

Jan. 15, 1952

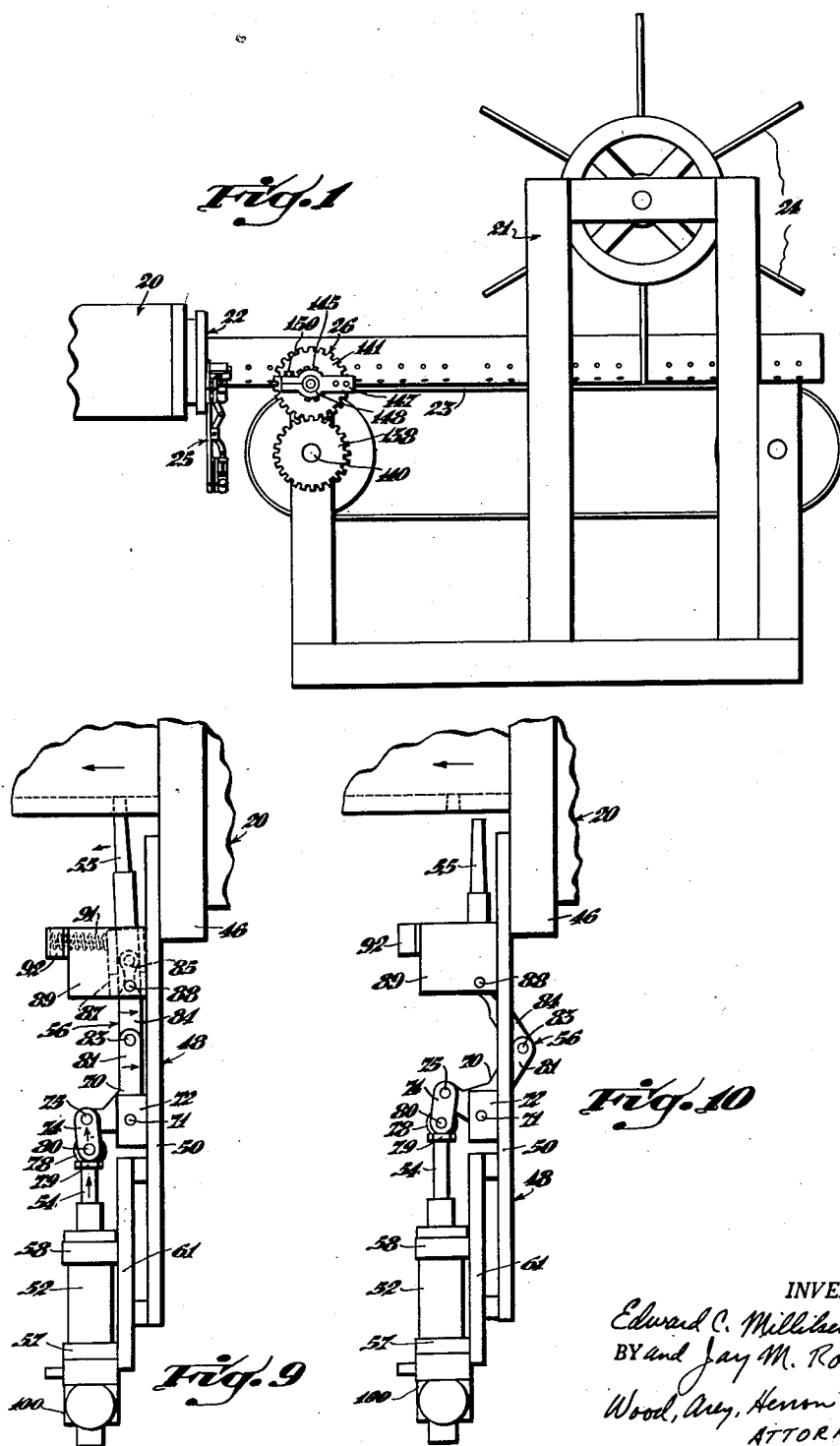
E. C. MILLIKEN ET AL

2,582,645

TILE PERFORATING MACHINE

Filed March 9, 1949

5 Sheets-Sheet 1



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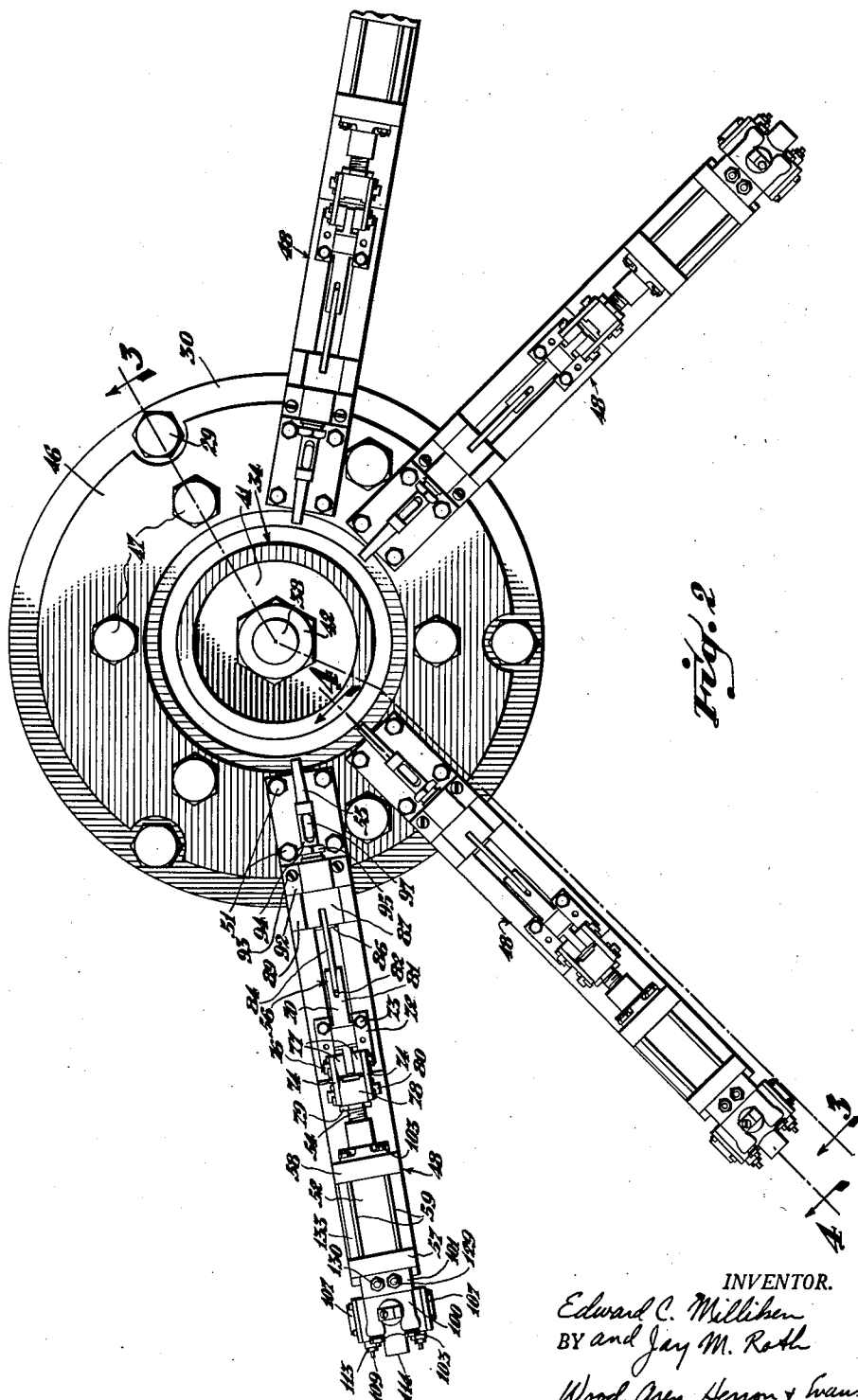
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5 Sheets-Sheet 2



