that upon closure of the #2 contacts of the magnet R3, the solenoid valve winding 250 is energized through the output leads 105 and 107 and, by means of the valve VS, air is supplied under pressure to the lower end of the movable cylinder 130 so that the latter will be driven downwardly to actuate the drill 122.

The solenoid valve VS is likewise a part of the commercially available drill unit and a schematic representation of its operation has been made in Fig. 10. Upon energization of the winding 250, the solenoid core 252 is moved in a direction to shift the valve core 254, through the medium of the link 256 and operating arm

258, and thus establish a pneumatic circuit extending from a source Sa of air under pressure, through conduit 260, valve core passage 262, and conduit 264 to the lower end of the cylinder 130 through conduit 266 and passage 268 to the atmosphere.

After the various holes 14 have been formed in the plates P, the arm 132 engages the operating finger 134 of the microswitch M1 and closes the #1 and #2 contacts thereof. Closure of the #2 contacts causes energization of the relay magnet R4, the circuit extending from the low voltage line 23, through leads 25, 27, 109, magnet R4, leads 111, 113, #2 contacts of switch M1, and leads 115, 117, 63, to the line 13.

Energization of the magnet R4 causes opening of its normally closed #1 contacts and, upon opening of these contacts, the previously described circuit through the magnet R3 is broken, thus deenergizing the magnet R3 and causing the #2 contacts thereof to open and actuate the relay device SpR and deenergize the spindle winding 250. Deenergization of the winding 250 will return the valve core 254 to its normal position whereupon a pneumatic circuit will exist from the source Sa of air under pressure, through conduit 260, passage 270 and conduit 266 to the upper end of the cylinder 130, thus driving the cylinder upwardly and retracting the various spindles 119 and drills 122.

Deenergization of the magnet R3 causes the #1 contacts thereof to close, thus establishing the previously described circuit through the motor ML and causing the carriage 36 to again proceed in its path of travel to the left as viewed in Fig. 1 so that the sensing finger 208 leaves the pin 202 and, due to the previously described holding circuit for the previously energized magnet R1, the motor ML will continue to run until such time as any succeeding pin 202 in the longitudinal row of such pins is engaged, whereupon the magnet R3 will again become energized through the previously described circuit extending through the sensing finger 208. Ordinarily the sequence of operations thus far described involving periodic deenergization of the motor LM upon contact of the finger 208, subsequent drilling operations, and reenergization of the motor LM will take place repetitiously as long as there remain pins 202 in the longitudinal row undergoing sensing. However, according to the pattern selected for illustration, the sensing plate 200 contains only one pin 202 in the first row thereof so that, after this pin has been sensed as described above, further longitudinal movement of the carriage 36 to the left will allow the carriage to run out to the limit of its extent of movement whereupon the block 224 will engage the switch STF and close the #1 and #2 contacts thereof.

Energization of the magnet R4 under the influence of the microswitch M1 also closes the #2 holding contacts thereof so that the magnet is maintained energized as long as the sensing finger 208 remains in contact with the sensing pin 202. This holding circuit extends from the line 23, through leads 25, 27, 109, magnet R4, lead 97, sensing finger 208, pin 202 and lead 99 to the line 13. This holding circuit will remain in effect until such time as the sensing finger 208 moves away from the pin 202, at which time the circuit is broken and the magnet R4 is deenergized.

Closure of the #1 contacts of the switch STF will cause energization of the relay magnet R7 through a circuit extending from the line 23, through leads 25, 27, 29, 31, 47, 49, magnet R7, leads 51, 151, #1 contacts of switch STF and leads 57, 59, 61, 63 to the line 13. Energization of the magnet R7 will, as previously described cause opening of its #2 contacts, thus deenergizing the relay magnet R5 and closing the contacts thereof to again cause transverse movement of the carriage 28. The sensing finger 168 will move from the first pin 156 in the series and proceed to the second such finger whereupon the previously described circuit through the sensing finger 168 and magnet R5 will become effective to terminate further transverse feed of the carriage.

