Feb. 7, 1967 P. A. TAYSOM ETAL 3,302,494

AUTOMATIC DRILLING MACHINE

Filed May 27, 1964 5 Sheets-Sheet 1

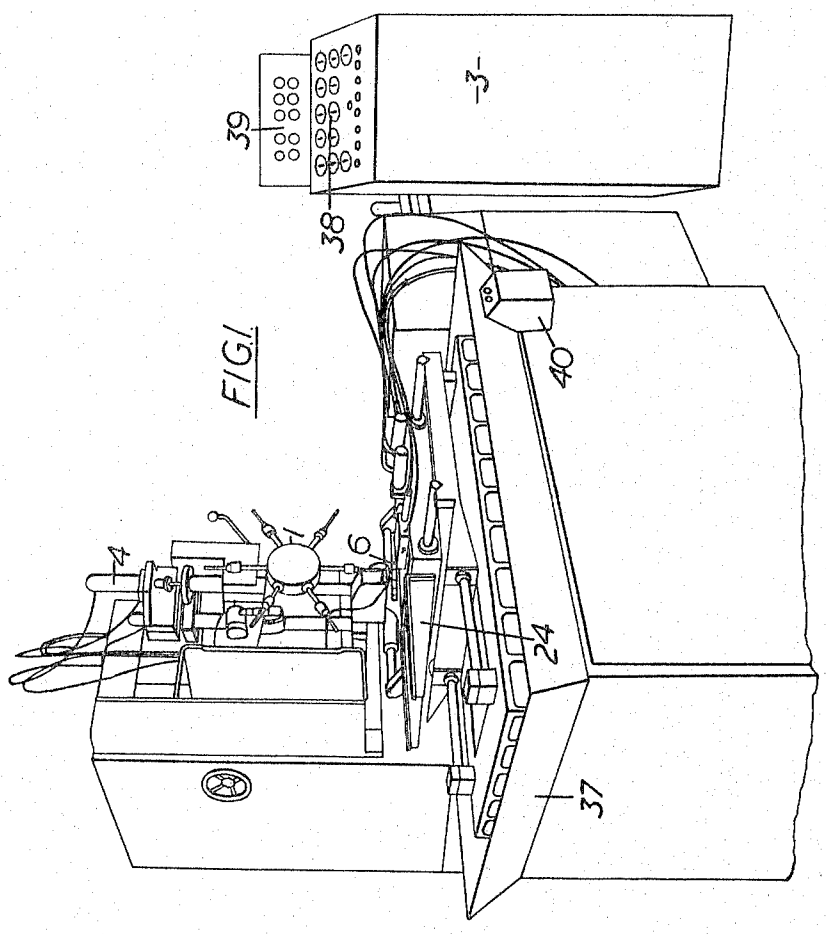


FIG. 1

Inventors
PATRICK A. TAYSOM
ROBERT E. KIRK
By
Percy P. Lantzy
Attorney

Feb. 7, 1967 P. A. TAYSOM ETAL 3,302,494

AUTOMATIC DRILLING MACHINE

Filed May 27, 1964 5 Sheets-Sheet 2