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5 Sheets-Sheet 3

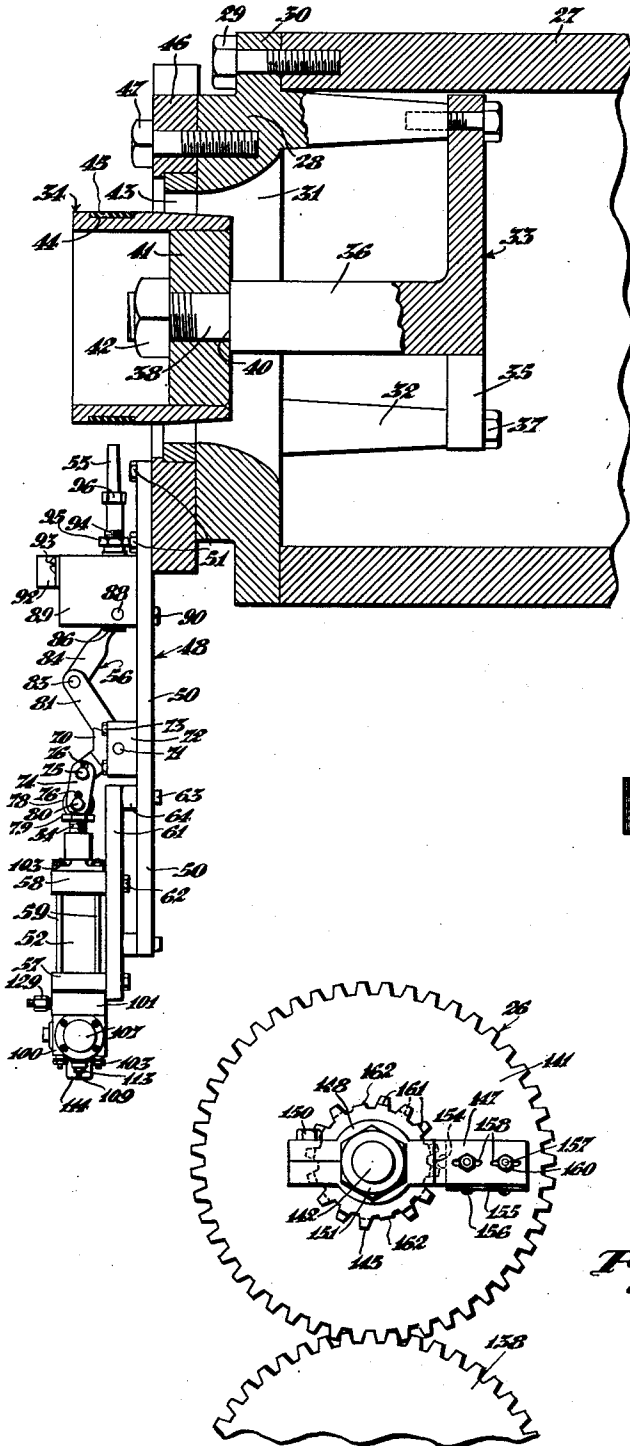


Fig. 3

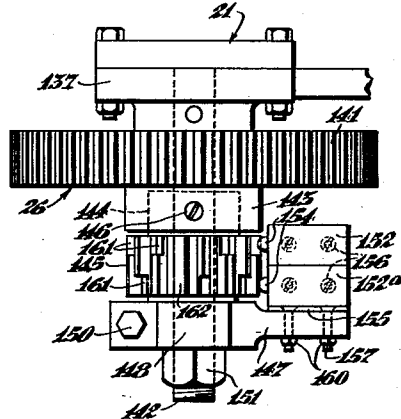


Fig. 11

Fig. 12

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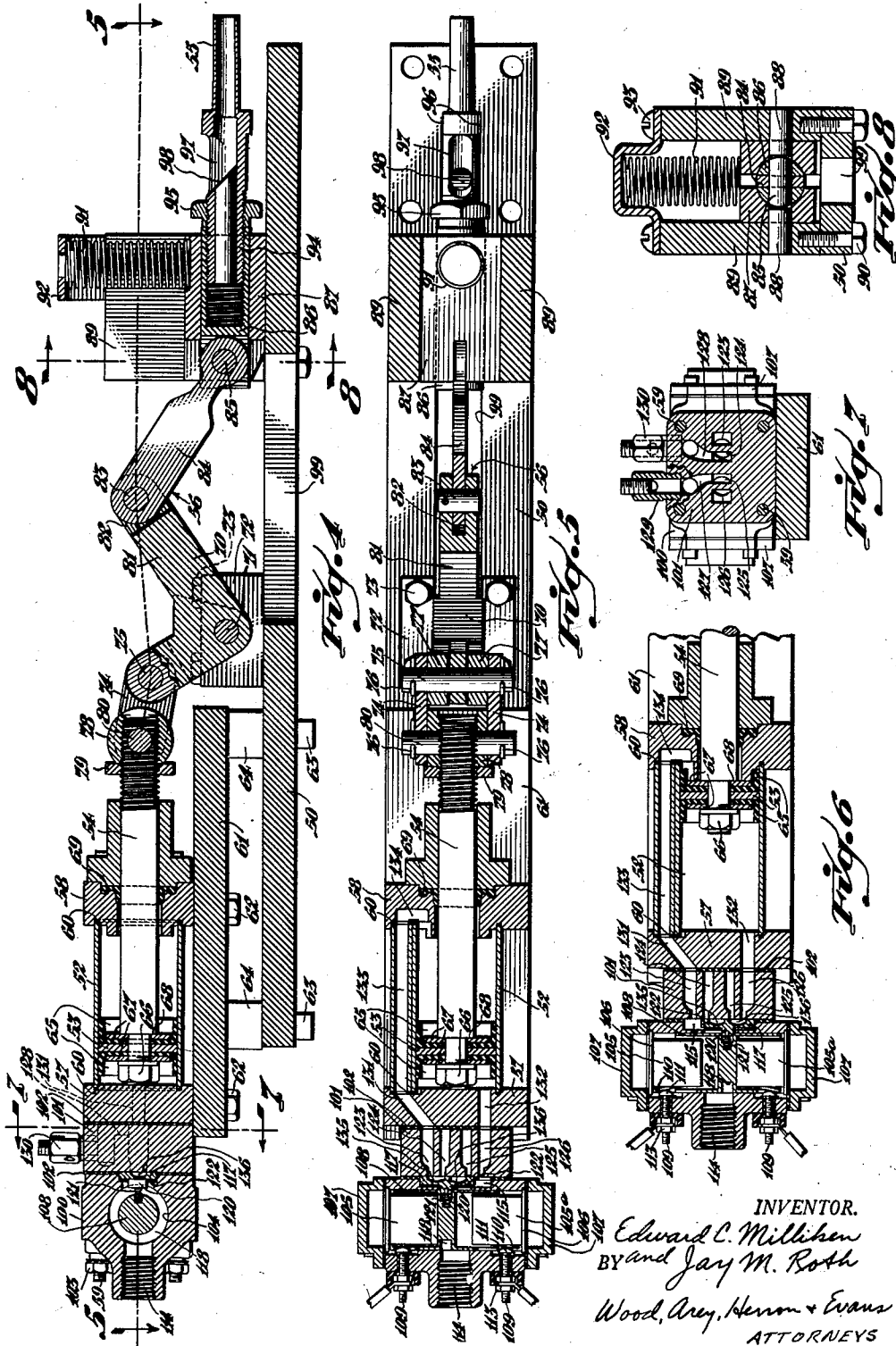
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TILE PERFORATING MACHINE

