Feb. 11, 1958 C. E. WEBB 2,822,599

CLAY PIPE PERFORATING MACHINE

Filed Oct. 22, 1953 5 Sheets-Sheet 1

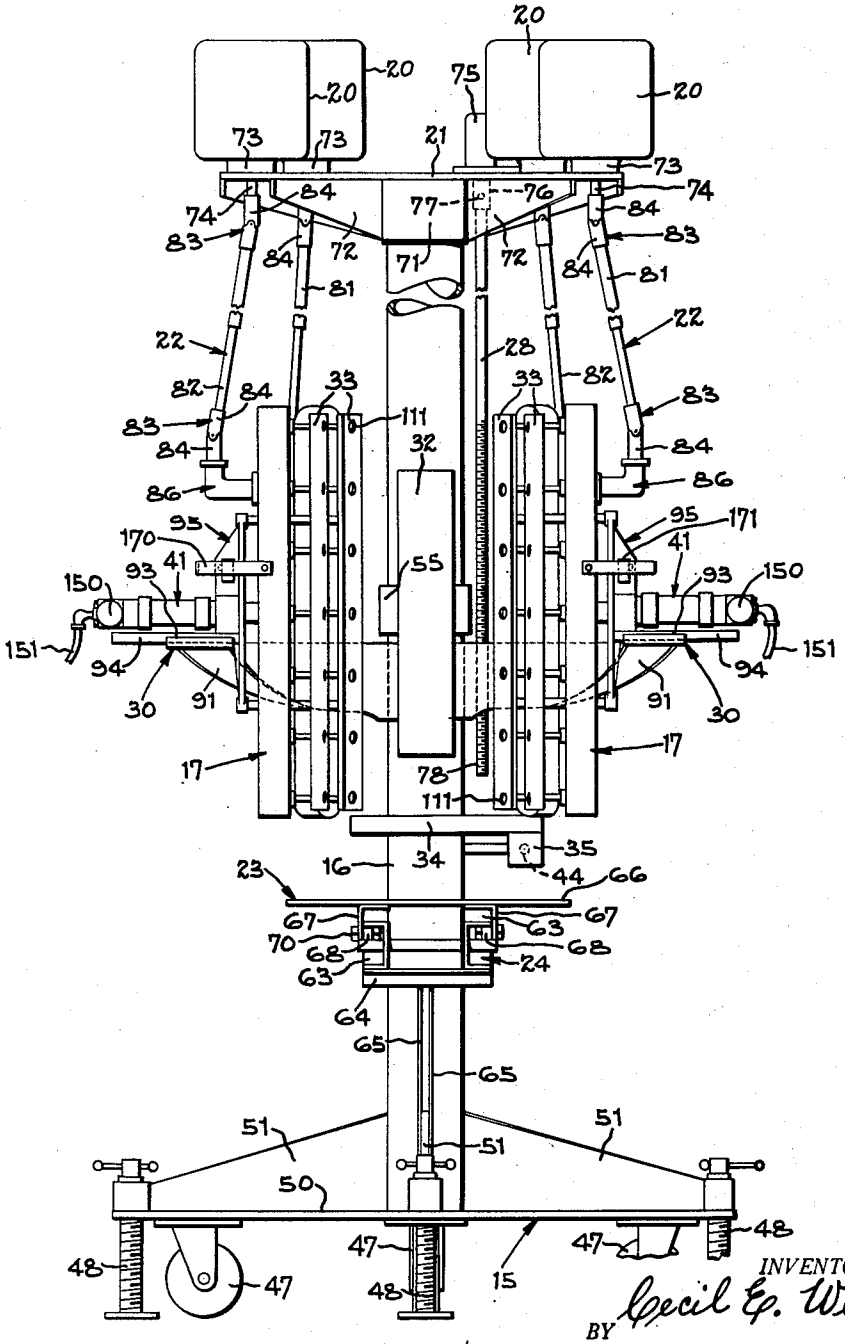


Fig. 1

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Filed Oct. 22, 1953 5 Sheets-Sheet 2

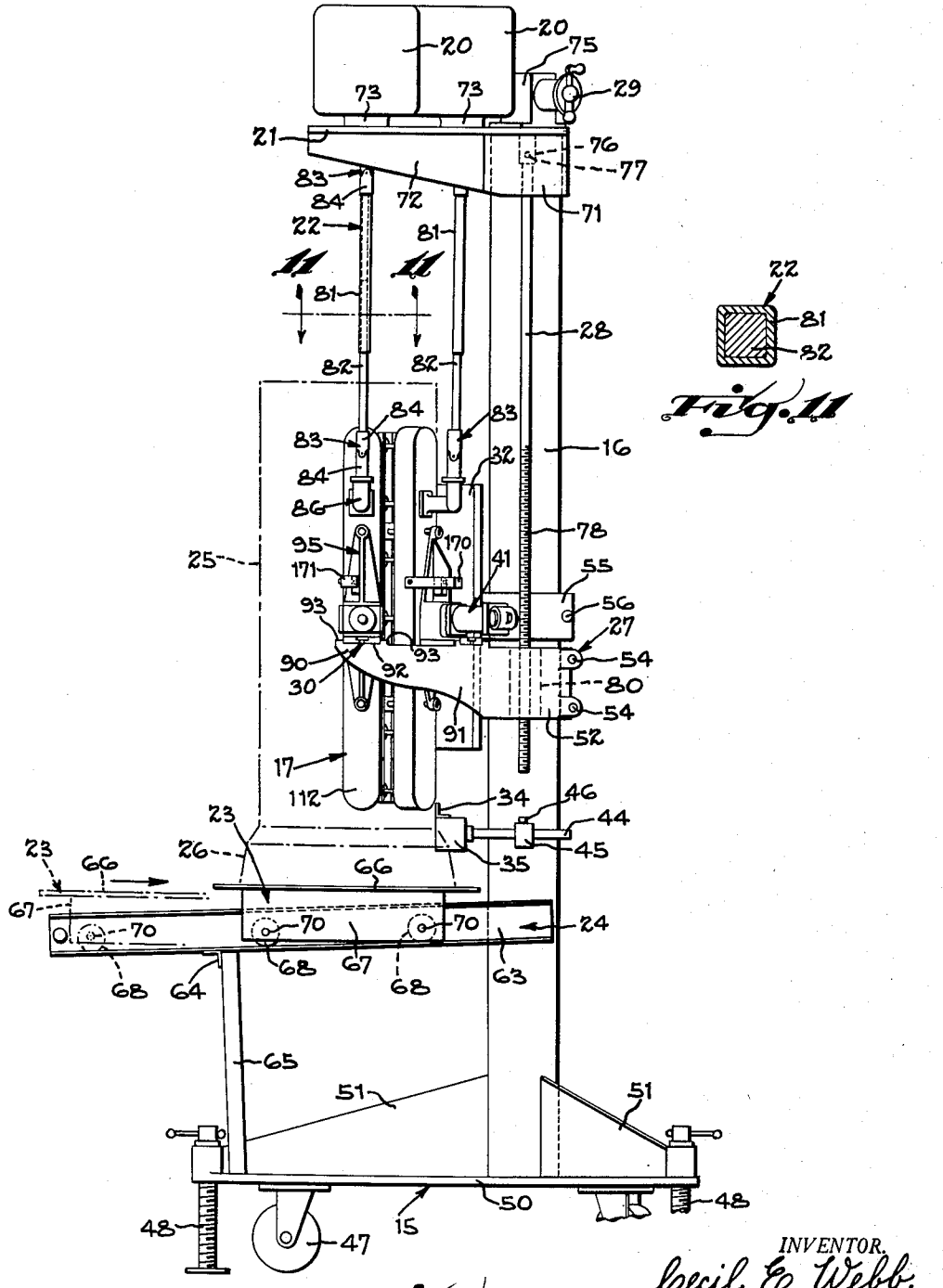


Fig. 2

Fig. 11

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CLAY PIPE PERFORATING MACHINE

