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Foulks et al.

[11] **3,815,399**

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[54] **PIPE PERFORATING MACHINE**

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[52] **U.S. Cl.** **72/186,** 72/325, 83/54, 83/187

[51] **Int. Cl.** **B21d 31/02**

[58] **Field of Search** 83/187, 54; 72/186, 325

[56] **References Cited**

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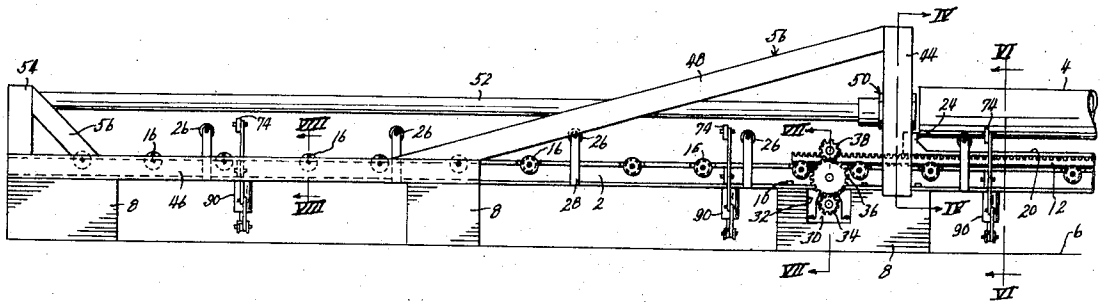
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Primary Examiner—Frank T. Yost
Attorney, Agent, or Firm—John A. Hamilton

[57] **ABSTRACT**

A pipe perforating machine consisting of a bed adapted to support a pipe for movement longitudinally of itself, powered mechanism for driving the pipe in both directions, and a plurality of cooperating pairs of perforating elements carried in spatially fixed relation by the bed and operable to perforate the pipe as it is moved in either direction. At least several parallel rows of perforations may be cut on each pass of the pipe, and the pipe may be angularly indexed after each pass for cutting several additional rows of perforations during the next subsequent pass of the pipe in the opposite direction.