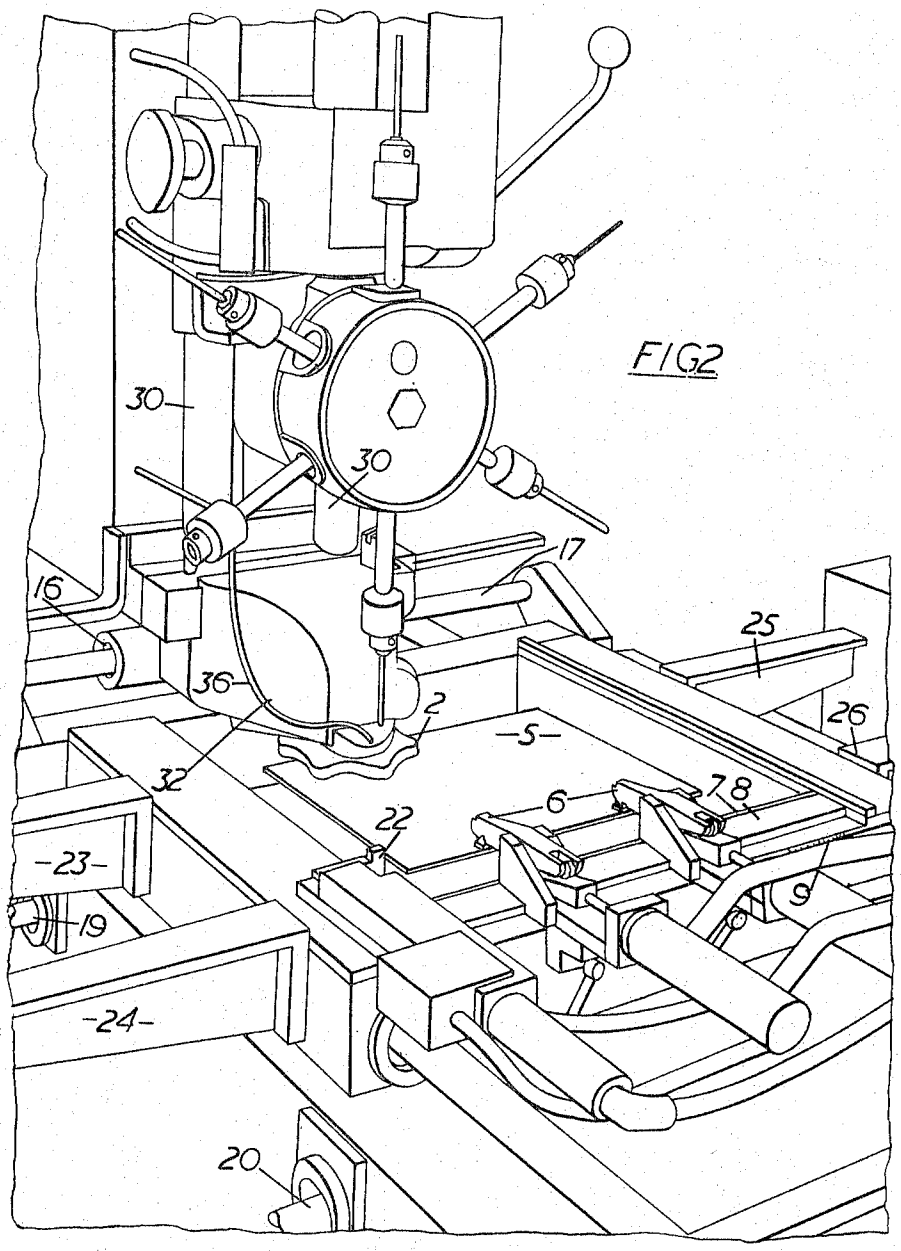


FIG2

Inventors
PATRICK A. TAYSOM
ROBERT E. KIRK
By Percy P. Lantzy
Attorney

Feb. 7, 1967 P. A. TAYSOM ETAL 3,302,494

AUTOMATIC DRILLING MACHINE

Filed May 27, 1964 5 Sheets-Sheet 3

FIG3

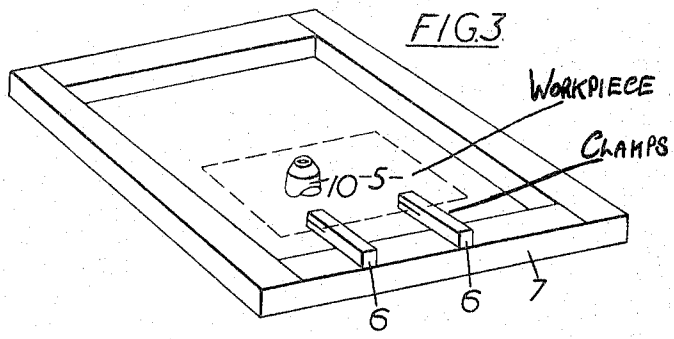
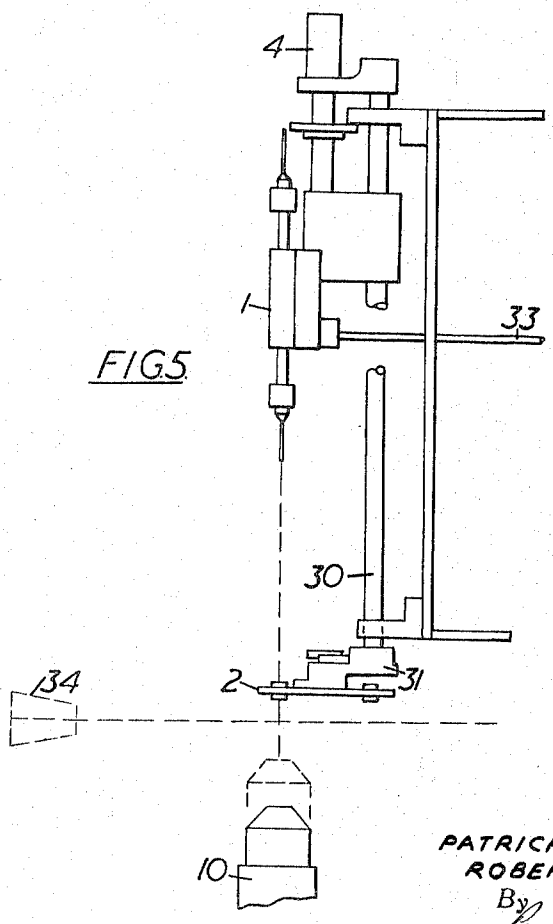