Closure of the #2 contacts of the switch STF effects energization of the magnet R2 through a circuit extending from the line 23 through leads 25, 27, 29, 161, magnet R2, leads 163, 165, 167, 169, #2 contacts of switch STR, and leads 59, 61 and 63 to the line 13. A holding circuit for the magnet R2 extends from the line 23 through leads 25, 27, 29, 161, magnet R2, leads 163, 165, 175, #3 contacts of magnet R2, leads 177 and 21 to the line 13. Opening of the #1 contacts of the magnet R2 breaks the previously described holding circuit for the magnet R1.

Closure of the #2 contacts of the magnet R2 establishes a circuit through the longitudinal feed motor LM which now operates in a reverse direction to move the longitudinal feed carriage 36 to the right as viewed in Fig. 1. This motor circuit extends from the high voltage line 11 through lead 65, #1 contacts of the magnet R3 (now closed), leads 67, 69, 179, #2 contacts of the magnet R2, lead 181, motor ML, and leads 61 and 63 to the line 13.

The carriage 36 now moving to the right as viewed in Fig. 1 will continue to move until such time as the first pin 202 in the second longitudinal row of pins on the plate 200 is encountered by the sensing finger, at which time the previously described circuit through the sensing finger and magnet R3 is again established. The motor LM is thus deenergized and further movement of the carriage 36 terminates. The previously described sequence of operations involving traversing of the first row of pins is repeated with the magnet R2 instead of the magnet R1 controlling the reverse direction of the motor LM. After the extreme right hand pin 102 has effected its function, the carriage 36 moves to the right until the block 212 engages the switch SLF whereupon rearward motion of the transverse carriage 28 is again initiated thus commencing a second machine cycle.

The operation of the machine is continuous with the sensing finger 208 sensing the pins 202 in each succeeding longitudinal row in a different direction and with the sensing finger 170 sensing the various pins 156 successively from front to rear. After the last pin 202 in the rearmost longitudinal rows of pins has been sensed by the sensing finger 208, an abutment 270 on the machine carriage 28 will engage switch SP and open the same whereupon the cross feed motor MC will be disabled. Prior to the next machine set-up, the switch SR will be depressed as previously described to return the carriage 36 to its extreme forward position.

Referring now to Figs. 12 to 17 inclusive, a modified form of longitudinal feed template and a modified form of cross feed template are shown as being applied to the automatic drilling machine of Figs. 1 to 11 inclusive for the purpose of producing the same hole pattern in the workpiece P. The cross feed template has been designated at 300 while the longitudinal feed template has been designated at 302.

It is to be noted that the various holes 14 in the workpiece 48 of Figs. 5 and 6 are twenty-four in number, there being five rows of holes looking in both 45° diagonal directions which, but for the omission of a single center hole to accommodate the fastening bolt 104, would total twenty-five holes. However, in both the longitudinal direction and in the transverse direction there are nine rows of holes. To cover the nine rows of transversely spaced holes, it is obvious that the cross feed template of either form of template illustrated herein must contain nine sensing pins. However, to cover the maximum number of holes in any longitudinal row, there need be but five sensing pins (disregarding for the time being the omitted center hole). Where circular workpieces are concerned, the longitudinal row containing the most number of holes will ordinarily be the middle row in the case of an odd number of rows, or the two middle rows in the case of an even number of such rows. Since, in the case of individual sensing pins such as the

pins **202** of Fig. 7, all of the pins are electrically connected in common, and since the pattern involves diagonal rows of points, by utilizing a series of diagonally extending ribs, instead of rows of pins, there need be employed only the exact number of such ribs as there are diagonally extending rows of points. In the twenty-five point pattern shown in Fig. 5, there are only five diagonal rows in each direction and, according to the present invention, the template **200** of Figs. 1 and 7 is replaced by a template such as the template **302** having five contact ribs **306** formed thereon and mounted on the platform portion **194** so that these ribs extend at an angle of 45° from the directions of longitudinal and cross feed. Although there may be nine longitudinal rows of points, at no transverse location are more than five such points arranged in alignment.