5 Claims, 8 Drawing Figures



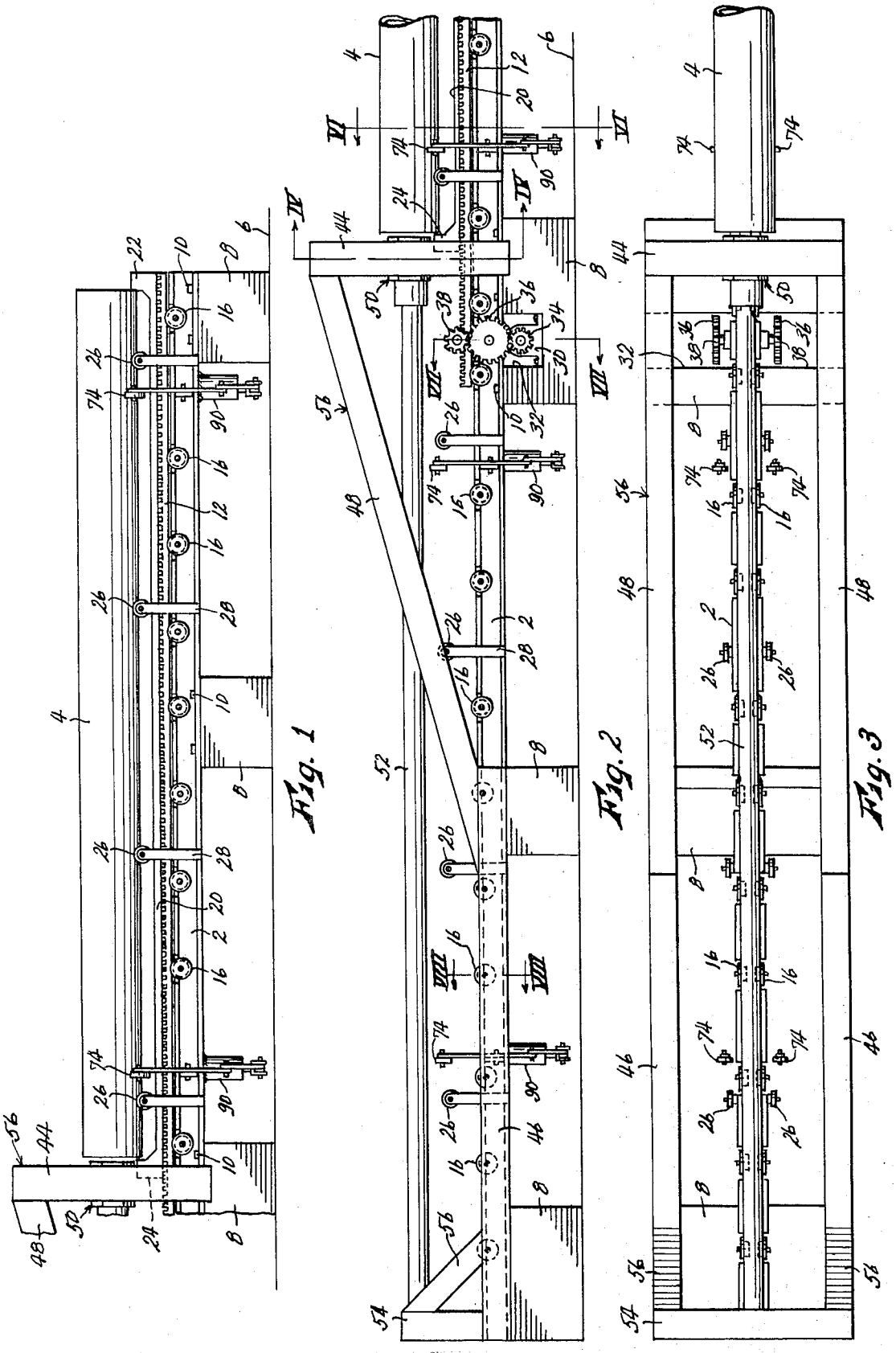


Fig. 1

Fig. 2

Fig. 3

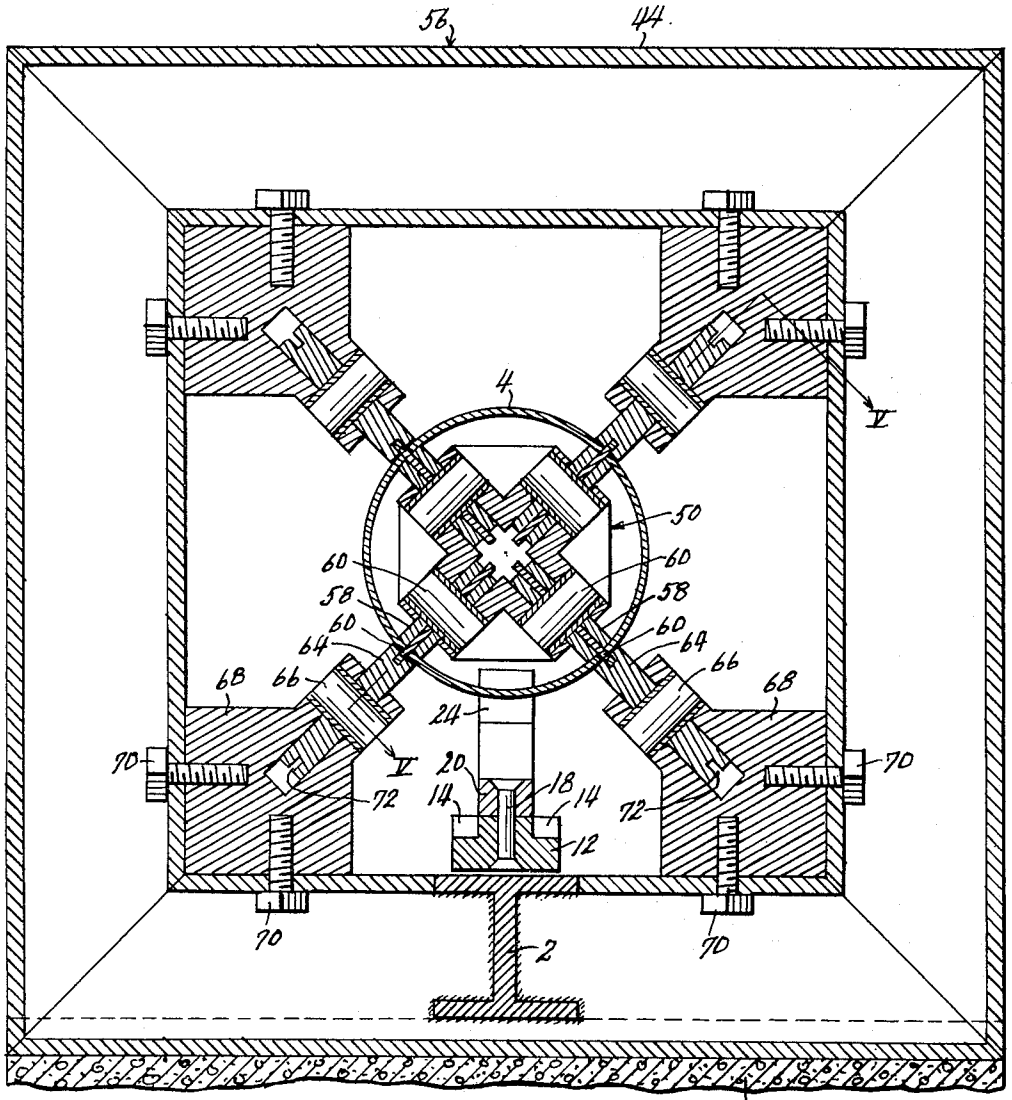

56
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4
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70
72
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18
14
12
2
8

Fig. 4