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5 Sheets-Sheet 4



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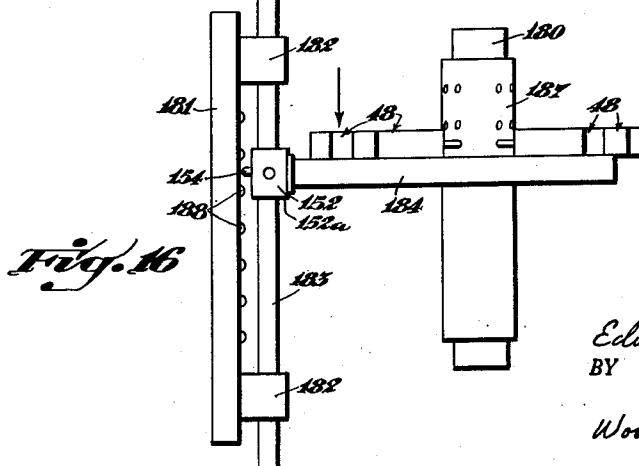
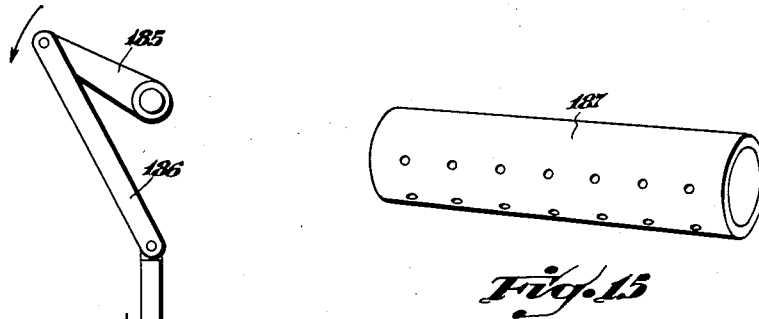
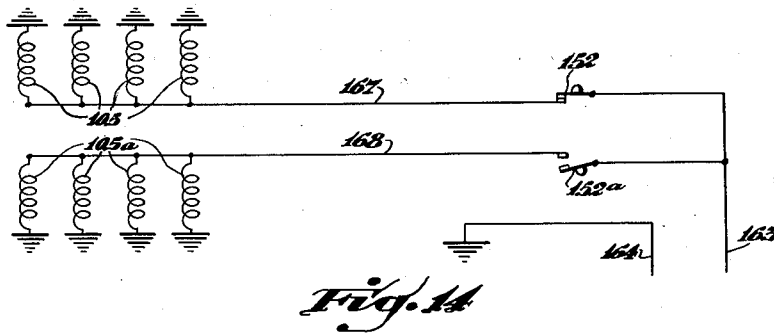
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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,582,645

TILE PERFORATING MACHINE

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Application March 9, 1949, Serial No. 80,454

15 Claims. (Cl. 25-20)

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This invention relates to the manufacture of drain tiles of the type having openings or perforations in the periphery thereof to facilitate the admission of drainage water into the tiles.

The principal objective of the invention has been to provide an automatic perforating apparatus which is adapted to operate upon the tile while the clay thereof is in a plastic condition, or prior to the time that it is fired. Heretofore, it has been conventional to perforate drain tiles by inserting them, one after another, in a jig or fixture which is equipped with manually operated punches capable of producing the openings desired. This method of production is slow and exceedingly laborious and, as a result, the cost of such tiles has limited the utilization which their improved efficiency would otherwise command.

This invention is based upon the concept of operating upon the clay of the tile as it is issued from an extrusion machine, steam press or the like, and in an automatic or semi-automatic manner whereby holes may be provided in predetermined positions in one or more lengths of tile, either before or after they are severed from one another. The invention is disclosed particularly to the perforation of clay while it is in the form of an advancing column or cylinder, as issued from an extrusion machine. The column, after perforation, may then be severed into individual tile lengths bearing perforations in desired locations, such that manual labor incidental to the perforating step is avoided completely.

More specifically, one of the primary problems to which the invention is addressed is that of moving a punch or perforator element transversely through the wall of a clay cylinder and then retracting the punch, while the cylinder is advancing axially, in such manner that a clean perforation is produced without distortion of the perforation because of the movement of the clay while it is being worked upon. In this respect the invention contemplates a power driven punch and means for moving it at a rapid rate both into and out of the clay wall before the linear advancement of the clay wall is of sufficient consequence to cause distortion of the hole or perforation.

To meet this requirement one of the features of the invention is the utilization of a motion-multiplying toggle mechanism operated by a driver and so constructed and arranged that movement of the driver in one direction is effective to cause both the advancement and retract-

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tion of the perforator to and from the work. In this manner time delays incidental to motion reversal of the driver are avoided. Once the driver has moved in one direction to advance and retract the punch, the next successive movement thereof, in an opposite direction, is effective to again advance and retract the punch thereby producing a succeeding perforation.