Filed Oct. 22, 1953 5 Sheets-Sheet 3

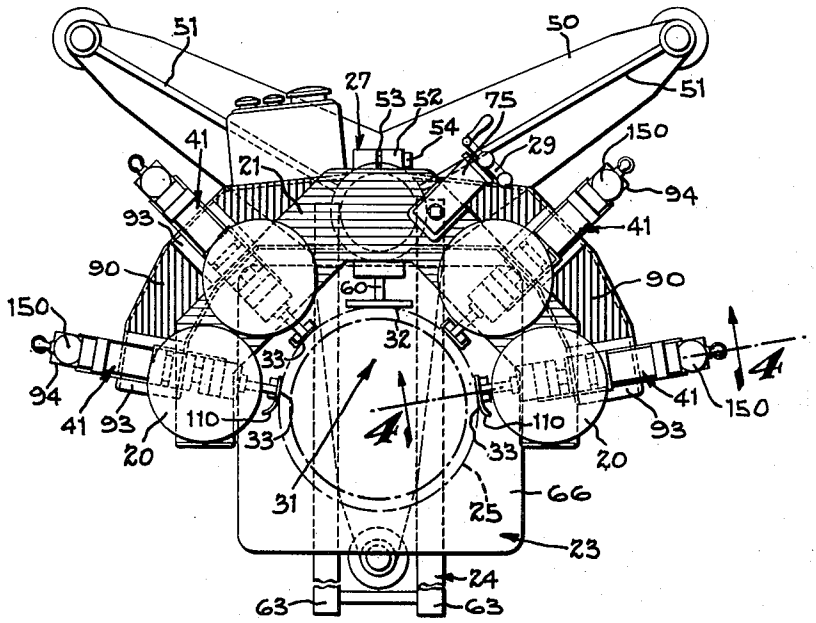


Fig. 5

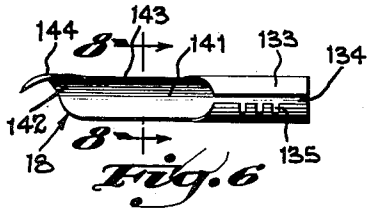


Fig. 6

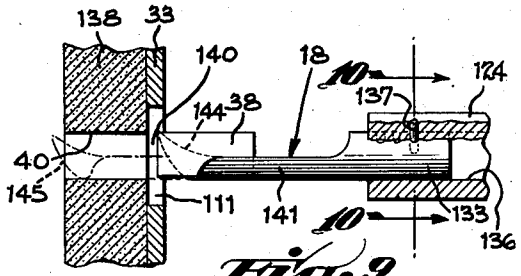


Fig. 9

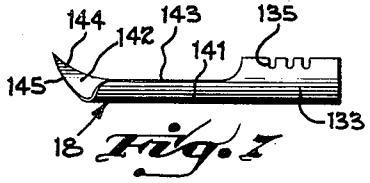


Fig. 7

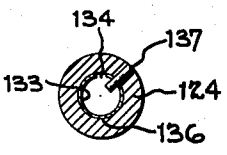


Fig. 10

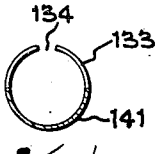


Fig. 8

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CLAY PIPE PERFORATING MACHINE

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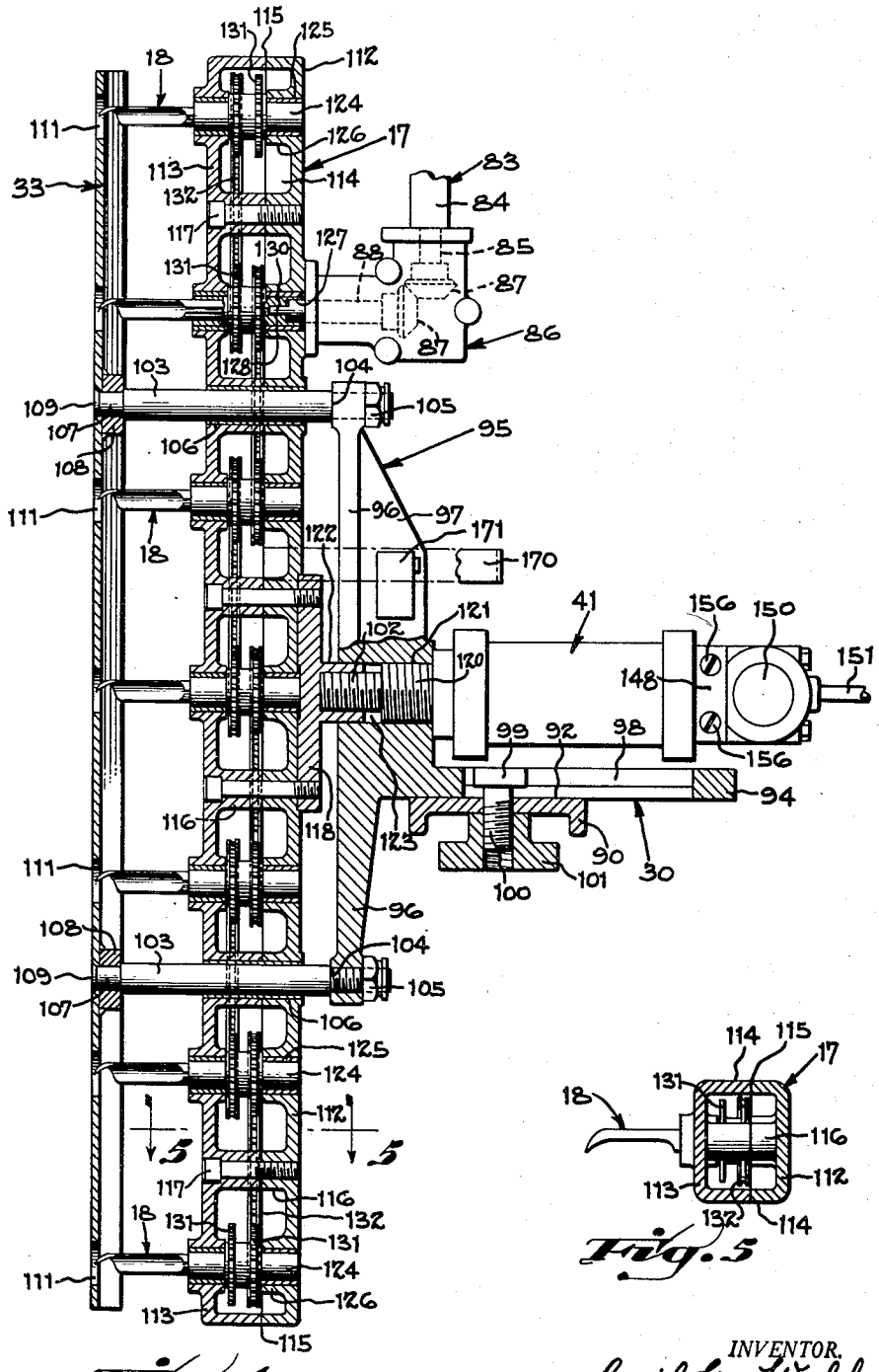


Fig. 4

Fig. 5

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CLAY PIPE PERFORATING MACHINE

Filed Oct. 22, 1953 5 Sheets-Sheet 5

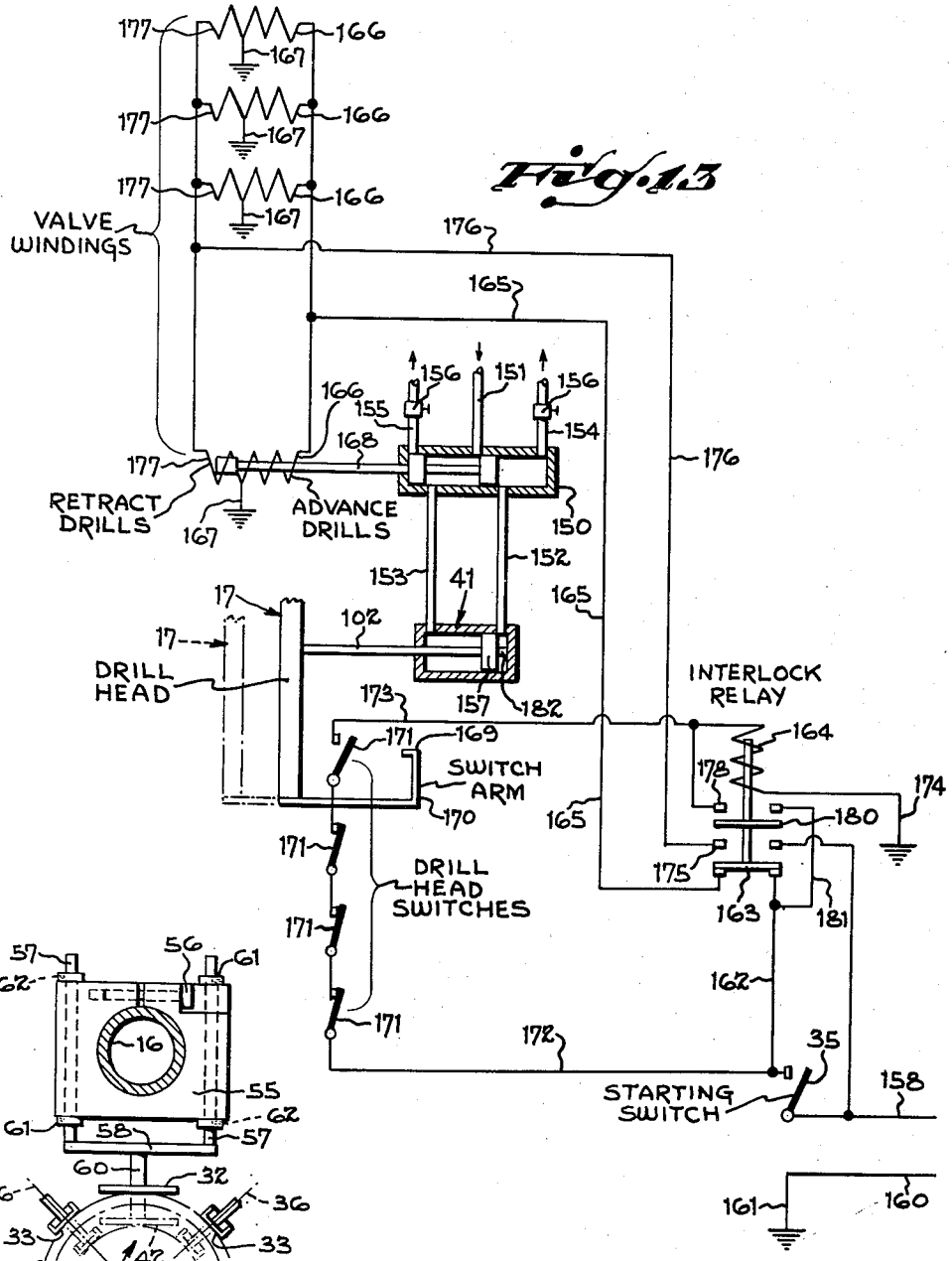


Fig. 13

Fig. 12

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United States Patent Office

2,822,599

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CLAY PIPE PERFORATING MACHINE

Cecil E. Webb, Cincinnati, Ohio, assignor to M. S. Bowne, Clearfield, Ky., trustee

Application October 22, 1953, Serial No. 387,647

11 Claims. (Cl. 25—105)

This invention relates to the manufacture of clay tile drainage pipes of the type provided with longitudinal rows of holes to permit liquids to drain through the wall of the pipe; more particularly, the invention is directed to a machine for executing a perforation operation upon the clay pipes while they are in plastic condition.