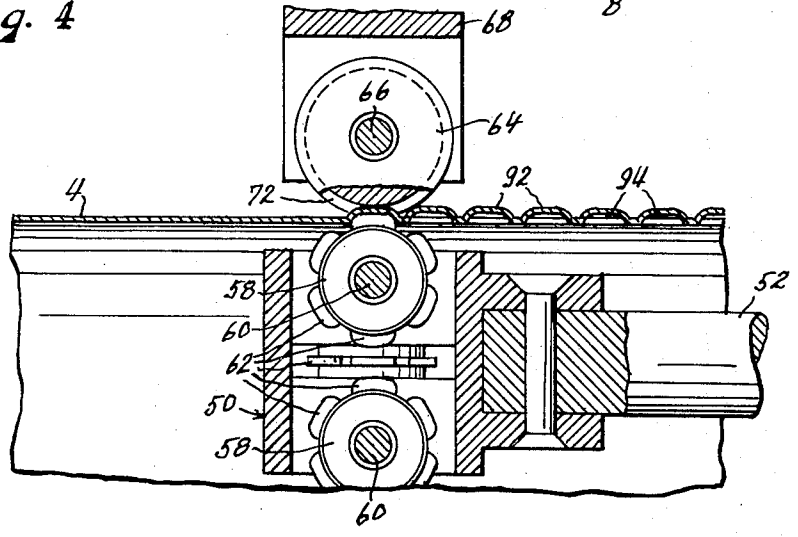

68
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64
4
72
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94
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58
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62
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Fig. 5