It is desirable, for best drainage purposes, to provide a plurality of perforations longitudinally of a drain tile at spaced intervals. However, a typical extrusion machine employed to produce clay tile or sewer pipe operates continuously, discharging an advancing column or cylinder of clay, which is then severed into suitable lengths. To avoid the necessity of manually feeding individual pieces of clay tile to a perforating machine, a preferred embodiment of the invention is constructed to operate upon the clay as it advances from the extruding machine or press, but in timed relationship to the apparatus by which the column is subsequently severed into individual pieces. To meet this objective the invention contemplates a tile fabricating assembly including a machine for producing a cylinder of tile, either continuously or intermittently, an automatic perforator for producing holes at spaced intervals in the cylinder of clay, a device for severing the tile into one or more individual pieces, and a synchronizing control device which is effective for coordinating the points at which the holes appear in relation to the points at which the tile is severed.

The apparatus of the invention is adapted for use either in conjunction with a conventional tile clay extruding machine or, in the alternative, with a stream press by which lengths of clay, of more or less indiscriminate length, intermittently are formed and then are severed. Clay cylinders may be perforated as desired by this improvement at virtually no extra cost, and, as an incident to the formation of the clay into its cylindrical form. Therefore, the invention enables perforated tiles to be manufactured at a cost which is sufficiently low to enable their full utilization.

From the foregoing description of the principles of the invention, and the following detailed description of the drawings in which typical embodiments of the improvements are disclosed, those skilled in the art readily will comprehend various modifications to which the invention is susceptible within the meaning of the claims.

In the drawings:

Figure 1 is a general diagrammatic view illus-

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trating the perforating apparatus mounted upon the discharge end of an auger mill and arranged to perforate and discharge the extruded clay column upon a cutting machine.

Figure 2 is an enlarged end view of the perforating assembly, looking toward the discharge end of the auger mill, illustrating the general arrangement of the apparatus and the means for mounting it upon the extrusion die.

Figure 3 is a fragmentary sectional view taken on line 3—3, Figure 2, further detailing the extrusion die and mounting structure for the perforating assembly.

Figure 4 is an enlarged longitudinal sectional view taken on line 4—4, Figure 2, detailing one of the perforator units.

Figure 5 is a longitudinal sectional view taken on line 5—5, Figure 4, further detailing the unit.

Figure 6 is a fragmentary sectional view similar to Figure 5, illustrating the reversing valve apparatus in a position opposite to that shown in Figure 5.

Figure 7 is a cross sectional view taken on line 7—7, Figure 4, detailing the valve ports and passageways of the reversing valve.

Figure 8 is a cross section taken on line 8—8, Figure 4, detailing the construction of the spring loaded trunnion block for the perforator plunger.

Figure 9 is a diagrammatic view illustrating the toggle linkage in an intermediate position during an operating stroke of the perforator unit.

Figure 10 is a diagrammatic view similar to Figure 9, showing the linkage at the completion of an operating stroke.

Figure 11 is a top plan view illustrating the timer unit.

Figure 12 is an end view projected from Figure 11, further illustrating the timer.

Figure 13 is a developed view illustrating the arrangement of timing gear teeth by which the control switches are actuated alternately.

Figure 14 is an electrical diagram illustrating the circuit between the timer and valve actuating solenoids.

Figure 15 is a perspective view illustrating a finished tile or pipe length.

Figure 16 is a diagrammatic view illustrating the perforating apparatus applied to an apparatus in which the tile length is mounted stationarily with the apparatus arranged to feed relative to the tile length during the perforating operation.

Referring to Figure 1, the perforating apparatus is disclosed diagrammatically in conjunction with a portion of a horizontal de-airing machine or auger mill 20, which discharges upon an automatic cutting machine 21, both being commercial products which need not be disclosed in detail. In general, the de-airing machine embodies means for feeding clay or other plastic material under sufficient pressure to eliminate voids or air bubbles and its discharge end, indicated generally at 22, constitutes an extruder having a nozzle or die for shaping the outside diameter of the extruded tube and an internal die or bell for forming the inside diameter, as hereinafter disclosed with reference to Figure 3.

The de-airing machine extrudes a continuous plastic clay column or tube which advances directly from the discharge end 22, in a horizontal plane to the automatic cutter 21. The latter, while not disclosed in detail, generally constitutes an endless conveyor 23, arranged so that the moving column of clay resting upon it and advancing by extrusion pressure, will drive it forwardly and

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advance the column. If necessary, the cutting machine can be equipped with a sensitive friction driving device in instances where the column of clay is too light to operate it. There is provided a rotary cutter near the discharge end of the conveyor, which, in the present instance, includes a number of radial cutters 24 in the form of U-shaped frames, each having a cutter wire or rod stretched tautly across its open end adapted to pass through the plastic clay column to cut it into tile or pipe lengths. The rotary speed of the cutter is correlated with the lineal feed of the clay column so that the wires pass through the column at right angles, forming square ends. The cutters are spaced according to the required tile length and the rotary cutter is rotated in timed relationship with the advance of the column.

As shown, the perforating operation is performed by a perforator assembly, indicated generally at 25, mounted directly upon the extrusion nozzle. As disclosed, this assembly constitutes a group of four perforator units extending in angular relationship around the lower portion of the column; and the units operate simultaneously to punch holes in circumferential rows, spaced longitudinally along the column. The longitudinal spacing of the holes is regulated by a timer 26, connected to one of the shafts of conveyor 23, the timer including electrical switches which are closed intermittently in timed relationship with the lineal advance of the column to energize the perforators periodically.

The perforator units are operated in the present instance by air cylinders, controlled by electrically operated valves, interconnected with the timer. Thus, the extruded clay column drives the conveyor by frictional engagement, and the timer, being in driving connection with the conveyor, causes the holes to be spaced uniformly according to the advance of the column. The perforator and cutter thus are synchronized so that the column first is perforated then cut to length at prescribed points between the perforations. After the cutting operation, the individual lengths are removed from the conveyor either by hand or by suitable conveying apparatus for further processing or firing.

Extruding and perforating apparatus

As illustrated in Figures 2 and 3, the discharge end 22 of the auger machine constitutes a cylinder 27 having an external extrusion die 28 secured to its open end by screws 29. For this purpose die 28 includes a flange 30 seated upon the end of the cylinder 27, the die having an internal converging bore 31, communicating with the cylinder. The inner face of the die 28 includes support studs 32 extending rearwardly into cylinder 27, providing means for mounting a spider, generally indicated at 33, which supports the internal die or bell, indicated generally at 34. Spider 33 includes three radially extending arms 35, one for each of the studs 32, and a centrally located stud 36 projecting forwardly through the bore of die 28. The respective spider arms 35 are secured to the studs 32 by means of screws 37. Upon the outer end of stud 36 there is provided a counterturned screwthreaded stud 38, providing a shoulder 40 against which the internal die 34 is seated. For this purpose, die 34 includes an end wall 41 having a centralized bore fitted upon stud 38, the end wall being seated against shoulder 40 and clamped in position by the nut 42 screwthreaded upon the stud 38. The internal

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bore 31 of die 28 and the external diameter of die 34 are concentric with each other, the diameter of the internal die 34 being substantially smaller than the bore 31 to provide the space 43 which determines the wall thickness of the extrusion. Spider 33 is so arranged that its arms 35 do not materially interfere with the passage of the clay which is expressed under high pressure through the cylinder 27, through the annular space 43 to form the cylindrical column.