Perforated clay pipes of this type are used for many purposes, by way of example, they are widely used in the construction of leaching lines for draining into the soil liquids from septic tanks and the like and for draining water from fields and farm lands. The pipes are furnished either with plain ends or with a socket or coupling hub at one end which, upon installation in the trench, is interfitted over the plain or spigot end of an adjoining pipe and sealed with cement. The holes are formed in rows located longitudinally along slightly less than half the diameter of the pipes and they are installed with the holes facing downwardly in the trench to avoid having the soil clog the holes after the trench is filled in.

The pipes are fabricated from clay in plastic condition, usually by an extrusion process which forms the clay spigots or cylinders and, if required, forms the socket at one end of the clay spigot. One machine which is extensively used in the clay pipe industry comprises a steam press from which the clay cylinders are extruded at a high production rate, the socket (if required) being formed as a part of the extrusion operation. A production line operation is utilized in many plants in fabricating clay pipe, and in this case, the relatively soft clay pipes issuing from the extrusion press are placed in perpendicular position upon a conveyor for advancement to a finishing machine and from the finishing machine to the perforating machine of the present invention. In other plants, the pipes are perforated as a separate manual operation after they are extruded and finished. In either event, after the pipes are finished and perforated, they are placed in a drying area where they are dried by exposure to warm air currents in preparation for firing and glazing.

One of the primary objects of the present invention has been to provide a perforating machine which, at high production speed and in response to the random advancement of individual pipes to the machine simultaneously drills several longitudinal rows of holes in the pipe wall in a single operation and in a completely automatic manner, with the holes clean-cut and completely free of burrs.

The invention is predicated upon the concept of providing a plurality of drill heads, each including a parallel row of tubular drills, the drill heads being located in radial positions delineating a semi-circular throat arranged to receive the pipe, with the axes of the several rows of drills all radiating toward the central axis of the pipe when it is positioned in the throat. A back stop locates the pipe relative to the drill heads and each drill head is provided with a guide bar, fixed to the head, which collectively with the back stop, engage the periphery of the perpendicular pipe and locate it in drilling position.

The drill heads are shifted radially by power means toward and away from the axis of the pipe in an automatic manner in response to the movement of the perpendicular pipe into the throat, so as to perforate the pipe wall. An automatic control system is provided, having a starting switch which is tripped by the clay pipe when in perforating position in the throat. The control system provides rapid automatic cyclic operation to advance and retract the drill heads by power; thereupon, the perforated pipe is removed from the machine.

In order to feed the pipes into the throat, a wheeled carriage is mounted upon an upwardly inclined track and supports the pipe in perpendicular position at a fixed plane relative to the perforating heads, the carriage being movable laterally relative to the open side of the semi-circular throat. The pipe is placed conveniently in perpendicular position upon the carriage and advanced up the inclined track into the throat at a predetermined elevation or longitudinal relationship to the drills to locate the holes lengthwise of the pipe, while the back stop and radial stop bars locate the pipe accurately in radial position.

A further object of the invention has been to provide an improved tubular drill, having a spiral leading end cooperating with a drill head which provides a correlated rate of drill speed and feed and is capable of drilling holes which are clean-cut and free of burrs without utilizing a mandrel or other supporting means for the internal wall of the pipe. The tubular drill and its head thus contribute directly to the speed and efficiency of the drilling operation.

For its intended purpose, each drill is formed of light guage sheet metal generally tubular in form and having a spiral leading end portion which has a tendency to pull the clay outwardly, in cork screw fashion, as it penetrates the clay wall so as to pull out the burr which would otherwise be formed around the internal edge of the hole. In order to provide this effect, the rate of advancement of the tubular drill through the pipe wall is less than the pulling effect of its rotating spiral end to provide an outward screwing action along the leading end portion as the drill moves inwardly. Accordingly, the drill severs a clay plug from the wall as it advances and extracts the severed plug as it retracts, leaving the hole clean-cut and free of burrs.

The tubular drills which cooperate with the present drill heads are disclosed in a copending application which was filed on November 16, 1953 bearing Serial No. 392,239 entitled, "Tubular Drill for Perforating Plastic Clay Pipe."

A further object of the invention has been to provide a machine in which the drill heads may be repositioned to accommodate various standard pipe diameters and lengths, such that the machine is capable of being set up quickly and conveniently for perforating a run of a given pipe size.

The machine includes a vertical column upon which is slidably mounted for vertical adjustment, a mounting bracket which supports all of the drill heads in a common plane. A vertical elevating screw is suspended from the top of the column and, upon being rotated, shifts the mounting barcket and drill heads vertically relative to the carriage so as to locate the drills longitudinally of the perpendicular pipe resting upon the carriage. To provide radial adjustment for the several pipe diameters, the back stop is adjustably mounted with respect to the column so as to position the pipe at a given center which corresponds to the point of intersection common to the radial axes of the drills. After the back stop is properly located, the drill heads are adjusted relative to the mounting bracket

along the lines corresponding to the radial axes of the drills, such that their stop bars delineate the receiving throat for the new pipe diameter, In addition, the starting switch which initiates the cycles, is also arranged to be repositioned to locate its actuating arm in a position to be tripped by the new pipe diameter.

Since the machine responds automatically to the random advancement of the pipes, the present machine may be operated manually by placing the pipes upon the carriage then pushing the pipe and carriage along the inclined track toward the receiving throat and into engagement with the back stop. This trips the starting switch causing the machine to run through its cycle automatically. The advancement and retraction of the drills is so rapid that the operator may simply push the pipe into the throat and release it, allowing the perforated pipe and carriage to return of its own accord down the inclined trackway for removal of the pipe.

On the other hand, the present machine is also intended to be utilized in conjunction with an automatic finishing machine which responds automatically to the advancement of pipes from an extrusion press to finish the opposite ends of the pipes. This machine is disclosed in the copending application of Cecil E. Webb, entitled "Automatic Apparatus for Finishing the Ends of the Tile Sections," Serial No. 237,920, filed July 21, 1951 now Patent No. 2,713,189, to which attention is invited.

The finishing machine includes a revolving turret having radially disposed clamping jaws which are indexed stepwise in a horizontal plane, and a feed conveyor which advances the extruded but unfinished pipes toward the jaw at the receiving side of the machine for engagement by it. Upon entering the open jaw at the receiving side, a cycle is initiated, causing the jaw to close upon the pipe, then to index the pipe to a pair of axially movable finishing heads which enter the opposite ends of the pipe and execute the finishing operation. Upon the next cycle, the jaw, with the finished pipe clamped in it, is indexed to a discharge conveyor where the finished pipe is released.

The perforating machine of the present invention may be located at the end of the discharge conveyor and is preferably served by two operators. At the pipe approaches the end of the discharge conveyor, one of the men transfers the pipe to the carriage and pushes it upwardly along its trackway toward the drill heads until it engages the back stop. Since the perforating cycle is executed almost instantly upon touching the back stop, the pipe need not be held in position and instead is allowed to immediately roll back away from the heads, whereupon the second man transfers the pipe manually from the carriage to a truck or other means for conveying the perforated pipes to the drying area. In the meantime the carriage rolls by gravity down to its starting point adjacent the conveyor in position to receive the next pipe. By virtue of the rapid perforating action and the elimination of a mandrel or other part internally of the pipe, the runs of pipe are perforated at extremely high production rate.

Various other features and advantages of the invention will be more fully apparent to those skilled in the art from the following description taken in conjunction with the drawings.

In the drawings:

Figure 1 is a front elevation of the perforating machine showing the general arrangement of parts with the drill heads in normal retracted position.

Figure 2 is a side elevation of the machine as projected from Figure 1, showing the carriage with a pipe resting upon it and being shifted inwardly toward the drill heads.

Figure 3 is a top plane view of the machine with a clay shown in perforating position in the drill head throat at the start of a cycle.