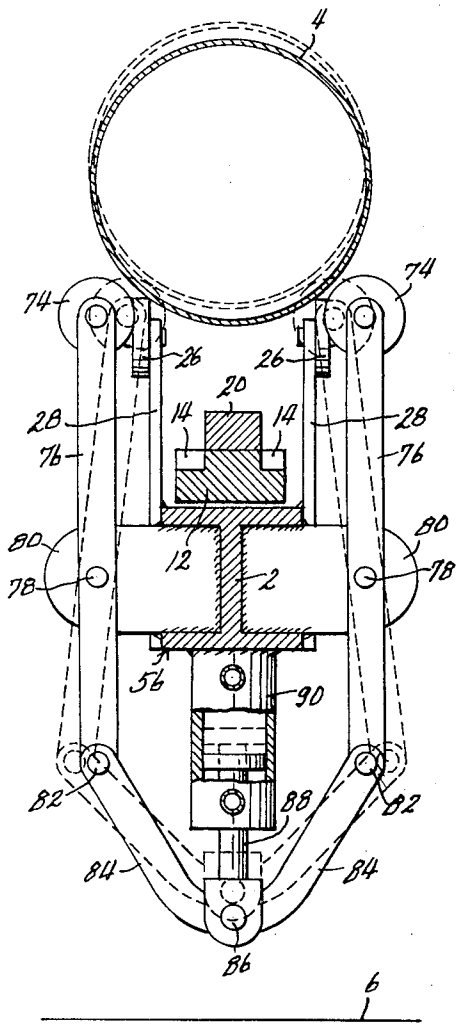


Fig. 6

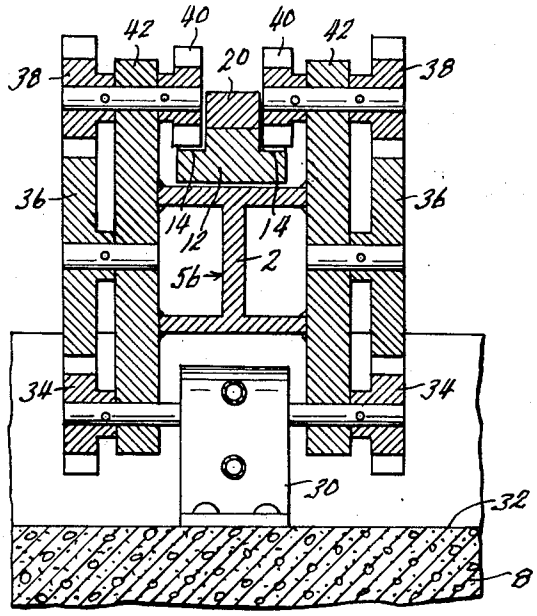


Fig. 7

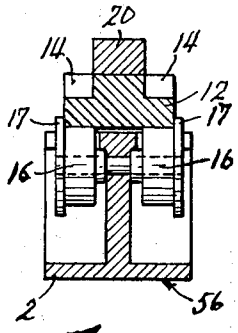


Fig. 8

PIPE PERFORATING MACHINE

This invention relates to new and useful improvements in machines for perforating the walls of pipes, and has particular reference to the production of perforated pipe for use in water wells or the like, said pipe being utilized in sections of a well casing within the water-bearing formation in order to admit water preparatory to pumping it to the ground surface.

The principal object of the present invention is the provision of a machine capable of perforating preformed cylindrical pipe in a new and advantageous manner, in that during each transverse of the length of the pipe by the cutting elements, four and possibly more parallel rows of perforations may be formed, rather than one or two rows as has been the case with all prior machines within our knowledge, and in that different rows of perforations may be cut on consecutive passes of the perforating elements and the pipe, rather than, as in prior machines, requiring two full passes of the cutters, the full length of the pipe, to cut only one or two rows of perforations. Thus the pipe may be perforated much more rapidly, and with far less labor costs, than has heretofore been possible.

The principal feature of the present machine contributing to these advantages is that in the present machine, the pipe itself is driven longitudinally of itself relative to cutting elements carried in spatially fixed relation by the machine frame, rather than moving the cutting elements longitudinally through a pipe which is fixedly related to the machine frame. The pipe itself may be moved longitudinally of itself with far simpler mechanism, and with far fewer problems of support and guidance, than the relatively expensive mechanisms required to support and guide the movement of cutting elements through a fixed and stationary pipe. Also, the use of spatially fixed cooperating cutting elements, by means of their simplified supports, permits generally a reduction of the size of the supports, and the elimination of movement guides which are required for travelling cutters, so that the interior of the pipe can accommodate a greater number of cutting elements, so that a greater number of rows of perforations can be cut during each pass of the pipe over the cutters.

Other objects are simplicity and economy of construction, and efficiency and dependability of operation.

With these objects in view, as well as other objects which will appear in the course of the specification, reference will be had to the accompanying drawing, wherein:

FIG. 1 is a side elevational view of the right end portion of a pipe perforating machine embodying the present invention, showing a pipe to be perforated supported thereon,

FIG. 2 is a side elevational view of the left end portion of the machine shown in FIG. 1, being a leftward extension of FIG. 1,

FIG. 3 is a top plan view of the portion of the machine shown in FIG. 2,

FIG. 4 is an enlarged, fragmentary sectional view taken on line IV—IV of FIG. 2, showing the pipe in the process of being perforated,

FIG. 5 is a fragmentary sectional view taken on line V—V of FIG. 4,

FIG. 6 is an enlarged sectional view taken on line VI—VI of FIG. 2, showing the index rollers in their inoperative positions in solid lines, and in their operative positions in dotted lines,

FIG. 7 is an enlarged, fragmentary sectional view taken on line VII—VII of FIG. 2, and

FIG. 8 is an enlarged sectional view taken on line VIII—VIII of FIG. 2.