It will be noted in Figure 3 that a portion of the internal die 34 extends beyond the end of the external die 28. The extended portion of the die includes a groove 44 in which is placed a ring 45 of non-metallic material, for example, a fibrous composition such as brake lining material. This ring provides a backing for the perforator punches which are located radially in alignment with ring 45 to prevent damage to the cutting edges of the punches. These punches periodically punch through the wall of the plastic column and immediately retract, the internal die 34 thus defining the inside diameter of the extrusion and also supporting it during the perforating operation.

As shown in Figures 2 and 3, the perforating apparatus is mounted directly upon the outer end of the die 28 by means of a face plate 46 which is secured to the die by the screws 47. In the present disclosure, there is provided a set of four perforator units, each indicated generally at 48 although it will be apparent that the number of perforators is optional and may be varied according to the requirements of the work. As shown, each perforator unit extends radially with respect to the center of the extrusion die assembly as viewed in Figure 2, so as to locate the perforations at spaced radial points around the lower circumference of the extruded cylinder. As disclosed, the perforator units are located in longitudinal alignment with each other, although in certain instances it may be desirable to stagger the units with respect to each other according to the type of perforating operation required.

Perforator unit

As detailed in Figures 4 and 5, each perforator unit constitutes an elongated base plate 50, one end of which is secured to the face plate 46 by means of screws 51 (Figure 3). This unit is powered by a cylinder 52 having a piston 53 and piston rod 54, connected to a punch 55 by means of toggle linkage 56. In the present disclosure, the piston is operated by air pressure, although it can be hydraulically energized if desired. The cylinder assembly is constructed and arranged so that the perforator punch 55 executes a forward and return stroke at one stroke of the piston in either direction. As hereinafter disclosed, the timer 26 energizes alternately a pair of solenoids mounted within a control valve unit forming a part of cylinder 52, having suitable ports and passageways to admit air pressure alternately to the opposite ends of cylinder 52, depending upon which of the solenoids is energized. Thus, when one solenoid is energized, the piston rod assumes its fully extended position and when the other is energized, the rod is fully retracted.

As shown in Figure 3, cylinder 52 includes cylinder heads 57 and 58 secured upon its opposite ends by draw bolts 59 passing through the respective heads and drawing the heads firmly against the ends of the cylinder. Gaskets 60—60 are disposed between the respective cylinder heads to provide an air tight seal. The cylinder

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assembly is secured to a mounting plate 61 by screws 62 passing through the plate into the cylinder heads and plate 61 is mounted in spaced relationship to mounting plate 50 by screws 63 passing through spacers 64.

The piston constitutes a pair of oppositely facing cup-shaped members 65 formed from rubber or other resilient material secured upon the end of piston rod 52 by the clamping nut 66. The cup members are interposed between metal washers 67 and the assembly is seated against the piston rod shoulder 68. The cylinder head 58 includes a packing or seal ring 69 embracing the piston rod, the ring being formed of a resilient material similar to the piston cups. As herein-after described, the valve structure is arranged to conduct air pressure to either end of the cylinder to cause reciprocation of the piston.

The toggle assembly 56 constitutes a bellcrank lever 70 pivotally mounted as at 71 upon bearing blocks 72 secured by screws 73 to the base plate 50. The bellcrank lever is connected to the end of the piston rod 54 by means of spaced links 74—74 pivotally connected to the bellcrank lever by a pivot pin 75, locked in place by cotter pins 76—76. Spacers 77—77 are placed between the links and the short arm of the bellcrank lever. The opposite ends of the links are connected to the piston rod by means of a spacer block 78 screwthreaded upon the end of the piston rod and locked in position by a nut 79. A pivot pin 80 passes through the links and block, also being locked by cotter pins 76—76.

The long arm 81 of the bellcrank lever 70 is bifurcated as at 82 and is pivotally connected by a pin 83 to a link 84, the arm and link constituting a toggle joint. The opposite end of link 84 is pivotally connected as at 85 to a plunger 86 which carries the perforator punch 55. Plunger 86 is slidably mounted in a bore formed in a trunnion block 87, pivotally mounted as at 88 between bearing blocks 89—89 (Figure 8). These blocks are secured by screws 90 to base plate 50. Trunnion block 87 normally is seated upon the base plate 50 by a compression spring 91 having one end seated upon the block 87 and its opposite end bearing against a U-shaped bracket 92 secured by screws 93 to the tops of blocks 89—89. It will be noted that spring 91 is located in advance of pivot point 88, yieldably pressing the trunnion block and plunger assembly against the base plate but permitting the assembly to be pivoted to the left, against the spring, as viewed in Figure 9. This permits the punch 55 to follow the moving column of clay during a punching operation to prevent distortion of the perforation, as might occur should the punch be confined to a fixed path of travel.

The outer end of plunger 86 is provided with a screw-threaded bore to receive the screw-threaded shank 94 of punch 55, providing longitudinal adjustment, a lock nut 95 being threaded on the shank to lock the punch in adjusted position in the plunger. The shank 94 is somewhat larger in diameter than the operating end of the punch, and is provided with wrench flats 96 on opposite sides to facilitate adjustment. The operating end of the punch is tubular so that the displaced slugs of clay may pass through the punch and the shank 94 is provided with a lateral opening 97, having an angular end wall 98 to guide the slugs laterally and discharge them. The punch is adjusted so that on its outward limit of travel, its end makes contact with the non-metallic facing 45 to perforate the aperture

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clearly to prevent injury to the punch and provide a slight degree of yieldability precluding excessive stressing of the apparatus.

As above noted, the toggle joint assembly 56 is arranged to advance and retract the punch 55 upon one stroke of the piston rod 54. As shown in Figure 9, during the forward stroke of the rod, the long arm 81 of bellcrank lever 70 swings in an arc about its pivot pin 71 and its cooperating link 84, being pivoted as at 83 to arm 81, will exert endwise pressure upon the plunger 86, link 84 being pivotally joined as at 85 to the plunger. This movement forces the plunger and punch forwardly until the pivot pins 71, 83 and 85 are in line with each other, at which time the end of the punch will be in contact with the facing 45. At this point the piston rod has advanced approximately $\frac{1}{2}$ of its forward stroke and as the piston rod movement continues, the arm and link 81 and 84 pass beyond dead center to the position shown in Figure 10 which is substantially opposite to that of Figure 3, thus bringing the punch back to its retracted position with the piston rod fully extended. The base plate is slotted as at 89 to provide clearance for the toggle links when they assume this position. When air is admitted into the opposite end of the cylinder, the piston rod 54 will be retracted, causing the toggle linkage again to advance and retract the punch through a repeat cycle.