FIG5



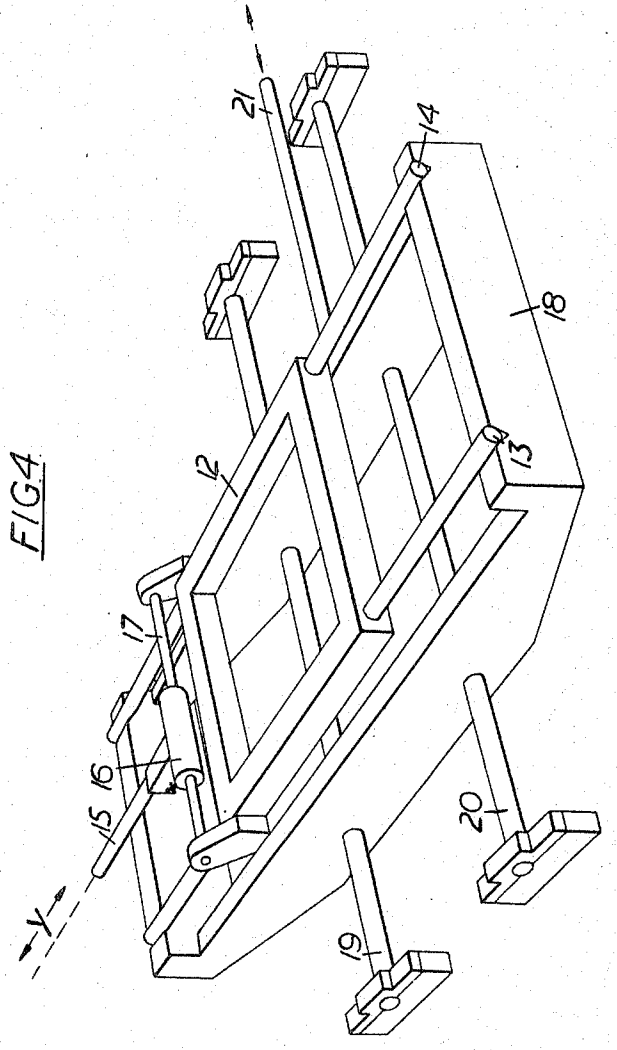
Inventors
PATRICK A. TAYSOM
ROBERT E. KIRK
By Percy N. Lantzy
Attorney