Like reference numerals apply to similar parts throughout the several views, and the numeral 2 applies to a beam forming the machine bed. Said beam may be of I-form, and is somewhat greater than twice the length of the pipe 4 to be perforated. Said bed beam is disposed horizontally, and is supported above the floor 6 by a series of concrete pedestals 8 spaced along the length thereof, to which said beam is rigidly secured by any suitable means 10.

A geared rack bar 12, with gear teeth 14 formed along the top side thereof at its laterally opposite edges, extends along the upper edge of beam 2. Said rack bar is of somewhat greater length than pipe 4, and is supported for longitudinal movement along said beam by a series of pairs of rollers 16 (see FIG. 8) spaced along substantially the entire length of the beam. The rollers 16 of each pair are disposed respectively to support the opposite lateral edges of the rack bar, and are carried by beam 2 for rotation on horizontal axes transverse to the beam. They support the rack bar slightly above the beam to prevent friction therebetween, and are flanged as at 17 to prevent transverse movement of the rack bar.

Extending along the top of rack bar 12, between the teeth 14 thereof, and affixed thereto as by rivets 18 (see FIG. 4) spaced along the length thereof, is a bar 20 at the ends of which are provided upright fingers 22 and 24 respectively. The spacing between said fingers corresponds closely to the length of pipe 4, so that said pipe may be fitted therebetween, as best shown in FIG. 1. However, the pipe is supported above bar 20, when the pipe is moved longitudinally of itself by fingers 22 and 24 as rack bar 12 is driven as will appear, by a series of roller pairs 26 spaced along substantially the entire length of the machine. As best shown in FIG. 6, the rollers 26 of each pair are disposed respectively at opposite sides of the midline of the machine, each being rotatably mounted, on an axis transverse to the pipe axis, at the upper end of a post 28 which is fixed at its lower end to beam 2.

Rack bar 12 is driven, whereby to move pipe 4 longitudinally of the machine, in either direction, by a reversible hydraulic motor 30 disposed below beam 2 in a well 32 formed in the top of one of pedestals 8 at about the midpoint of the length of the machine. The controls of said motor may be standard, and are not shown. It drives a pair of gears 34 disposed below and respectively at opposite sides of beam 2. Each gear 34 meshes with an idler gear 36 disposed thereabove, which in turn meshes with a gear 38 to which is affixed a gear pinion 40 which is meshed with the teeth 14 of rack bar 12 at the adjacent side of said bar. The axes of all of gears 34, 36, 38, and 40 are horizontal and transverse to beam 2, and the gears at each side of said beam are rotatably supported by a bearing member 42 affixed to that side of the beam (see FIG. 7).

A square open yoke 44 is disposed in a vertical plane transverse to the machine, at about the midpoint of the machine. Rollers 26 support pipe 4 for longitudinal movement through said yoke, coaxially therewith. Said yoke is set at its lower edge into one of pedestals 8,

preferably the same pedestal carrying hydraulic motor **30,** so that the upper surface of the lower beam thereof is flush with the top surface of beam **2,** as shown in FIG. **4.** At the left end portion of the machine, there are provided side rails **46** parallel with and spaced laterally outwardly from beam **2,** and also based on certain of pedestals **8.** Yoke **44** is reinforced by diagonal braces **48** extending from the upper edge thereof to rails **46.** Yoke **44** carries the perforating cutter elements to be described.