Valve structure

As shown in Figures 4 through 7, the reversing valve unit is a commercial product but a generalized description is believed necessary in order to disclose the function of the apparatus. The valve unit constitutes two sections, a solenoid housing 100, and an intermediate block 101 which is disposed between housing 100 and cylinder head 57. Gaskets 102 are interposed between the meeting faces of these units and they are clamped together by draw bolts 59 which extend there-through, nuts 103 being engaged upon the opposite ends of the draw bolts. The solenoid housing 100 includes an internal bore 104 having a pair of cylindrical solenoid units 105 and 105a mounted in the opposite ends thereof, the solenoid units having end flanges 106 which are clamped by the end closure caps 107-107. A sleeve 108 is slidably sustained within bore 104, the opposite ends of the sleeve being telescoped partially over the ends of the solenoid units 105 and 105a, the sleeve being adapted to shift longitudinally by magnetic flux as the solenoid units are energized.

The solenoids are energized alternately by current conducted from the timer to the insulated terminal screws 109-109, one for each solenoid unit. The circuit for each solenoid is established from the screw 109 to the solenoid by a flat spring 110 secured to the solenoid and bearing against the head 111 of the screw, which also includes nuts 113 for securing the leads to the outer end thereof. The circuit through the solenoid units is completed by grounding the opposite ends of the solenoid windings (see diagram), the opposite side of the control circuit being grounded to the apparatus for this purpose.

As shown, the housing 100 includes an intake passageway 114, and its opposite face, which engages housing 101, is provided with a recess 115 for slidably receiving a reversing slide valve element 117. Air pressure is conducted from the intake passageway to the recess 115 by means of a circumferential groove 118 formed in sleeve 108,

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Slide valve 117 is mechanically connected to sleeve 108 by a spur 120 engaged in the groove 118 so that the valve is shifted unitarily with the sleeve. The valve block is in facial contact with the intermediate block 101, being spring loaded by means of the compression spring 121 to provide an air tight seal between the face of the housing 101 and the slide valve. It will be noted that there is provided a clearance 122 between the back wall of recess 115 and the valve block to provide passage of air from the groove 108 to the recess.

As shown in Figure 5, intermediate block 101 is provided with adjoining pairs of valve ports, the ports of one pair being indicated at 123 and 124 and the other pair at 125 and 126. The individual inner ports 124 and 125 each communicate with a respective passageway 127 and 128, which lead to the exhaust nozzles 129 and 130 respectively (Figure 7). The individual outer ports 123 and 126 communicate with a respective passageway 131 and 132 formed in the cylinder head 57. It will be noted that passageway 132 opens directly into the cylinder while passageway 131 extends at an angle through the cylinder head to a tube 133, extending to the opposite end of the cylinder. The cylinder head 58 at the opposite end includes a right angular passageway 134 extending from the end of tube 133 to the interior of the cylinder.

The bearing face of the slide valve element 117 is provided with a pair of recesses 135 and 136 which are arranged to interconnect either the pair of ports 123 and 124 or 125 and 126, depending upon the position of the valve element. When the slide valve is in the position shown in Figure 4, ports 123 and 124 are connected together through the recess 135 and the outer port 126 is exposed so that air pressure may pass through groove 118, recess 115 through port 126 directly into cylinder 52 to cause forward motion of the piston. As shown, it is assumed that the valve has been shifted but that the piston stroke has not yet commenced. As the piston moves forwardly, the air is exhausted from the forward end of the cylinder through the passageway 134 in the forward cylinder head 58, back through tube 133, angular passageway 131 of cylinder head 57 to valve port 123, to recess 135 of slide element 117. From recess 135 the air passes to the port 124 to passageway 128 and is exhausted into the atmosphere through the exhaust nozzle 130.

When the opposite solenoid is energized to reverse the operation, the slide valve element moves to the position shown in Figure 6, uncovering port 123 to admit air pressure into the angular passageway 131 to tube 133 so as to supply air pressure to the opposite end of the cylinder, causing the piston to move rearwardly. Air is exhausted from the rearward portion of the cylinder through the passageway 132, port 126 to the recess 136 of the valve slide block. The air passes through recess 136 to port 125 to passageway 127 and is exhausted through the exhaust nozzle 129. It will be apparent that when solenoid unit 105 is energized, the piston will move forwardly and when unit 105a is energized, the piston will be retracted.

The valve and cylinder structure is such that the perforating operation is performed at a relatively high rate of speed in proportion to the lineal travel of the clay column, minimizing the tendency of the punch to follow the column. The slight deflection which is required to compensate

for the advance of the column is permitted by the compression spring 91 as previously described. Since the punching operation is completed during a single stroke without reversal of the piston, a rapid forward and return punch stroke results. The toggle linkage provides high initial velocity constantly decreasing as the punch penetrates the clay wall, with a momentary dwell period as the linkage passes its neutral axis before withdrawal of the punch. The linkage develops increasing leverage as the punch penetrates, and resistance increases, with a high pressure dwell against the die facing 45, resulting in clean, well formed perforations.

Timing apparatus

As shown in Figures 1, 11 and 12, the timer is mounted upon the frame of the cutting machine 21 by means of a mounting plate 137 and is driven by a gear 138, keyed upon the shaft 140 of the conveyor 23 so as to drive the timer in synchronism with the lineal travel of the clay column. In detail, the timer mechanism includes a gear 141 loosely journaled upon a shaft 142 fixed to the mounting plate 137. Gear 141 includes a coupling collar 143, telescopically engaging the hub 144 of a two cycle timing gear 145, the hub 144 being connected to sleeve 143 by means of a set screw 146 so that gears 141 and 145 rotate as a unit.

Adjoining the timing gear 145 there is provided a switch mounting arm 147 which includes a split collar 148 frictionally engaged upon shaft 142, the collar being locked upon the shaft by means of the bolt 150. The end of shaft 142 may be screwthreaded to receive a nut 151 for adjusting the parts longitudinally with respect to the shaft to provide proper running clearances. Upon the extended switch mounting arm 147 there is mounted a pair of micro-switches 152 and 152a each including an actuating plunger 154. These switches preferably are mounted upon an angle bracket 155 by means of screws 156. The angle bracket is secured to the arm by means of screws 157, the arm preferably being slotted as at 158 to permit the switches to be adjusted laterally with respect to the timing gear 145. The assembly is locked in adjusted position by means of nuts 160 engaged upon the screws 157. The switches are positioned so that the plungers 154 are depressed by the teeth of gear 145 as the gear rotates.

As shown in Figure 11, the plungers 154—154a of the micro-switches are in alignment with the end portions of gear 145 and normally both plungers would intermittently be depressed in unison by the gear teeth as the gear rotates. In order to provide alternate operation of the micro-switches, the endwise portion of alternate teeth is cut away as indicated at 161, so that successive gear teeth alternately depress the plungers of switches 152 and 152a. The ratio between the gears 138 and 141 is such that gear 141 and timer gear 145 make $\frac{1}{2}$ revolution for each tile length, or in other words, one complete revolution of gear 145 constitutes two cycles of operation.