Feb. 7, 1967 P. A. TAYSOM ETAL 3,302,494

AUTOMATIC DRILLING MACHINE

Filed May 27, 1964 5 Sheets-Sheet 4

FIG 4



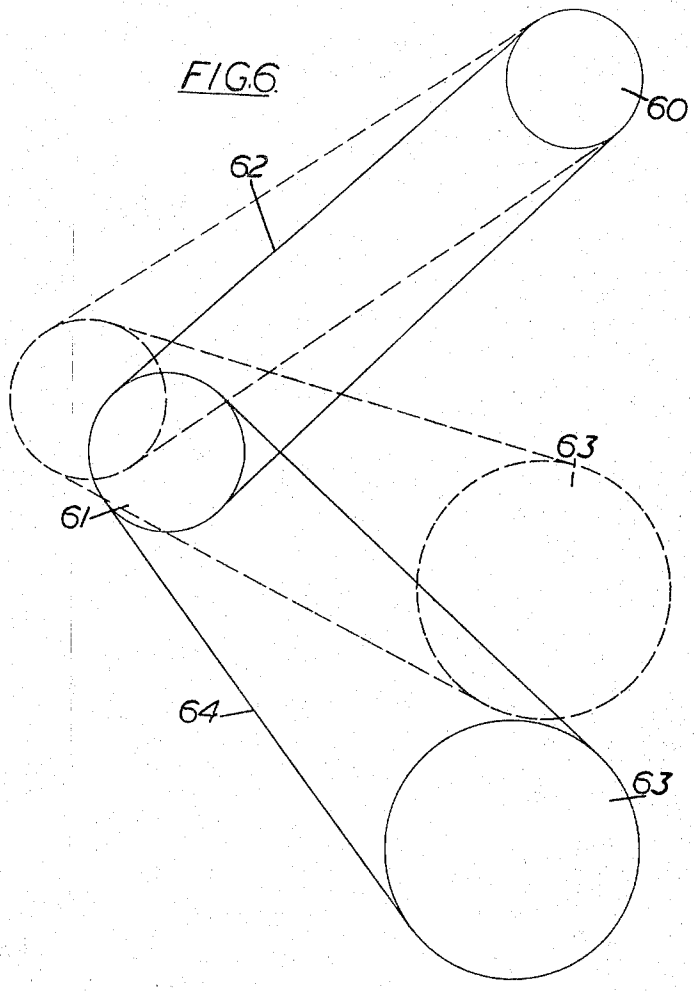
Inventors
PATRICK A. TAYSOM
ROBERT E. KIRK
By
Percy P. Lantzy
Attorney

Feb. 7, 1967 P. A. TAYSOM ETAL 3,302,494

AUTOMATIC DRILLING MACHINE

Filed May 27, 1964 5 Sheets-Sheet 5

FIG.6



Inventors
PATRICK A. TAYSOM
ROBERT E. KIRK
By
Percy P. Lantzy Attorney

United States Patent Office

3,302,494

Patented Feb. 7, 1967

3,302,494

AUTOMATIC DRILLING MACHINE

Patrick Arnold Taysom, Cardiff, Wales, and Robert Edwin Kirk, Brookmans Park, England, assignors to International Standard Electric Corporation, New York, N.Y., a corporation of Delaware

Filed May 27, 1964, Ser. No. 370,520
Claims priority, application Great Britain, July 8, 1963, 26,972/63
1 Claim. (Cl. 77—63)

The present invention relates to machine tools, and, more particularly, to a machine for processing materials in sheet or strip form, the processing operations each being performed at a relatively localized part of a workpiece.

The term "processing" as used herein refers to drilling, punching, forming, slotting, assembling, and other such operations, and the present invention provides a processing machine which has for its work table an open framework with a rectangular hole the size of which defines the working area. The workpiece is supported by clamps on one side of the framework, and in addition there is a spindle below the work position. The framework and hence the workpiece can be moved with respect to the working position and hence with respect to the spindle.

Although the invention is not so limited, the invention will be described in its application to a drilling machine; and a drilling machine which embodies the present invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a pictorial view of the drilling machine and of a control unit whereby the operations of the machine can be controlled either by manually operated switches or automatically from a programed tape;

FIGURE 2 is a pictorial view illustrating in more detail than FIGURE 1 the work table, drilling head and immediately adjacent parts;

FIGURE 3 is a simplified sketch illustrating the three-point suspension of a workpiece;

FIGURE 4 is a perspective view showing (with many parts omitted) the arrangements for positioning the work table in two coordinates;

FIGURE 5 is a side view showing the arrangement of the drill head; and

FIGURE 6 is a schematic diagram of the driving-pulley arrangement.