Figure 4 is an enlarged sectional view taken on line 4—4, Figure 3 detailing one of the drill heads and its actuating mechanism.

Figure 5 is an enlarged sectional view taken on line 5—5 Figure 4, further detailing one of the drill heads.

Figure 6 is an enlarged side view of one of the tubular drills.

Figure 7 is a view of the drill taken at right angles to Figure 6, further detailing its construction.

Figure 8 is an enlarged sectional view taken on line 8—8, Figure 6, further detailing the tubular drill.

Figure 9 is a fragmentary sectional view of the drill mounted in operating position in the chuck of the drill head, showing its operating stroke with respect to the wall of a clay pipe.

Figure 10 is a sectional view taken on line 10—10, Figure 9, detailing the locking means for the tubular drill.

Figure 11 is a cross sectional view taken along line 11—11, Figure 2, detailing this telescopic connection of one of the extensible shafts.

Figure 12 is a sectional view of the back stop and its mounting structure, showing diagrammatically the adjustment of the back stop to accommodate different pipe diameters.

Figure 13 is a diagrammatic view of the control system, showing the electrical circuit and the valves and cylinders in the position assumed at the start of a perforating cycle.

General structure and operation

Referring to Figures 1 and 2, the perforating machine consists generally of a base indicated at 15 having a perpendicular column 16 rising upwardly and supporting, at an intermediate elevation, a plurality of drill heads 17. Each of the drill heads is provided with a set of tubular drills indicated at 18, the drills of each head being rotated individually by electric motors 20 which are mounted at the top of the column upon a platform 21, one motor for each head. The motors are connected to the respective drill heads by articulated drive shafts 22, which rotate the sets of drills and allow the heads to be shifted laterally by power means during a cycle of operation. The motors are constantly energized while the machine is in operation and the heads are shifted laterally toward one another to feed the drills rapidly through the wall of the clay pipe and then to retract them in response to the advancement of the pipe into the machine, as explained later in detail. The articulated drive shafts also allow the heads to be adjusted laterally and longitudinally to accommodate the several pipe diameters and lengths.

The lengths of the clay pipe, which may be either in plastic condition fresh from the press or in semi-plastic condition, are fed to the perforating machine in a perpendicular position upon a carriage 23 which is mounted upon an inclined trackway 24. As the pipes issue from the press, they may be advanced by a conveyor through a finishing machine, as explained earlier, then transferred from the discharge conveyor of the finishing machine to the carriage, whereby the perforating machine executes its operation in conjunction with the finishing machine. On the other hand, the pipes may be fed to the perforating machine as a separate operation after they have been extruded, finished and allowed to dry for a limited period, but while they are still in semi-plastic workable condition if the plant follows such procedure. In either event, the machine reacts automatically to the random advancement of the individual pipes to execute its drilling or perforating cycle at high speed.

It is to be noted that the tile drainage pipes 25, for which the machine is intended, are furnished with either plain ends or with a socket formed at one end as indicated at 26 (Figure 2). The socket provides a telescopic connection with the plain or spigot end of an adjoining pipe when the pipes are placed end-to-end in the trench, the socket providing an annular space surrounding the end of the spigot, the space being packed with cement or the like to seal the joint. As shown in Figure 2, the pipe may be advanced into the machine with the socket resting directly upon the surface of the carriage; however, in

some instances involving large heavy pipes, the socket is supported upon a socket board or pallet, resting on the carriage, which provides a stud projecting upwardly into the socket and engaging a shoulder therein to prevent distortion of the relatively soft socket. In other instances, in handling socket type pipes, the pipe may be placed in an inverted position upon the carriage with its spigot end resting upon the carriage to protect the socket.

In order to locate the drills longitudinally to perforate a run of pipes having a given length, the drill heads are mounted in common upon a vertically adjustable bracket **27** which is slidably connected to the column. A rotatable elevating screw **28**, connected to a hand wheel **29**, is utilized to adjust the bracket and drill heads vertically relative to the perpendicular length of pipe resting upon the carriage. The adjustment means, in a simple manner, provides the required hole location for the several standard pipe lengths, either of the plain or socket type.

The machine is also arranged to accommodate the various standard diameters of pipe by repositioning the drill heads radially in a common horizontal plane relative to the central axis of the pipe. This adjustment is provided by individual slide connections between the drill heads and bracket as indicated generally at **30** in Figures 2 and 4.

When the machine is properly set up for a particular length and diameter of pipe, the pipes are placed individually upon the carriage, with the carriage in the extended position, indicated in broken lines in Figure 2. Referring to Figure 3, it will be observed that the drill heads, as viewed from above, are arranged generally in a semi-circle to delineate a receiving throat as indicated generally at **31**. The carriage, with the pipe resting upon it, is advanced along its trackway, carrying the pipe into the throat and into contact with the back stop indicated at **32** and the fixed radial stop bars **33**. As the pipe approaches the back stop, it engages and trips a pivoted arm **34** which extends from cycle starting switch **35** forming a part of an electrical control system. The arm **34** extends across the path of the pipe slightly in advance of the plane of the back stop and, upon being shifted rearwardly by the pipe, closes the switch and initiates an automatic cycle of operation. During the cycle, the drill heads are advanced laterally by fluid pressure toward one another and retracted, causing the tubular drills to be advanced through the stop bars and through the wall of the pipe to perforate the wall, then retracted as indicated in Figure 9.

Each drill head is provided with vertically disposed rows of tubular drills located in parallelism to provide rows of holes longitudinally along the pipe and the several heads are radially disposed relative to one another, as explained earlier. As indicated by the broken lines **36** in Figure 12, the axes of the drills of the several heads radiate from a common center **37** which corresponds to the central axis of the pipe when in perforating position. Upon initiation of the perforating cycle, the heads are shifted by fluid pressure cylinders (preferably air) inwardly along the respective axes **36**, such that the drills feed radially through the wall of the pipe and penetrate it generally in cork screw fashion to sever a clay plug as indicated at **38** in Figure 9. Upon being retracted back to the starting position, the drills extract the clay plug so as to clear the hole **40** in the pipe wall. As explained earlier, the drilling operation is executed without the usual internal support such as a mandrel, and instead, the drills pass through the wall of the pipe without breaking out the holes or burring them. The absence of mandrels naturally simplifies the operation and promotes high speed production. The axial feed rate of the drill, which has a generally spiral leading edge, is so correlated to the rate of its rate of rotation, that the drill has a tendency to pull the clay outwardly in cork screw fashion as the clay plug is severed. In other words, the rate of advancement of the rotating spiral, as determined by its rotary speed, is greater than the lineal advancement provided by the drill head. Upon penetrating the inside diameter of the pipe, the spiral leading end of the drill pulls outwardly the burr which would otherwise be formed around the internal edge of the hole. By way of example, it has been determined at a drill speed of approximately 1725 R. P. M., that a feed rate which provides approximately one and one half turns of the drill during its penetration of the clay wall is most efficient and provides a clean-cut hole, free of burrs at both edges.

Since the drill is retracted at approximately the same rate of speed, it will be perceived that the perforating operation is completed at a high rate of speed which is found to provide the best results. The axial reciprocation of the heads and drills is provided by the respective air pressure cylinders **41**, one for each head, the cylinders being arranged to advance and retract the drill heads in unison, at a regulated speed provided by adjustable metering valves, through a complete cycle of operation each time the starting switch is tripped.

It will be observed in Figure 3, that the axes **36** of the drills are disposed within an arc of less that 180° with respect to the circumference of the pipe. The holes are thus grouped in rows along less than one half the pipe diameter and upon installation in the trench, the pipes are placed with the holes facing downwardly. This prevents the holes from being clogged with soil after the drainage line is covered over with soil.

As indicated earlier, the machine can be adjusted to accommodate different diameters of pipe by adjusting the several drill heads along the axes **36**. By way of example, if the drill heads are repositioned to accommodate a pipe of smaller diameter, then the back stop **32** must be shifted outwardly as indicated in broken lines **42** in Figure 12 to contact the circumference **43** of the smaller pipe with the center of the pipe located upon the same center **37** previously occupied by the larger one.

It will also be understood that the starting switch **35** and its arm **34** must be repositioned to correspond to the position of the back stop and stop bars. For this purpose the switch is carried upon the outer end of a bar **44** which is slidably confined in a mounting block **45** attached to the column **16** as shown in Figure 2. The bar is clamped in adjusted position with respect to the block by a set screw **46** threaded through the block and engaging the bar.

In addition to the means for repositioning the parts to compensate for the length and diameter of several standard pipe sizes, the machine also includes means to accommodate the difference in the wall thickness of the pipes. The control system, which reciprocates the drill heads, provides a fixed stroke as described later in conjunction with the circuit diagram shown in Figure 13; therefore, wall thickness changes are met by changing the length of the drills. To accommodate several thicknesses, the drills **18** are set to project outwardly the required distance beyond the drill heads by means illustrated in Figure 9. The construction of the tubular drills and adjustment means are described in detail later.