In the arrangement disclosed, the timing gear is provided with fourteen teeth (Figures 12 and 13) so as to provide seven perforations for each length of tile as shown in Figure 15. It will be noted that two entire teeth on diametrically opposite sides of gear 14 are removed as indicated at 162 to provide an inactive period at the beginning and end of the cycle to space the perforations properly from the ends of the tile as shown,

bearing in mind that the lengths are severed after being perforated. In order to synchronize the timer with the cutter and locate the perforations with respect to the tile column, the micro-switches may be adjusted radially with respect to the timing gear 145. This is accomplished by loosening the clamp screw 150 and rotating the switch mounting arm 147 with respect to the timing gear.

In the present disclosure, the two cycle timing gear 145 is driven at the same speed as shaft 140 of the conveyor by gears 138 and 141, to perform two complete perforating cycles for each revolution of conveyor shaft. The tile lengths subsequently are severed at the interruption between the groups of perforations, which interruptions represent the end of the timer cycles, as above noted.

The tile length is thus determined by the gear ratio between the conveyor shaft and timer, which groups the perforations according to length, based upon the spacing of the radial arms of cutter 21. If the length is to be changed, suitable changes in the cutter are made and the ratio between the conveyor and timer correspondingly is changed by substituting gears 138 and 141 for other gears bearing the necessary ratio to each other. It will be noted also that the spacing between the individual perforations is determined by the teeth of gear 145, correlated to the lineal advance of the tile column. The spacing can be altered by installing a timer gear having a different pitch, thus providing a different number of perforations per tile length, at correspondingly different spacing, the overall length of the tiles remaining the same.

Operation

The control circuit for the apparatus is disclosed diagrammatically in Figure 14. As shown, the micro-switches 152 and 152a are of the normally open type, so arranged that a circuit is established through the switches when the respective plungers 154 are depressed. As shown, the circuit is energized by the power lines 163 and 164 which may lead from a transformer or other power source, depending upon the design of the electrical components. As disclosed, line 163 is connected in common to both micro-switches and line 164 is grounded to the machine. Micro-switch 152 is connected in common to the winding of solenoids 105 by line 167 and micro-switch 152a is connected in common to all of the windings of solenoids 105a. The opposite ends of the windings are grounded so as to complete the circuit to the power line 164.

Since the micro-switches are closed alternately, it will be apparent that all of the solenoid units 105 or 105a will be energized simultaneously to operate the perforator units in unison, the piston of each being advanced when one switch is energized and retracted when the other is energized. It will be observed that additional perforating units may be applied as required by the particular job, and, if desired, certain perforations may be omitted by disconnecting the lines 167 and 168 from the respective binding posts 109 of certain of the solenoid units.

Modified apparatus

As disclosed in Figure 16, the perforating apparatus may be applied to a machine in which the soft clay tile length is stationarily supported, while the perforating machine moves longitudinally relative to the tile. This type of operation may be combined with steam operated presses

which are in common use in the tile industry, which essentially constitute a steam cylinder operating intermittently to extrude length of tile or pipe. The modified arrangement may be constructed to operate directly in conjunction with such presses or it may be arranged to perforate the tile sections at stations remote from the press. As shown, the arrangement embodies a stationary mandrel 180, arranged vertically to receive and support the tile sections, either directly as they are extruded, or slipped thereon as a separate operation. Alongside the mandrel 180, there is provided a vertical bracket 181, providing slide bearings 182—182 for a vertical slide rod 183. Secured to the slide rod is a horizontal mounting plate 184 upon which is mounted a group of perforator units 48 having plungers directed radially toward the mandrel in the manner previously disclosed. The slide rod 83 and perforating assembly may be reciprocated vertically by any appropriate means, the example disclosed being a crank 185 connected to the upper end of the rod by a link 186, the crank having a throw sufficiently long to reciprocate the assembly for the length of the tile, indicated at 187. The perforating units 48 are identically the same as previously described, each including a cylinder having a pair of solenoid operated valves connected to respective switches 152 and 152a. In the present instance however, the timing unit 26 is omitted and the switch plungers 154 are actuated directly by means of skids or buttons 188 mounted upon bracket 181 and arranged in alternate positions so as to energize the switches alternately in the manner as previously described. Thus, the circumferential rows of perforations will be located in alignment with the skids 188. The apparatus may be caused to operate both during its ascending stroke and descending stroke, or during one stroke only. In the former instance the tile may be placed upon the mandrel when the perforator assembly is at its upper limit of travel, and the operation performed during descent as illustrated. When the assembly reaches its lower limit of travel, the tile may be removed and a subsequent one placed upon the mandrel for perforation during the ascending stroke.

Having described our invention, we claim:

1. In an apparatus for perforating a continuous tube formed of plastic material, a perforator unit including a reciprocable perforator punch constructed and arranged to perforate the tube substantially at right angles to the longitudinal axis of the tube, means for continuously advancing the tube longitudinally relative to the perforator punch, power means arranged intermittently to actuate the punch to advance and retract the same to form perforations along the continuously advancing tube in spaced groups means in driving connection with the advancing tube for severing the continuous tube between the groups of perforations to form individual lengths of tubing and timer means in driving connection with the severing means constructed and arranged to energize the said power means in timed relationship with the advancement of the tube.

2. In an apparatus for perforating a continuous tube formed of plastic material, an extruder having an internal and external die arranged to express a continuous tube of material, the said internal die being constructed and arranged to define the inside diameter of the tube and to form a backing for supporting the tube wall against collapse during the perforating operation,

a perforating mechanism mounted on the external die and including a punch adapted to advance and retract rapidly through the moving tube of material, the end of the punch being adapted to bottom against said internal die.

3. In an apparatus for perforating a continuous tube formed of plastic material, an extruder having an internal and external die arranged to express a continuous tube of material, the internal die extending outwardly beyond the external die, a perforating mechanism mounted on the external die and including a punch adapted to advance and retract rapidly through the moving tube of material, the internal die being arranged to support the tube wall against collapse during the perforating operation, the end of the punch being adapted to dwell against said internal die, the internal die having a band of non-metallic material to protect the end of the punch.

4. A perforating unit constituting a base, a cylinder mounted on the base having a piston slidably sustained therein, means for admitting fluid pressure into the opposite ends of the cylinder alternately to actuate the piston, a perforator plunger slidably mounted relative to the base, and toggle linkage connecting the perforator plunger to the piston to reciprocate the plunger.

5. A perforating unit constituting a base, a cylinder mounted on the base having a piston slidably sustained therein, a reversing valve associated with the cylinder and arranged to admit fluid pressure into the opposite ends of the cylinder alternately, means for actuating said valve, a perforator plunger slidably mounted relative to the base, and toggle linkage connecting the perforator plunger to the piston to reciprocate the plunger, the toggle linkage being constructed and arranged to advance and retract the punch through a complete cycle upon one stroke of the piston in either direction.