As can be seen from the general view, FIGURE 1, the machine has a drill head **1**, with a six-spindle (i.e. six different drilling positions) turret which can be indexed automatically to allow selection of any one of six drills. These drills are fitted in chucks (see FIGURE 2) and are guided by drill bushings in a turret plate **2**, which rotates with the drill turret. The driving arrangements for the turret are such that they allow a range of nine spindle speeds and nine spindle feeds, any of which can be selected automatically under control of the control unit **3**. The spindles are driven by a half-horsepower electric motor, and the spindle feed is hydraulically controlled, the drill feed unit being indicated at **4**.

The drilling table, whose movements are hydraulically controlled, has (in the example being described) a working area which can take plates of up to 12 inches square. This table (see FIGURE 2) is in the form of a frame, with the workpiece **5** held in position by two clamps **6** mounted on one side of the frame. These clamps are actually mounted on a slide bar **8** extending along the side **7** of the frame. The positions of these clamps are adjusted manually; a scale **9** is provided to facilitate the positioning.

The nature of the table is seen in the simplified sketch, FIGURE 3; here the clamps **6** are shown for simplicity as if they were mounted directly on the frame side **7**, instead of being mounted on a slide bar, as mentioned above. A workpiece is indicated at **5** in dashed lines. When drilling is in progress, the workpiece is supported at the actual point of drilling by a spindle whose uppermost end is indicated at **10**. This spindle has a hollow portion which receives the end of a drill during operation, and being retractable, is retracted between drillings to clear drill chips.

The arrangements for coordinate positioning of the worktable are shown in FIGURE 4. Here the frame **12** is shown slidably mounted on two rods **13**, **14** which are journaled within the frame in ball bearings to minimize friction. Movement in the Y direction is effected by a drive shaft **15** which works on a sleeve **16**, the latter being on a shaft **17** so that movement in the X direction does not affect the drive shaft. The shaft **17** is mounted on a pair of brackets at the back of the table **12**, and is journaled within the sleeve **16** in ball bearings to minimize friction.

The two support and guide rods **13**, **14** have their ends supported on V-shaped notches in the two sides of a further frame **18**. Caps may be placed over the notches when the rods are in place. The frame **18** is movable in the X direction along a further pair of guide rods **19**, **20** journaled in ball bearings in the frame **18** and also journaled in capped V notches as can be seen from the drawing. The X-direction movement is imparted to the frame **18**, and hence to the worktable, by a drive shaft **21** acting on the frame.

The two drive shafts are each movable in the "positive" and "negative" directions as indicated by the arrows placed alongside them in FIGURE 4, the extent of movement being limited by position control arrangements such as those of British Patent No. 870,186 (P. A. Taysom). However, the position control arrangments are not shown in the drawings.

Referring to FIGURE 2 again, the frame which forms the worktable has a retractable stop **22**, which serves to locate the workpiece accurately. This retractable stop is shown in FIGURE 2 in its non-retracted position although it is retracted when in use so as to preclude interference with the turret plate **2**.

One point about the worktable which has not been mentioned as yet is that is has two wings **23**, **24**, **25**, **26**, at each side as shown in FIGURE 2 (these being omitted from FIGS. 3 and 4 in the interests of simplicity). These wings serve to support the ends of long strip-like workpieces being dealt with. Hence, although the drilling area is restricted to 12" square (in the case of the machine described herein) for any one setting of a workpiece, the manual control system is so arranged that the workpiece can be repositioned along the X axis, using a previously drilled hole as a new datum position. Hence, workpieces longer than 12", with drillings along the whole length can be dealt with.

The arrangement of the drill proper is shown in FIGURE 5, which shows the turret **1**, the drill-feed unit **4** and the turret plate **2** already mentioned. The turret and turret plate are coupled by two shafts **30** (see also FIGURE 2) on which the turret unit is slidably mounted. The turret plate **2** has a control device **31** controlled so that when the turret is indexed, the turret plate is correspondingly indexed. The indexing is effected hydraulically under control of the control unit **3**, as will be mentioned later. The lower ends of the shafts **30** are journaled in a casing **32**, above the turret plate **2**.

The whole drill unit including the turret **1** is movable up and down, so that the drive shaft **33**, via which drive reaches the drill to be used, has a flexible coupling (not shown). Also shown in FIGURE 5 is the position of the clamps, dotted at **34**, and the spindle **10** in its retracted and non-retracted positions.