During operation of the machine in conjunction with an automatic finishing machine, the pipes advancing along the conveyor are transferred to the carriage which normally resides in the extended position, shown in broken lines in Figure 2. The pipes are transferred manually and the carriage with the pipe upon it is then shifted manually toward the open throat delineated by the several drill heads to be perforated. As soon as the starting switch is tripped the drill heads rapidly advance and retract and complete the operation almost instantly; therefore the pipe may be released immediately to be carried out of the throat under gravity for removal.

Machine details

To allow the machine to be moved conveniently, the base **15**, upon which the column is mounted, is provided

with castors 47 and further includes screw jacks 48 arranged to support the machine firmly in its operating position. The base is generally of welded construction comprising a flat plate 50, the lower end of the column being welded to the plate and braced laterally by ribs 51 which are also welded to the base plate and column.

The mounting bracket 27 which supports the drill heads has a sleeve 52 encircling the column and includes a split portion 53 (Figure 3) including clamping screws 54 which draw the sleeve into clamping engagement with the column.

As best shown in Figures 1 and 12, the back stop 32 comprises a vertical plate extending parallel to the column and spaced outwardly from it in a position to engage the side of the pipe when the pipe is in position to be perforated. In order to adjust the back stop to the required pipe diameter, it is adjustably mounted upon a split block 55 embracing the column and clamped to it by a screw 56. A pair of bars 57—57 slidably pass through the block on opposite sides of the column and extend forwardly in parallelism with one another in a horizontal plane. A cross member 58 extends across the outer ends of the bars and includes at its center a stud 60 projecting outwardly. The back stop is attached to the outer end of the stud and is thus adjustably supported by the bars 57. The bars are locked in adjusted position with respect to block 55 by clamp collars 61 having screws 62 threaded through the collars and engaging the surface of the bars.

The inclined trackway 24 upon which the carriage 23 is tracked, consists of a pair of spaced channel irons 63—63 having their inner ends welded or otherwise secured at diametrically opposite sides of the column 16. The rails are secured in spaced relationship by the angle iron 64 which extends transversely across them (Figure 2) and are braced by the vertical support bars 65—65. The support bars have upper ends attached to the cross member and lower ends attached to opposite sides of one of the ribs 51.

The carriage consists of a metal platform 66 having along opposite side edges a pair of angle irons 67—67 which are welded to the underside of the plate and overhang the channel irons at opposite sides. A pair of rollers 68—68 are rotatably journalled as at 70 upon the overhanging flanges at front and rear, the rollers being tracked upon the lower webs of the channel members. It will be noted in Figure 2 that the forward pair of rollers is located in a relatively lower plane than the rearward pair, the relative planes corresponding to the inclination of the channel members. The arrangement is such that the platform 66 is maintained in a level plane relative to the inclined tracks so as to support the pipes in perpendicular position corresponding to the relationship of the drill heads.

The platform 21 which supports the driving motors for the drill heads consists of a flat steel plate welded to a sleeve 71 fitted upon the upper end of the column. As shown in Figure 3, the plate is generally V-shaped and overhangs the column in cantilever fashion, so as to support the motors generally in vertical alignment with the respective drill heads to which they are connected. The platform 21 is also of welded construction and includes a series of ribs 72 welded to the lower surface of the plate and having their inner ends welded to the sleeve 71. The motors 20, which are commercial units, are mounted upon the platform with their shafts disposed vertically, the motors having suitable mounting collars 73 at their lower ends attached to the mounting plate, with their drive shafts 74 projecting downwardly through the plate and in driving connection with the extensible drive shafts 22, as described in detail later.

The hand wheel 29 for rotating the vertical elevating screw 28 is rotatably journalled in a gear box 75 which is also mounted upon the motor platform 21. The gear box is a commercial structure including a set of bevel gears (not shown) connected to the hand wheel and to the drive sleeve 76 (Figure 2) to provide the right angular driving connection from the hand wheel shaft to the elevating screw shaft. The sleeve projects downwardly through the mounting plate and the upper end of the elevating screw shaft is pinned as at 77 to the shaft. The threaded lower portion 78 of the screw shaft passes through a threaded bore machined in a boss 80 forming a part of sleeve 52 of the drill head mounting bracket 27.

Drill heads

The extensible drive shafts 22 which extend from the driving motors to the perforator heads are of articulated, telescopic construction to allow the heads to be vertically adjusted relative to the carriage and to allow the drill heads to shift laterally during the perforating operation and during adjustment for pipe size. As best shown in Figures 2 and 11, each shaft 22 comprises an upper section 81 and a lower section 82, the upper section being tubular and square in cross section. The lower shaft section is also square in cross section and is slidably interfitted into the lower end of the upper section, as indicated in dotted lines in Figure 2. This construction provides a driving connection between the two shaft sections and also provides extensibility.

In order to allow the drill heads to shift laterally, the upper and lower ends of each drive shaft are provided with universal joints indicated generally at 83—83. The universal joints are of conventional construction, each comprising a pair of sleeves 84 having their inner ends pivotally connected together by an internal member (not shown) which provides universal articulation. The universal joints at the upper ends of the extensible shafts provide a driving connection with the shafts 74 of the motors and those at the lower ends are connected to the drive shafts 85 (Figure 4) of the bevel gear drive units 86. The drive units are commercial items, each consisting essentially of an elbow-shaped housing enclosing a pair of bevel gears 87—87, the housings being attached to the rear wall of the drill heads 17, as shown in Figure 4. Each housing includes a stub shaft 88 disposed at right angles to shaft 85 and providing a driving connection common to all the drills 18 of the head by a chain drive system.

Referring to Figure 3, the mounting bracket 27 for the drill heads comprises a casting which is generally U-shaped as viewed from above, having two limbs 90—90 forming an integral part of sleeve 52 and projecting forwardly in cantilever fashion above the carriage. Referring to Figures 2 and 4, the limbs 90 each include stiffening ribs 91 and a series of slideways 92 delineated by spaced rails 93—93 (Figure 3) to slidably receive the horizontal mounting bars 94 of the drill heads. The longitudinal axes of the slideways are parallel to the axes 36 of the drills such that the drill heads and their drills are adjustable radially to the center 37 of the pipe, as explained earlier.

Referring to Figure 4, the mounting bars 94 form an integral part of the mounting spider 95 which supports the drill heads 17. Each mounting bar 94 includes a pair of vertical arms 96—96 which project above and below the plane of the mounting bar 94 at right angles to it. The limbs are stiffened by suitable ribs 97 to provide a rigid support for the drill heads. Each mounting bar includes a longitudinal slot 98 which is T-shaped in cross section (Figures 2 and 4) to receive the head 99 of a clamping screw 100. The clamping screw projects downwardly through an opening in the slideway 92, and includes a threaded knob 101 engaged upon it to clamp the drill head assembly in adjusted position.

The drill head, as shown in Figure 4, is in retracted position and is shifted to its extended position during the drilling operation by the air cylinder 41 which is mounted directly upon the spider 95 and includes a piston rod 102 connected to the drill head. The upper and lower arms 96 support the drill head in vertical position during its reciprocation to extended and retracted position and also

support the stop bars 33 which contacts the outside diameter of the clay pipe during the drilling operation.

For this purpose the outer ends of the arms 96 include a respective horizontal guide rod 103—103, each having a threaded end passing through the arms and providing a shoulder 104 seated against the arms. A nut 105 is threaded on the opposite end of the threaded shafts such that the guide rods are clamped rigidly to the spider arms. The drill head is provided with a pair of bushings 106—106 slidably embracing the guide rods and thereby supporting the head relative to the spider.

The outer end of each guide rod is counter turned as at 107, the counter turned portion passing through a collar 108 at opposite ends of the stop bar 33, with the end of the guide rod peened over as at 109 to attach the stop bar rigidly to the ends of the rod. The intermediate stop bars are generally U-shaped in cross section and the two bars at the open side of the throat 31 have curved leading edges as at 110. All of the bars are fabricated from sheet metal and are provided with a series of holes 111 in axial alignment with the drills 18. As indicated in broken lines in Figure 9, the drills advance through the holes 111 and through the wall of the pipe which is resting against the bar; thus the bar maintains the pipe in fixed relation to the drill, with the fixed feed range of the drill related to the pipe wall. The bar also holds the pipe against displacement as the drill is withdrawn from the perforated wall.

Described in detail with reference to Figures 4 and 5 each drill head 17 consists of an elongated housing or made up of a pair of castings 112 and 113, each casting having a peripheral flange 114 forming side and end walls. Two castings are bolted together face to face, as shown in Figure 5, to form a box-like enclosure, the abutting edges of flange 114 forming a sealing interface 115. Each casting includes a series of mating bosses 116 extending across the central axis of the housing with their inner ends in abutment and are secured together by screws 117 which pass through the bosses and clamp the two castings together. At the intermediate portion of the housing, the screws 117 extend into threaded engagement with the flange 118 of a bracket which is connected to the piston rod 102 of cylinder 41. The two intermediate bosses 116 are located in axial alignment with the guide rods 103 and include the bushings 106 slidably engaging the bars as explained earlier.