6. A perforating unit adapted to be mounted upon an extruder to form a series of perforations in a tube as the tube is expressed from the extruder comprising, a base secured to the extruder, a cylinder mounted on the base having a piston slidably sustained therein, means for admitting fluid pressure into the opposite ends of the cylinder alternately to actuate the piston, a perforator plunger slidably mounted relative to the base, and toggle linkage connecting the perforator plunger to the piston to reciprocate the plunger, the toggle linkage being constructed and arranged to advance and retract the punch through a complete cycle upon one stroke of the piston in either direction, the extruder having an internal die for defining the inside diameter of the tube, the plunger being arranged to bottom against the internal die at the forward limit of plunger advancement.

7. In an apparatus for perforating a continuous tube formed of plastic material, an extrusion die for extruding the tube, a plurality of perforator units mounted in angular positions relative to said die, said perforator units each including an actuating cylinder and piston and a perforating punch directed radially toward the tube, the punch being connected to the piston by means of toggle linkage, and being adapted to execute a complete stroke for one reciprocation of the piston, said cylinders each having an electrically operated reversing valve, and a timer associated with the extrusion apparatus and in electrical connection with said reversing valves operable to actuate said valves simultaneously in

alternate directions at timed intervals to form circumferential rows of apertures at spaced points along the advancing tube.

8. A perforator unit adapted to be mounted upon an extruder to form a series of perforations in a tube as the same is expressed from the extruder comprising, a base secured to the extruder, an actuating cylinder mounted upon the base, a piston including a piston rod slidably sustained within the cylinder with the piston rod extending through one end thereof, means for admitting fluid pressure into the opposite ends of the cylinder alternately to actuate the piston, a bellcrank lever pivotally mounted upon the base, a link connecting the end of said piston rod to one arm of the bellcrank lever, a perforator plunger slidably mounted in a mounting element yieldably secured to the base, a link connecting the opposite arm of the bellcrank lever to said plunger, said bellcrank lever and last mentioned link being constructed and arranged to advance and retract the perforator plunger through a complete cycle of operation during one stroke of the piston in either direction, the yieldable mounting element adapting the plunger to deflect angularly to follow the advancing tube during the perforating cycle of the plunger.

9. A perforator unit adapted to be mounted upon an extruder to form a series of perforations in a tube as the same advances from the extruder comprising, a base secured to the extruder, a cylinder mounted upon the base, a piston having a piston rod slidably sustained within the cylinder and extending through one end thereof, means for admitting fluid pressure into the opposite ends of the cylinder alternately to advance and retract the piston rod, a tubular perforator plunger, a trunnion block pivotally mounted on the base and adapted slidably to sustain the perforator plunger, yieldable means operable to maintain the trunnion block and plunger substantially at right angles to the axis of the advancing tube, toggle linkage connecting the perforator plunger to the end of said piston rod, the toggle linkage being constructed and arranged to advance and retract the perforator plunger through a complete cycle of operation during a single stroke of the piston rod in either direction, the trunnion block adapting the plunger to deflect angularly to follow the advancing tube during the perforating cycle of the plunger.

10. An apparatus for perforating a tube formed of plastic material comprising, a base, a cylinder and piston unit mounted on the base, a perforator plunger operatively connected to the cylinder and piston unit and arranged to perforate the tube, a reversing valve for said cylinder, a pair of electrical components for alternately actuating the reversing valve, timer means including a pair of switches in electrical connection individually with said electrical components and arranged to actuate said switches and electrical components alternately to cause forward and reverse actuation of the piston and cylinder unit to reciprocate the perforator plunger, means for effecting a relative movement between perforator apparatus and tube in a direction longitudinally of the tube to space the perforations along the tube.

11. An apparatus for perforating a tube formed of plastic material comprising, a plurality of perforator units radially mounted with respect to the axis of the tube, each of said units having a base, a plunger directed toward the tube, a cyl-

inder and piston unit mounted on the base and connected to the plunger, a reversing valve for admitting fluid to the cylinder and piston unit to reciprocate the same, a pair of electrical components for alternately actuating the reversing valve, timer means including a pair of switches, one for each of said electrical components, each switch being in electrical connection in common with the respective electrical components of all of the perforator units to cause simultaneous operation thereof, said timer means being arranged to actuate the switches and electrical components alternately to cause forward and reverse actuation of the piston and cylinder unit to reciprocate the plungers of all of said units simultaneously, and means for effecting a relative movement between the perforating apparatus and tube in a direction longitudinally of the tube.

12. An apparatus for perforating a tube comprising, a mandrel for supporting a tube, a plurality of perforator units radially mounted with respect to the axis of the mandrel, each of said units having a base, a plunger directed toward the mandrel and adapted to penetrate a tube placed thereon, a cylinder unit mounted on the base and connected to the plunger, an electrically operated reversing valve for admitting fluid pressure alternately to the opposite ends of the cylinder unit, a support member for slidably mounting the perforating apparatus, a plurality of switch actuating skids mounted upon the support member, a pair of switches mounted on the apparatus engageable alternately with said skids, said switches being in electrical connection in common with the electrically operated reversing valves of all the cylinder units to cause simultaneous forward and reverse reciprocation of the plungers, and means for feeding the perforating apparatus longitudinally with respect to the tube.

13. A perforating unit adapted to form a series of perforations radially with respect to the longitudinal axis of a tube comprising a base plate, a plurality of cylinders mounted upon the base plate, each cylinder including a piston slidably sustained therein, the said cylinders and pistons being radially disposed with respect to the longitudinal axis of the tube, means for admitting fluid pressure into the opposite ends of the cylinders alternately to actuate the pistons simultaneously, a respective perforator plunger for each of said cylinders slidably mounted upon the said base plate and radially disposed with respect to the longitudinal axis of the tube, and respective toggle linkages connecting each of the perforator plungers to the said pistons to reciprocate the plungers.

14. A device for producing lateral holes in a moving length of plastic tile, said device comprising, a power motor having a lineally movable driving member, a source of power for the motor, a device for controlling application of power from the said source to the motor, a slidable perforator plunger, and a toggle linkage connecting the perforator plunger with the driving member of the motor, the toggle linkage being constructed and arranged to advance and retract the perforator plunger through a complete cycle upon movement of the driving member of the power motor in one direction, in response to actuation of said control device, at a rate which is great in relation to the movement of the tile so that the perforator plunger may move into, through, and from the tile while the tile is mov-

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ing without causing substantial distortion of the hole produced by the perforator plunger.

15. An apparatus for producing lateral holes in a plastic tile section comprising, a stationary mandrel for receiving the plastic tile section, a hole punching unit including, a power motor having a lineally movable driving member, a source of power for the motor, a device for controlling application of power from the said source to the motor, a slidable plunger, having a perforator at one end thereof, a toggle linkage connecting the other end of the perforator plunger with the driving member of the motor, the said toggle linkage being constructed and arranged to rapidly advance and retract the perforator plunger through a complete cycle upon lineal movement of the driving member in one direction in response to actuation of said control device, and the said mandrel constituting a support surface for the tile upon which the perforator may bottom itself at the end of its advancement and before its retraction.

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