Coolant for the drill (shown in FIGURE 2) and also for the workpiece is supplied to the working point via a pipe **36** whose lower end is near the bushing plate. The machine itself has a coolant tray **37** (see FIGURE 1) for catching the coolant.

Now it is necessary to describe briefly the control unit **3**, shown in FIGURE 1, which allows the machine to work unattended (except for loading and unloading) under control of a programed tape. In the arrangement shown, punched tape is used, being read by an electromechanical tape reader of known type. However, a photoelectric tape reader could be used for this purpose; and in fact, such a device may be preferable as it has fewer moving parts than does an electromechanical reader.

The control unit has a number of multi-position switches **38**, and also an indicator panel **39** with lamp indicators for representing the settings of the various controlled entities of the machine. There are also fault-indicator lamps on the control circuit. Finally, there is an on-off switch unit **40**.

The drive shaft **33** for the drill receives its power from an electric motor whose drive is applied via two stages of belt drive, as schematically indicated in FIG. 6, in which a first pulley **60** is shown, this being the driver pulley, rotated by the electric motor. Pulley **60** drives an idler pulley **61** by a multi-V belt **62**, this pulley **61** being mounted on a slidable block so that it can move along a slot at right angles to a radius struck from the center of the pulley **60**.

Pulley **61**, or a second pulley rotatable therewith, drives the first or driving pulley **63** via a further multi-V belt **64**. The pulley **63** is mounted on the vertically-adjustable drill head carriage, and is movable up and down by 6", its other extreme position being shown in broken lines at **63**. The centers of the pulleys **63** and **61** are maintained a constant distance apart by a connecting link (not shown).

Thus, if the driving pulley **63** moves vertically, as it does when the drill head moves vertically, it moves the pulley **61** along a path at right angles to the radius struck from the center of the pulley **60**, so that a constant belt length is maintained between pulleys **61** and **63** and very nearly a constant length between pulleys **60** and **61**. There is, in fact, a variation of about 1/16" of the length of the belt between pulleys **60** and **61** over the full adjustment of 6" of pulley **63** because the pulley **61** follows a straight path, but this is taken up by the flexibility of the rubberized belt.

These pulleys and the motor are in the casing behind the drill turret **1** (FIGURE 1).

The variable-speed device for varying the speed of the drive to the spindle on the drilling machine has a rotatable control shaft which can be angularly adjusted either clockwise or counterclockwise, to select the required speed. This is achieved by driving the shaft through an electro-magnetic clutch by a reversible electric motor, which also drives, through a gear change, a multi-position rotary switch. Selection of a required speed on the operator's console or by punched tape energizes one of the contacts on the rotary switch, energizes the electromagnetic clutch, and starts the electric motor. When the wiper arm of the rotary switch reaches the energized contact, the electromagnetic clutch is de-energized, thus de-coupling the speed control shaft which then stops. It is now in the position appropriate to the speed required.

The electrical supply to the motor is cut at the same instant as the electromagnetic clutch is de-energized, and the motor stops after a short over-run period. The function of the electromagnetic clutch is two-fold:

(a) To provide immediate de-clutching of the speed-control shaft independent of the over-run to the motor and

(b) To act as a safety clutch which will slip and prevent damage to the speed-control device for the motor, should the motor fail to stop when required.

When a new speed is selected, the control circuit automatically senses whether the new speed is faster or slower than the previous speed and instructs the motor to rotate clockwise or counterclockwise, accordingly.

The above-mentioned shaft control governs in a well known manner the speed at which the motor which drives the drill runs. These elements are also in the casing of FIGURE 1.

The feed of the drill head is effected by hydraulic cylinder **4**; to vary the feed speed, a variable hydraulic flow is used to vary the flow of oil from the hydraulic cylinder. By varying the flow of oil, the speed of movement of the cylinder, and thus the feed rate of drilling, is varied.

The requirement is to select any one of nine feeds, and this is achieved by actuating the flow valve by a hydraulic cylinder via a rack-and-pinion drive. Also driven by the rack, through a further pinion, is a multi-contact rotary switch.