Disposed centrally within yoke **44** is a cutter head designated generally by the numeral **50,** and which is rigidly connected to a heavy push-pull beam **52** which is horizontal and which extends coaxially of the pipe to the left end of the machine, as shown in FIGS. **2** and **3,** where it is rigidly fixed to an upright bracket **54** fixed at its lower end to beam **2** and side rails **46.** Said bracket is reinforced by diagonal braces **56** extending from the upper edge of said bracket to said side rails. Beam **2,** together with yoke **44,** bracket **54,** side rails **46** and braces **48** and **54,** conjointly form a fixed rigid machine frame indicated generally by the numeral **56.** Cutter head **50** carries four cutter wheels **58,** mounted therein by axles **60** for rotation on axes transverse to the pipe, and adapted to move in extremely tight rolling contact with the interior surface of the pipe wall, along longitudinal lines of said surface space angularly apart by 90°, as best shown in FIG. **4.** Each cutter wheel has a series of angularly spaced, radially extending cutter teeth **62.** Each tooth is transversely square, projects radially from its associated cutter wheel by a distance greater than the pipe wall thickness, and has an angular length corresponding to the length of the perforations desired to be cut in the pipe, as will appear.

Exteriorly of the pipe, a die wheel **64** is positioned to roll along the exterior surface of the pipe wall in opposed relation to each of cutter wheels **58.** Each die wheel is rotatably mounted, by means of axle **66,** in a bracket **68** fixed in an interior corner of yoke **44** by screws **70.** The axis of each die wheel is parallel to that of its associated cutter wheel **58,** and has a peripheral groove **72** formed therein. The transverse width of said groove is slightly greater than the width of cutter teeth **62,** and its radial depth is equal to the pipe wall thickness plus the amount by which the radial projection of the cutter teeth exceeds the pipe wall thickness.

As will appear, there are stages in the operation of the machine when it is necessary that the pipe be rotated about its axis for angular indexing thereof between successive passes thereof through the cutter elements. For this purpose, there are provided four pairs of indexing rollers **74** so spaced along the length of the machine that two of said pairs can be engaged with the pipe, respectively adjacent opposite ends of the pipe, whether the pipe is disposed to the right or to the left of yoke **44.** As best shown in FIG. **6,** the rollers **74** of each pair are disposed respectively at opposite sides of beam **2,** below a pipe **4** supported by rollers **26.** Normally, as shown in solid lines in FIG. **6,** rollers **74** do not engage the pipe. Each roller **74** is rotatably mounted at the upper end of a lever arm **76** which extends downwardly at one side of beam **2,** each lever arm being pivoted intermediate its ends, as at **78,** to a bracket **80** affixed to said beam. At its lower end each arm **76** is pivoted, as at **82,** to a link **84.** Links **84** converge beneath beam **2,** and are connected by common pivot **86** to the lower end of the piston rod **88** of a hydraulic cylinder **90** which is vertical and which is affixed at its upper end to beam **2.** Cylinder **90** is double-acting. Its control means may be standard and is not shown. Thus it will be seen that when piston rod **88** is extended downwardly, as shown in dotted lines in FIG. **6,** links **84** and lever arms **76** function to move the two index rollers **74** closer together, whereby they engage and lift pipe **4** upwardly from rollers **26.** The pipe, then supported by rollers **74,** the axes of which are parallel to the pipe, can be easily rotated about is axis, either manually or otherwise.

In operation, a pipe **4** to be perforated is placed on traverse rollers **26** to the right of yoke **44,** as shown in FIG. **1,** with its ends engaged between fingers **22** and **24** of rack bar **12.** Hydraulic motor **30** is then energized to drive said rack bar to the left, whereby the pipe passes over cutter head **50,** the pipe wall entering between cutter wheels **58** and die wheels **64,** as shown in FIG. **4,** and being driven therebetween with great force by finger **22** of the rack bar, until the pipe is moved completely to the left of yoke **44.** During this pass of the pipe, the cutter and die wheels cooperate to form four parallel rows of perforations in the pipe wall, at 90° angular intervals. As shown in FIG. **5,** each cutter wheel tooth **62** cooperates with the associated die wheel to cut two parallel slits in the pipe wall, and to offset the band **92** of wall material between said slits outwardly into the groove **72** of the die wheel. The angular ends of each tooth are rounded as shown so that bands **92** are not cut out or severed from the pipe, but the outward offset is greater than the wall thickness, so that narrow slots **94** are opened between bands **92** and the undisturbed portion of the pipe wall. This type of perforation is considered preferable to cut-out perforations, from a functional point of view, since it weakens the pipe wall to a lesser degree, provides easy regulation (by selecting the radial extension of teeth **62**) of slots **94** to regulate the gain size of sand or other foreign particles which can enter the pipe, and provides a good proportion of perforation area to total pipe area.