It is pointed out that if the hole pattern of Fig. 5 were turned 45° so as to produce a square pattern with five holes in each longitudinal and transverse row, there would need be but five sensing elements on each of the two templates but the illustrated arrangement of Figs. 12 to 17 inclusive has been selected to more clearly illustrate the principle of pin-reduction involved in the present invention. In commercial meat grinder plates containing upward of 8,000 holes, it is obvious that according to the present invention employing contact rigs instead of contact pins, the amount of decrease in the number of sensing elements required is considerable.

Whereas in producing the template **200** of Fig. 7 it is necessary to employ the exact number of sensing pins as the number of holes desired, according to the present improvement, a reduction of approximately four-fifths is attained.

The template **302** comprises a relatively thick metal plate which may be milled between ribs **306** to provide trough portions **308**. The plate may initially be milled completely across the face thereof and, subsequently, the excess metal of the various ribs **306** which falls outside the boundary of the pattern proper may be relieved by a suitable metal-removal operation leaving flat areas such as have been indicated at **310**.

According to the present invention, means are provided whereby the template **302** is capable of limited angular adjustment about a central vertical axis. Accordingly, a series of arcuate slots **312** are formed in the plate and a series of clamping bolts **314** pass through the slots **312** and are threadedly received as at **314** in the platform portion **194**. Washers **316** are interposed between the upper face of the plate and the heads of the bolts **314**. By such an arrangement, it is possible to vary the pattern of holes in the workpiece by varying the angularity of the diagonal rows of holes.

Referring now to Figs. 16 and 17, the template **300** is in the form of an alongated bar of metal which has been milled so as to produce a series of troughs **322**, leaving raised ridges **320** which constitute the sensing elements proper. The bar is fixedly secured to the supporting bracket **150** in any suitable manner, as, for example, by welding and since the travel of the sensing pin **170** is linearly straight, no provision need be made for adjusting the position of the template **300**. If patterns involving longitudinal rows of pins which are spaced apart at varying distances, it is contemplated that template substitution will be resorted to.

The invention is not to be limited to the exact arrangement shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. In an automatic drilling machine for successively drilling a series of holes at points which are predeterminedly equally spaced in each of both longitudinal and transverse rows, as well as in diagonal rows, in a workpiece, in combination, a stationary machine framework including means establishing a transversely extending guideway, a transverse feed carriage slidable in said guideway, means on said carriage and movable bodily therewith establishing a longitudinally extending guideway, a longitudinal feed carriage slidable in said latter guideway between two extreme positions, a horizontally disposed work support on said longitudinal feed carriage and movable bodily therewith, energizable cross-feed means for moving said transverse feed carriage, energizeable longitudinal feed means for moving said longitudinal feed carriage, a work support mounted on said longitudinal feed carriage, a fixed drill unit above said work support and including a rotatable drill designed for vertical register with said points and movable between raised and lowered positions and operable during downward movement thereof to engage a workpiece on the work support, energizeable means for actuating said drill unit, means for sensing which row in the workpiece is in register with said drill and means controlled thereby for controlling the operation of said energizeable cross feed means to terminate the movement of the transverse feed carriage so as to maintain said row in vertical register with said drill, said sensing means comprising a pattern plate having electrical contacts thereon arranged in alignment in a row extending transversely of the framework and conformable to the spacing of the longitudinal rows of points on the workpiece, and a sensing finger mounted on said transverse feed carriage and engageable with said contacts, means for sensing which point in any given row of points in the workpiece is in vertical register with said drill, said latter sensing means comprising a second pattern plate having electrical contacts thereon conforming in number to number of transverse rows of points in the workpiece, said latter electrical contacts being in the form of raised ribs on the latter pattern plate, said ribs being linearly straight and extending in parallelism, the spacing between adjacent ribs being conformable to the spacing between adjacent transverse rows of points in the workpiece, and a sensing finger engageable with said latter contacts.

2. In an automatic drilling machine for successively drilling a series of holes at points which are predeterminedly equally spaced in both longitudinal and transverse rows, as well as in diagonal rows in a workpiece, the combination set forth in claim 1 wherein said second pattern plate is angularly adjustable about a central axis, and means for clamping said second pattern plate in any desired position of angular adjustment.

No references cited.