Selection of the required feed, on the operator's console or by punched tape, energizes one of the contacts of the rotary switch, and operates a solenoid valve to start the hydraulic cylinder movement. This, in turn, rotates both the flow-control valve and the wiper arm on the rotary switch. When the wiper arm reaches the energized contact, the hydraulic cylinder is stopped, thus leaving the flow valve set at the required position. The hydraulic cylinder which positions the flow valve is additional to that used for the drill feed.

When a new feed is selected, the control circuit automatically senses whether the new feed is greater or lesser than the previous feed and "instructs" the hydraulic cylinder to move forward or backward accordingly.

Having described the general characteristics of the machine, a sequence of operations will now be described. The operator loads the workpiece with the clamps **6** correctly located and then operates a switch to close the clamps and retract the location stop. The start button (on the unit **40**) is then pressed, initiating the following automatic cycle (assuming that a tape is in position):

(a) Part of the first block of information on the punched tape is read by the reader, and enters the control circuitry. This, and all subsequent information on the tape, is in a binary-coded decimal notation.

(b) The table is moved by the hydraulic rams controlled by the position-control units, so that it is correctly positioned. Movement can occur during this positioning in both axes simultaneously, and when the movement is completed the table is clamped.

(c) During the table positioning, the remainder of the same block of information is read, this remainder relating to the spindle feed and speed selections (these will in general depend on the nature and on the thickness of the workpiece) and also the turret index instructions. This information is also fed into the control circuitry.

(d) The required spindle feed and speed are selected, the turret (and with it the turret plate) indexed, if not already in the correct positions, and the drill head advanced so that the chosen drill drills, whereafter the drill retracts.

(e) During the action given at (d) above, the table movement instructions of the next cycle, i.e. for the next hole to be drilled, are read and fed to the control circuitry. Hence immediately the head has been retracted the table is unclamped, repositioned and clamped again.

The above cycle of operations is repeated automatically until all the holes are drilled, when the machine stops to allow the operator to reload. For convenience, the tape is joined at its ends so that a closed loop is formed, whereby the tape is ready to start the next cycle.

If coolant is needed during the operation, it is applied automatically (under control of the data from the tape)

during the drilling cycle only, so that the coolant only flows while the drillhead is in motion.

In the early part of this specification it was mentioned that material processings other than drilling are possible in a machine such as described above. In such case it will be realized that the guide bushings in the turret plate would need to be suitably chosen as would the upper end configuration of the spindle 10.

While we have described the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention, as set forth in the accompanying claim.

We claim:

In an automatic drilling machine, a drilling table and means for positioning said drilling table and a workpiece carried thereby with respect to the drill bit of said drilling machine, said drilling table comprising a four-sided frame open in the center for accommodating said workpiece and a plurality of clamps positioned on one side of said four-sided frame for holding an edge of said workpiece, said drilling table having in cooperative arrangement therewith a centrally located spindle for supporting said workpiece at a point directly opposite the drilling position of said drill bit, said means for positioning said drilling table comprising a pair of parallel rods and a frame in which said parallel rods are journaled, said drilling table being slidable upon said parallel rods, a shaft mounted on two brackets respectively positioned

on either side of said drilling table and passing through a sleeve, a drive shaft coupled to said sleeve for moving said drilling table in a direction parallel to said pair of rods, said pair of rods being in turn supported by a four-sided frame, said frame being movable in a direction orthogonal to the direction in which said drilling table slides upon said pair of rods, said frame having means for moving it in said orthogonal direction to impart a second dimension to the positioning of said drilling table and said workpiece with respect to said drill bit.

References Cited by the Examiner

UNITED STATES PATENTS

277,817	5/1883	Wilder et al.	77—64
444,810	1/1891	Bonner	77—63
514,762	2/1894	Maier	144—93
1,724,250	8/1929	Berven	77—25
2,269,946	1/1958	Lange	144—93
2,819,743	1/1958	Birkel et al.	143—48
2,975,661	3/1961	Coleman	77—5
3,064,505	11/1962	Pierce	77—63
3,116,652	1/1964	Bregnard	77—5
3,124,018	3/1964	Gough	77—63
3,138,974	6/1964	Burg	77—25
3,183,780	5/1965	Little	77—63
3,192,801	7/1965	Gingras	77—5

FRANCIS S. HUSAR, *Primary Examiner.*