When the pipe has been moved completely to the left of yoke **44,** as described, cylinders **90** at that side of the yoke are actuated to cause index rollers **74** to engage and elevate the pipe from traverse rollers **26** as already described, the pipe is rotated axially by the desired degree, and again lowered to be supported by rollers **26.** Hydraulic motor **30** is then actuated in a reverse direction to cause finger **24** of the rack bar to drive the pipe to the right, during which pass four more rows of perforations are cut, in angularly spaced relation from those cut on the first pass. The process is repeated until the entire pipe wall area is perforated to the desired density at which time the pipe will be disposed to the right of yoke **44** and can be lifted from the machine.

It will be seen that since the teeth **62** of each cutter wheel **58** always project into the groove **72** of its associated die wheel **64,** by a distance equal to the radial width of perforation slots **94** of the pipe, the die wheels function to support cutter head **50** when the pipe is not engaged in the cutting elements, so that the cutter head cannot drop or sag, despite the great length of the push-pull beam **52** which supports said cutter head, and the resultant inevitable flexibility of said beam. That is, said cutter head may drop very slightly, due to the lateral clearance of said teeth in said grooves, but the drop will in no case exceed a few thousandths of an inch, and the

pipe wall will still enter between the cutter and die wheels freely, and automatically center the cutter head within the pipe.

Also, it will be seen that the direct engagement of the cutter wheel teeth with the die wheels, when the pipe is not disposed therebetween, secures the cutter wheels against rotation in the head. This fact has a valuable function in preventing the perforations from being cut through the extreme ends of the pipe, which is highly undesirable since it would leave sharp free ends of bands **92** projecting angularly from the pipe ends. To prevent this occurrence, the cutter wheels are rotatably indexed, while the pipe is in the position of FIG. **1**, and before movement thereof is initiated, to such a position that when the pipe is advanced, its end will first engage an angular end of one of the teeth **62** of each of the cutter wheels, whereby to commence rotation of said cutter wheels. Thus, the next following tooth of each wheel will cut the first perforation in the pipe wall in spaced relation from the left end of the pipe, as desired. Also, the diameter of the cutter wheels may be carefully selected, relative to the pipe length, so that the last perforation cut during the leftward movement of the pipe will also be cut in spaced apart relation from the right end of the pipe. When the pipe end does emerge to the left, the cutter wheels are instantly arrested against further rotation by engagement of the teeth thereof with their associated die wheels, so that when movement of the pipe is reversed to the right, the cutter wheels re-enter the pipe at the same angularly indexed positions as they emerged, and the perforations cut during the pass to the right again will not be cut through the ends of the pipe. The manual indexing of the cutter wheels need be performed only once. In this connection, it is important that the axes of the cutter wheels be inclined to the horizontal, as shown, rather than being horizontal and vertical. This provides that teeth of all of the cutter wheels will engage their die wheels, and their rotation arrested, when the pipe emerges from therebetween. If the axes of two cutter wheels were vertical, and the other two were horizontal, teeth of the wheels having vertical axes would engage their die wheels by gravity, but the teeth of the two wheels having horizontal axes might not engage their die wheels, since they have transverse clearance therein, and therefore might turn at random when not engaged by the pipe, destroying the desired angular indexing thereof.

Thus it will be seen that a pipe perforating machine having several advantages has been produced. It is quite simple in construction as compared to prior machine of comparable nature. It cuts multiple rows of perforations on each pass of the pipe in either direction, so that the time and labor required to perforate a pipe is greatly reduced. By simple adjustment, it can be provided that the machine will not cut perforations through either extreme end of the pipe.

Although we have shown a specific embodiment of our invention, it will be readily apparent that many minor changes of structure and operation could be made without departing from the spirit of the invention. For example, the machine could readily be adapted, by placing cutter wheels **58** in side-by-side coaxial relation, to cut perforations in a flat metal plate. Pipe is often formed by winding and welding a flat metal strip in helical form, and this modification would allow the perforation to be performed before the helical winding.