Cylinder 41 is mounted directly upon the spider 95, the cylinder head having a threaded sleeve 120 which is screwed into a bore 121 formed in the spider. The piston rod 102, which is also threaded, projects outwardly through sleeve 120 into threaded engagement with a boss 122 forming a part of the flange 118. The weight load of the drill head is carried by the guide bars and by the piston rod, the boss 122 is slidable in the bore 123 to allow the boss 122 to re-enter the bore without interference as the head is retracted.

In certain instances, the number of drills 18 may vary in accordance with the length of the pipe sections and other factors, and in this event, interchangeable drill head assemblies may be provided. In the present disclosure the head is provided with seven drills, all driven in common from the stub shaft 88 which was described earlier. Each drill 18 is rotatably mounted upon a stub shaft 124 journalled upon bushings 125, mounted in bosses 126 of the castings 112 and 113. The stub shaft 124 which establishes the driving connection with shaft 88 has its end bored as at 127 to receive shaft 88 and further includes a cross slot 128 to key with the tongue 130 formed on the end of shaft 88. Each of the stub shafts includes a pair of sprockets 131—131 which are preferably formed as an integral part of the shaft. The driving connection from shaft to shaft is provided by a series of sprocket chain loops 132 connecting alternate adjacent pairs of the sprockets.

It will be noted that the two end shafts require only one sprocket chain connection; however, the sprockets and shafts are machined as one-piece units including the two sprockets and the unused sprockets therefore serve no purpose. The housing completely encloses the sprockets and chains to protect them from dust and dirt and to provide a lubricant enclosure. It will be understood that the driving system rotates all of the drills in the same direction and at the same rate of speed.

Drill structure

As disclosed in the copending application, the drills 18 are generally of tubular construction and are formed by a blanking and stamping operation from light gauge spring steel, preferably in the neighborhood of .020" thick. Referring to Figures 6 to 10, each drill includes a tubular rearward end or chucking portion 133 having a longitudinal slot 134 which includes a series of lateral notches 135 opening into the slot along one side. As shown in Figure 9, the outer end of each stub drill head shaft 124 includes an axial bore 136 to receive the tubular end portion of the drill. The tubular portion 133 and bore 136 are held to relatively close tolerances, the diameter of the tube being slightly greater than that of bore 136 to provide an expansion fit. Upon inserting the drill in the bore, the tubular end of the drill is compressed slightly with the fingers, and upon release, expands outwardly within the bore.

The driving connection for the drill is provided by a pin 137 (Figure 10) which projects radially into the bore 136. Upon installing the drill, the slot 134 is aligned with the pin, the drill is then inserted into the bore for the required distance and is then rotated to the left, as viewed in Figure 10, to bring one of the lateral notches 135 into engagement with the pin. The pin and notch therefore provide the driving connection from the shaft to the drill, lock the drill axially within the shaft and provide length adjustment as explained later.

The thickness of the pipe wall, as indicated at 138 in Figure 9 varies in accordance with the size of the pipe and other factors, while the stroke of the drill head is fixed. In order to accommodate the several wall thicknesses therefore, the length of the drill projecting from the shaft must be varied to suit the thickness of the pipe wall.

In the present disclosure, three notches 135 are provided for this purpose, the notches being selectively engaged with pin 137 to provide the effective drill length, the drill being shown in its maximum length adjustment. In the retracted position, as shown in Figure 9, the end of the drill resides in spaced relationship to the outside surface of the pipe wall as indicated at 140. In extended position, the wall of the drill penetrates to and protrudes slightly beyond the inside diameter of the pipe as indicated in broken lines. To accommodate a thinner wall, the drill is adjusted inwardly to engage upon the pin one of the notches nearer the drill point; in this position, the end of the drill when retracted, is spaced outwardly a greater distance 140 from wall surface and penetrates the internal surface a distance corresponding to that shown in Figure 9. The degree of projection of the end of the drill is limited approximately to that shown in order to pull in the burr as described later.

As best shown in Figures 6 and 7, the shank 141 of the drill is semi-circular in cross section and the end of the shank includes a generally spiral spur 142 having the same radius as the tubular portion and shank, as viewed from the end, but rising upwardly to a point in an arc of approximately 45° above the straight edge 143 of the shank portion. As shown in Figure 7, the spur is delineated by the curved edges 144 and 145 which converge toward one another to provide the drill point. The spiral spur is adapted to advance in cork screw fashion through the clay wall at a rate of advancement correlated to its rotary speed to sever the clay wall and extract the clay plug 38 as explained earlier.

The control system for feeding the drill, which in the present instance is air operated, includes control valves which are adjusted to provide the required drill feed. As explained earlier, a feed rate which provides 1½ half turns during penetration of the drill through the clay wall is found to be most efficient. This provides a constant pulling action during penetration by operation of the spiral leading edge 144 of the spur. It has been determined by experiment that, under properly related feed and speed providing rapid penetration and retraction of the drill, an exceptionally clean-cut hole, free of distortion is formed. By virtue of the pulley action of the spur, both the inner and outer ends of the hole are completely free of burrs.

Upon retracting from the pipe wall, the clay plug 38 adheres to the inner surface of the shank and the forward end of the plug is positively confined by the spiral spur 142 which partially encircles the plug. In other words, the plug is confined within the spur and semicircular shank until the plug is fully withdrawn as shown in Figure 9. At this point, the high speed rotation of the drill is effective to throw the clay plug forcibly from the drill. Observation of the machine in operation indicates that the clay plugs are dislodged as soon as the drills retract; however, even if the plugs are not all dislodged at this time, they do not interfere with the next drilling operation because the plugs are simply forced axially along the drill and dislodged during the next operation.

Control system and operation

As explained earlier, the drill heads are driven continuously while the machine is in operation and the drills are fed through the clay wall in response to the tripping of the starting switch arm 34 which extends in front of the back stop and crosswise in the path of the moving pipe. The control system disclosed in Figure 13 employs an air pressure system including electrically operated valves for actuating the drill head cylinders 41, although it will be understood that substantially the same system can be driven by hydraulic or equivalent means. It will also be understood that each drill head has its own actuating cylinder and control valve, and that the electrical circuit extends in common to all of the individual cylinders. For purposes of illustration however, the air supply system is disclosed in relation to one of the air valves and cylinders, it being understood that the control system actuates all of the cylinders in unison during each cycle.

Referring to Figure 4, it will be noted that the cylinder head is provided with an electrically operated reversing valve indicated generally at 150 which includes an air pressure conduit 151. The cylinder and valve is a commercial unit including electrical windings for shifting the slide element of the valve and suitable ports and passageways for conducting and exhausting the air relative to the opposite ends of the cylinder to cause reciprocation of the piston and its rod. In order to illustrate the operation of the valve and cylinder, valve 150 is illustrated diagrammatically in Figure 13 as a simple, electrically operated reversing valve connected by conduits 152 and 153 to the cylinder. The conduits represent the internal air passageways extending from the opposite ends of the valve to the cylinder. In addition the valve includes two exhaust passageways communicating with the atmosphere as represented by the conduits 154 and 155. Air pressure is supplied to all of the cylinders of the drill head by way of conduits 151. In order to actuate all of the cylinders at the same time without dropping the line pressure, the hollow column 16 is utilized as an air reservoir. For this purpose, the column is sealed and the air supply is fed into it from the pump, the pressure lines 151 being connected directly to the column.

The present valve is designed to provide a cushioned piston action as the piston approaches the end of its stroke and for this purpose, the exhaust passageways are provided with adjustable needle valves 156—156 which restrict or meter the flow of exhaust air. As shown in Figure 4 the needle valves are threaded directly into the block 148 of the valve and are provided with exposed slotted heads for screw driver adjustment. The valves are also diagrammatically indicated at 156 in the exhaust conduits of the diagram in Figure 13. The needle valves also control the rate of drill speed in both directions and are therefore adjusted in accordance with drill speed to provide the cork screw action noted earlier.

When the valve is shifted to the position shown in the diagram, air pressure flows by way of the supply conduit 151 through the open ports and passageway of the valve body to conduit 153 so as to force the piston 157 to the right as viewed in Figure 13 so as to retract the drill heads. The exhaust air flows from the opposite side of the piston and passes through conduit 152 through the valve ports and passageway and through the needle valve 156 which restricts the rate of flow. As the piston moves toward the right, it progressively compresses the air trapped in the cylinder, and by operation of the needle valve, brings the piston to a cushioned stop as it reaches the limit of its travel. Although the inertia effect of the drill heads is considerable, proper adjustment of the valves is effective to substantially eliminate shock as the rapidly moving heads are brought to a stop. The needle valve of conduit 155 is effective in the same manner to cushion the heads as they are shifted to their extended positions.

The electrical circuit is effective to advance the drills as soon as the starting switch 35 is tripped to closed position by the clay pipe and, upon reaching fully advanced position, the valves are tripped electrically back to their original position so as to immediately retract the heads. Upon being retracted, the cycle ends and the heads remain stationary even though the starting switch is still held in closed position by the perforated pipe. For this purpose, an interlocking action, which provides one complete cycle each time the starting switch is closed, is brought about by a relay operating in conjunction with the starting switch and drill head switches. The interlock is described in detail with reference to the electrical circuit.