What we claim as new and desire to protect by Letters Patent is:

1. A pipe perforating machine comprising:

a. a frame,

b. traverse rollers carried rotatably by said frame, said traverse rollers being adapted to support a pipe for movement in a direction parallel to its axis a distance greater than the length of said pipe,

c. cooperating perforation cutting elements carried at a fixed position by said frame and operable to cut a line of perforations in the wall of said pipe during movement of said pipe, said cutting elements being disposed midway between the limits of movement of the pipe, whereby said pipe is disengaged from said cutting elements at each limit of its movement, whereby said pipe may be angularly indexed about its axis at each limit of its axial movement, so that another line of perforations will be cut therein by said cutting elements during the next successive pass of said pipe,

d. power means operable to move said pipe in either direction,

e. index rollers carried for rotation by said frame on axes parallel to said pipe, said index rollers normally not engaging a pipe supported by said traverse rollers, but being movable relative to said frame to an operative position in which they lift and support said pipe above said traverse rollers, and

f. means carried by said frame and operable to move said index rollers to and from said operative position.

2. A pipe perforating machine comprising:

a. a frame adapted to support a pipe for movement in a direction parallel to its axis a distance greater than length of said pipe,

b. cooperating perforation cutting elements carried by said frame at a fixed position midway between the limits of movement of the pipe, and operable to cut a line of perforations in the wall of said pipe during movement of said pipe in either direction, said pipe being disengaged from said cutting elements at each limit of its movement, whereby said pipe may be angularly indexed about its axis at each limit of its axial movement, so that another line of perforation will be cut therein by said cutting elements during the next successive pass of said pipe, and

c. power means operable to move said pipe in either direction, said power means comprising an elongated bar extending parallel to said pipe, and carried by said frame for longitudinal movement, a pair of fingers carried by said bar at spaced apart points therealong and extending laterally therefrom, the ends of said pipe being engageable between said fingers, said fingers engaging the wall of said pipe in angularly offset relation from said cutting elements so as to be movable past said cutting elements without interference therebetween, and power means carried by said frame and operable to move said bar longitudinally, selectively in either direction.

3. A pipe perforating machine comprising:

a. a frame adapted to support a pipe for movement in a direction parallel to its axis a distance greater than the length of said pipe,

b. cooperation perforation cutting element carried by said frame at a fixed position midway between the limits of movement of the pipe, and operable to cut lines of perforations in the wall of said pipe during movement of said pipe in either direction, said pipe being disengaged from said cutting elements at each limit of its movement, whereby said pipe may be angularly indexed about its axis at each limit of its axial movement, so that other lines of perforations will be cut therein by said cutting elements during the next successive pass of said pipe, said cutting elements consisting of a plurality of pairs of cooperating cutter wheels, said pairs being angularly spaced apart relative to said pipe to engage the wall of said pipe at different parallel longitudinal lines thereof, said cutter wheels of each pair being adapted to roll respectively along the interior and exterior surfaces of the pipe wall during movement of said pipe, one of said wheels being toothed and the other having a recess adapted to receive said teeth, the radial projection of the teeth of said one wheel being such that a tooth thereof is always engaged in the recess of said other wheel, the interior cutter wheels of said pairs being carried rotatably by a cutter head affixed to one end of a push-pull beam extending longitudinally of and parallel to said pipe, and of greater length than said pipe, the remote end of said beam being affixed to and forming a portion of said frame, whereby said beam extends completely through said pipe when the latter is at one limit of its movement, and

c. power means operable to move said pipe.

4. A pipe perforating machine as recited in claim **3** wherein the axes of all of said pairs of cutter wheels are inclined diagonally to horizontal, whereby when said pipe emerges from said cutter wheels, the tendency of the cutter heat to drop due to the flexibility of said push-pull beam will bring a tooth of each toothed cutter wheel into engagement with a wall of the recess of its associated recessed cutter wheel, whereby any further dropping of the cutter head is arrested, and whereby any further rotation of said toothed cutter wheels is prevented.

5. A pipe perforating machine as recited in claim **4** wherein said toothed cutter wheels have circumferences so related to the length of said pipe as to provide that said toothed cutter wheels, provided they are properly angularly indexed before the initial engagement thereof by said pipe, will not cut perforations through either extreme end edge of the wall of said pipe.

* * * * *