The electrical circuit is energized by the power lines 158 and 160, one side of the circuit being grounded through the machine, as indicated at 161. When the starting switch 35 is tripped to closed position, the circuit is completed by way of line 162, through the normally closed advance contactor 163 of the interlock relay 164 and, by way of line 165, to the advance winding 166 of the reversing valve. The circuit through the winding is completed by the ground line indicated at 167 which is common to both windings of the valve.

When winding 166 is energized, it shifts the slide member 168 of the valve from the position shown to its right hand position. In this position, air pressure flows from conduit 151 through the valve ports and passageways to conduit 152, causing the piston and drill head to be shifted toward the right as indicated in broken lines, thus feeding the drill heads and drills collectively through the clay wall of the pipe. Upon reaching its outward limit of travel, the switch actuating arm 170 of each head engages and trips a respective switch 171 to closed position.

The drill head switches 171 are preferably of the micro type and are mounted respectively upon the ribs 97 of the spiders 95 as shown in Figures 2 and 4. The switch actuating arms 170 consist of flat metal strips attached to the drill heads, the outer ends of the arms being bent at right angles as indicated at 169 to overlie and depress the pole of the switch. Since the switches and arms are fixed in their respective positions, a fixed stroke is provided for the drill heads.

As soon as switch 171 is closed, a circuit is established by way of line 158 through the starting switch 35 (which is still closed) to line 172, through drill head switch 171 and through line 173 to the winding of relay 164. The opposite end of the relay winding is grounded as at 174 to complete the circuit. When the relay is energized, its

normally closed contactor 163 shifts into engagement with the second or retract set of contacts 175, opening the circuit to the advance winding 166 of the valve. In its second position therefore, the relay contactor completes a circuit from line 158 by way of line 176 to the retract winding 177 of the valve. This shifts the valve slide element back to the position shown in the diagram causing the drill head to be retracted.

It will be understood at this point, that the drill head switch is effective to retract the drill head as soon as it reaches a predetermined position of advancement corresponding to that shown in broken lines in Figure 9. It will also be noted that the drill head does not run up against a positive stop but instead is cushioned at its forward limit by the back pressure provided by the needle valve 156.

It will be noted that the drill head switch 171 is closed momentarily when the drill head reaches the advance position and that it opens immediately thereafter since the head retracts as soon as relay 164 shifts the control valve back to retracting position. Normally, the opening of the drill head switch 171 would deenergize the relay winding, and bearing in mind that the starting switch 35 is still closed, a circuit would again be established by the deenergized relay to the advance winding 166 and thus cause the cycle to repeat.

In order to prevent this, interlock relay 164 is provided with a set of normally open holding contacts 178 which are engaged by the contactor 180 when the relay is energized by the drill head switch 171. A holding circuit for the relay is provided by line 181 from line 162, and by ways of holding contacts 178 to the winding of the relay. Thus, as soon as the drill head switch is closed to energize the relay winding, the holding circuit is completed through the starting switch 35 and contactor 180. This is effective to maintain the circuit through the relay and retract winding so long as the starting switch is held closed.

However, as soon as the clay pipe is removed, switch 35 opens and deenergizes the holding circuit and the circuit to the retract winding. This causes the relay to shift back to the position shown in the diagram, such that the normally closed interlock relay reestablishes the circuit from the starting switch (which is now open) to the advance winding and conditions the circuit for the next cycle of operation. Thus, the advance winding is again energized as soon as the next length of clay pipe is advanced into the machine to close the starting switch. From the foregoing, it will be seen that the starting switch and relay form an electrical interlock which provides a single cycle of operation each time the starting switch is closed.

For purposes of simplicity, the control circuit has been described in relation to a single drill head and associated electrical components. As a practical matter however, each drill head is provided with its own cylinder, electrical control valve and drill head switch 171, the switches being connected in series, as indicated in line 172 in the diagram. For purposes of illustration, these additional switches are all shown in closed position although in practice they open and close concurrently and make it necessary for all the drill heads to advance fully before the retracting circuit is completed. As shown in the diagram, there is also provided additional electrically operated valve windings 166 and 177 one for each drill head, which are connected in parallel to the lines 165 and 176. These windings are all under control of the relay 164 as indicated and all operate as described above.

It has been determined in practice, that due to air flow resistance and other variable factors, the drill heads do not always operate precisely in unison. Because of the series connection of the switches, any head or heads, which advance before the others, remain in this position until the last switch is closed, thereupon the winding of the relay 164 is energized, causing all of the retract windings 177 to be energized so as to retract the heads collectively.

As noted earlier, the drill head switches 171 are permanently fixed in position to advance the leading spiral ends of the drills slightly beyond the internal surface of the pipe, as indicated in Figure 9. In their retracted position, the heads are cushioned and finally brought up against a positive stop by engagement of the piston with the end of the cylinder, as indicated diagrammatically at 182 in Figure 13. The heads therefore have a fixed actuating stroke and variations in the wall thickness are accommodated by adjusting drills axially by the notches 135 as explained earlier.

By virtue of the rapid cyclic operation of the machine, the production of perforated pipes is limited only by the rate at which the pipes can be transferred to the carriage, advanced into the throat and removed from it in perforated condition. Even though no internal support is utilized, the machine produces clean smooth holes of high quality and at slight cost for the operation, since all of the holes are drilled concurrently. Very little effort is required to hold the clay pipe in drilling position in the throat because the drills collectively exert a pulling force as they are fed in radially toward one another.

Having described my invention I claim:

1. A machine for perforating the wall of a clay pipe or the like, said machine comprising a drill head, a drill rotatably mounted in the drill head and having an end portion projecting outwardly therefrom, motor means connected to the drill for rotating the same, a support structure slidably guiding the drill head for movement along a lineal path parallel to the axis of the drill, a pipe transfer carriage movable along a lineal path of travel in a plane spaced below the axis of the drill, the carriage being effective to support and advance a perpendicular length of clay pipe to a position adjacent the end of the drill, an air pressure cylinder attached to the support structure having a piston connected to the drill head effective to shift the drill head rapidly along said lineal path, a source of air pressure connected to the air cylinder, a control system including a two-position reversing valve interposed in the source of air pressure, and a control member interconnected in the control system and effective to shift the reversing valve, the control member having a movable element, which in normal position, shifts the reversing valve to a position to apply air pressure to an end of said cylinder to retract the drill head, said movable element disposed along the lineal path of travel of the carriage above the plane of the carriage in a position to be engaged by the length of pipe and shifted from said normal position, thereby to shift the reversing valve to a second position to cause the air cylinder rapidly to advance the drill head and rotating drill transversely through the wall of the clay pipe resting upon the carriage in response to the advancement of the clay pipe.

2. In a machine for perforating the wall of a length of clay pipe or the like, a support structure, a drill head having a drill mounting shaft adapted to rotatably mount a drill with an end portion of the drill projecting outwardly from the head along a horizontal axis, means on the support structure slidably supporting the drill head for movement along a line parallel to said horizontal axis, guide members fixed relative to the support structure and delineating a laterally open pipe receiving throat, said open throat effective to partially confine a length of clay pipe in perpendicular position with its longitudinal axis in alignment with the axis of said drill mounting shaft and at right angles thereto, a pipe transfer conveyor movable in a generally horizontal plane along a lineal path below said guide members to support and advance a perpendicular length of pipe into said open pipe receiving throat, a power device attached to the support structure and having a lineally movable element connected to the drill head, a source of power connected to the power device, a shiftable control member interposed in said

source of power, a movable actuating element connected to said control member for shifting the same, said actuating element disposed above the pipe transfer carriage along the lineal path thereof in advance of said open pipe receiving throat in position to be engaged and moved and by the pipe advancing into the throat, thereby to shift the control member, said control member being effective upon being shifted to cause the power device to advance and retract the drill heads along a line parallel to the axis of the drill mounting shaft, whereby the end of a drill mounted in said drill mounting shaft is passed transversely through the wall of the clap pipe confined in said open throat in response to the advancement of the pipe to the open throat.

3. In a machine for perforating the wall of a plastic clay pipe or the like, a support structure, a drill head having a tubular drill projecting outwardly therefrom, motor means connected to the drill for rotating the same guide means on the support structure slidably guiding the drill head for movement along a lineal path parallel to the axis of the drill, means for supporting a length of clay pipe to a position adjacent the end of the drill, a power device attached to the support structure having a lineally movable element connected to the drill head for cyclically advancing and retracting same along said lineal path, said tubular drill having a spiral leading end portion, said motor means having a constant rate of rotation in a direction to advance the spiral leading end portion of the drill in cork screw fashion througs the clay pipe wall, said power device providing a rate of lineal motion correlated to the rate of rotation of the motor means and drill, said rate of lineal motion being less than the screw advancement of the leading end of the drill, said correlated speed of rotation and lineal advancement causing the spiral leading end portion to exert a pulling action as it advances which is effective to sever a clay plug from the wall as the leading end penetrates the internal surface of the pipe, the tubular drill effective to extract the clay plug as the drill is retracted from the wall.

4. In a machine for perforating the wall of a plastic clay pipe or the like, a support structure, a drill head having a tubular drill projecting outwardly therefrom, motor means connected to the drill for rotating the same, guide means on the support structure slidably guiding the drill head for movement along a lineal path parallel to the axis of the drill, means for supporting a length of clay pipe in a position adjacent the end of the drill, a power device attached to the support structure having a lineally movable element connected to the drill head for cyclically advancing and retracting same along said lineal path at a rapid rate, said tubular drill having a spiral leading end portion, said motor means having a constant speed of rotation in a direction to advance the spiral leading end portion of the tubular drill in cork screw fashion through the clay pipe wall, said power device providing a rate of lineal advancement correlated to the rate of rotation of the motor means and drill, said rate of lineal advancement providing less than two complete revolutions of the drill as the spiral end advances through the pipe wall, whereby the spiral leading end severs a clay plug from the wall and extracts the plug during a rapid cycle to provide a clean-cut hole.

5. In a machine for forming multiple perforations in a length of plastic clay pipe, a column, a mounting bracket attached to the column, respective drill head mounting spiders attached to the mounting bracket, said spiders each including a drill head support member projecting upon respective axes which converge toward one another to a common center, respective pipe stop members attached to the extended ends of the support members, said stop members collectively delineating a semicircular throat having an open side, which is concentric to said common center, and effective to guide and position a length of clay pipe upon the common center, a carriage having a horizontal surface effective to support a length of clay pipe in perpendicular position, the carriage movable along a generally horizontal path which is radial to the common center of said throat and to the open side thereof, said carriage advancing a perpendicular length of pipe through the said open side and into contact with said stop members with the axis of the pipe residing on said common center, respective drill heads slidably mounted upon said drill head support members, each of said drill heads having a drill mounting shaft projecting along an axis parallel to the support member which supports the drill head, means connected to said drill heads for shifting the drill heads and drill mounting shafts along said converging axes toward said common center, the drill mounting shafts arranged to engage respective coaxial drills and to advance the drills through the confines of said open throat to penetrate the wall of a clay pipe positioned in said open throat and resting upon the said carriage, whereby the horizontal planes of the carriage and drill mounting shafts locate the drills lengthwise along the axis of the pipe.

6. In a machine for forming multiple perforations in a length of plastic clay pipe, a perpendicular column, a mounting bracket attached to the column, respective drill head mounting spiders supported by the mounting bracket, said spiders each including a drill head support member projecting horizontally upon respective axes which converge toward one another to a common center, respective pipe stop members attached to the extended ends of the support members, said stop members collectively delineating an open throat which is concentric to said common center and effective to guide and position a length of clay pipe in perpendicular position upon said common center, respective drill heads slidably mounted upon said drill head support members, each of said drill heads having a drill mounting shaft adapted to mount a coaxial drill which projects along a horizontal axis parallel to the support member of the drill head, said mounting bracket having respective slideways, one for each of said drill head spiders, said slideways having horizontal axes parallel to said support members, said slideways slidably confining said spiders for adjustment along said converging axes, whereby said spiders, drill heads and stop members are selectively positioned relative to said common center to selectively receive and position in said open throat clay pipes of different diameters, a carriage having a horizontal pipe support surface movable along a horizontal path radial to said common center, the carriage advancing a length of clay pipe in a perpendicular position into the open throat and into contact with said stop members with the axis of the pipe disposed upon said common center, and means connected to the drill heads for shifting the drill heads and drill mounting shafts along said converging axes toward said common center whereby the drills mounted in said shafts perforate the wall of a clay pipe confined in said open throat, the related horizontal planes of the carriage and drill mounting shafts being effective to locate the perforations lengthwise along the length of the pipe resting on the carriage.

7. In a machine for forming multiple perforations in a plastic clay pipe or the like, a perpendicular column, a mounting bracket slidably connected to the column, elevating means connecting the bracket to the column for raising and lowering said bracket upon the column, a plurality of drill heads, drill head support members extending horizontally from said mounting bracket and slidably supporting the respective drill heads, said support members being disposed upon respective axes which converge toward one another to a common center, respective drill mounting shafts journalled in said drill heads with their axes parallel to said support members, said shafts each adapted to mount a coaxial drill, means on said mounting bracket effective to shift said drill heads collectively toward said common center, and a carriage having a horizontal table surface effective to support a

perpendicular length of clay pipe, a generally horizontal guide structure movably supporting the carriage, the guide structure extending outwardly from said common center below the axes of the drill mounting shafts and guiding said carriage for movement along a line of travel radial to said common center, the carriage thereby advancing the perpendicular length of pipe to a position with its axis disposed upon said common center, the elevating means for raising and lowering the mounting bracket being effective to locate said drill mounting shafts and drills thereof longitudinally with respect to the length of clay pipe resting upon the carriage.

8. In a machine for forming multiple perforations in a length of clay pipe or the like, a plurality of drill heads, a mounting bracket having means for guiding the drill heads for lineal motion along respective axes which converge toward a common center, respective drill mounting shafts journalled in said drill heads along said axes, said shafts each adapted to mount a coaxial drill, respective fluid pressure cylinders attached to said bracket, each having a piston rod extending parallel with said converging axes and connected to the respective drill heads, an electrically operated valve on each of said cylinders having means for directing fluid pressure to an end of the cylinder, a source of fluid pressure connected to each of said valves, means for advancing a length of clay pipe to said common center, a starting switch fixed relative to the mounting bracket and having a shiftable member extending transversely across said common center adapted to be shifted by a length of clay pipe when the same is advanced to said common center, an electrical control circuit in common electrical connection with said electrically operated valves, said starting switch including contacts interconnected in the control circuit effective upon shifting of said shiftable member to energize the control circuit to shift said valves collectively to a position causing admission of fluid pressure to the cylinders, thereby to advance said drill heads and drills therein through the wall of the clay pipe in response to the advancement of the pipe to said common center.

9. In a machine for forming multiple perforations in a length of clay pipe or the like, a plurality of drill heads, a mounting bracket having means for guiding the drill heads for lineal motion along respective axes which converge toward a common center, respective drill mounting shafts journalled in said drill heads along said axes and projecting toward said common center, respective fluid pressure cylinders attached to said bracket, each having a piston rod extending parallel with said converging axes and connected to the respective drill heads, a shiftable reversing valve on each of said cylinders for directing fluid pressure alternately to the opposite ends of the cylinders, a source of fluid pressure connected to each of said reversing valves, a shiftable control element interconnected in the control system and effective, upon being shifted from a normal position, to shift said reversing valves and cause advancement of the drill heads, and a plurality of shiftable control elements interconnected in the control system effective, upon being shifted from a normal position, to shift said reversing valves to a position causing retraction of the drill heads, and means interconnecting said plurality of control elements respectively with the drill heads, effective to cause retraction of the drill heads in response to advancement of the drill heads to a predetermined limit.

10. In a machine for forming multiple perforations in a length of clay pipe or the like, a plurality of drill heads, a mounting bracket having means for guiding the drill heads for lineal motion along respective axes which converge toward a common center, respective drill mounting shafts journalled in said drill heads along said axes and projecting toward said common center, respective fluid pressure cylinders attached to said bracket, each having a piston rod extending parallel with said converging axes and connected to the respective drill heads, a shiftable electrically operated reversing valve on each of said cylinders for directing fluid pressure alternately to the opposite end of the cylinders, a source of fluid pressure connected to each of said reversing valves, a shiftable starting switch electrically connected to said reversing valves and effective, upon being shifted from a normal position, to shift said reversing valves to cause advancement of the drill heads, said switch having an element which is engaged and shifted by a clay pipe which is advanced to said common center and thereby effective to advance the drill heads and drill mounting shafts toward said common center to perforate the clay pipe in response to the advancement of the pipe, and a plurality of retracting switches electrically connected to said reversing valves and effective, upon being shifted from a normal position, to shift said reversing valves to a position causing retraction of the drill heads, respective actuating elements for said retracting switches, said actuating elements and retracting switches relatively mounted on the drill heads and mounting bracket and relatively engageable to shift the retracting switches from said normal position upon the advancement of the drill heads to a predetermined limit to retract the drill heads.

11. In a machine for forming multiple perforations in a length of clay pipe or the like, a plurality of drill heads, a mounting bracket having means for guiding the drill heads for lineal motion along respective axes which converge toward a common center, respective drill mounting shafts journalled in said drill heads along said axes, said shafts each adapted to coaxially mount a drill, respective air pressure cylinders attached to said bracket, each having a piston rod extending parallel with said converging axes and connected to the respective drill heads, an electrically operated reversing valve on each of said cylinders having means for directing air pressure alternately to the opposite ends of the cylinders, a source of air pressure connected to each of said reversing valves, means for advancing a length of clay pipe to said common center, an electrical control system in common electrical connection with said reversing valve, a starting switch including contacts interconnected in the electrical control system, the starting switch being effective to energize the control system and shift said reversing valves to a position causing said cylinders collectively to advance said drill heads and to cause the drills thereof to penetrate the wall of the clay pipe.

References Cited in the file of this patent

UNITED STATES PATENTS

247,137	Walters	Sept. 13, 1881
620,165	McAdoo	Feb. 28, 1899
1,835,539	Thomas	Dec. 8, 1931
1,888,566	Park	Nov. 22, 1932
2,697,264	Queberg	Dec. 21, 1954