

May 16, 1944.

N. R. ELLIOTT

2,349,033

BORING HEAD

Filed June 25, 1940

4 Sheets-Sheet 1

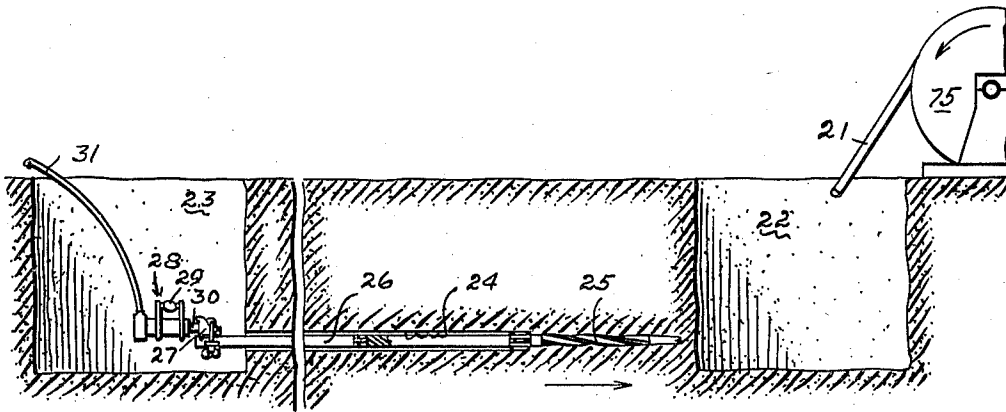


FIG. 1

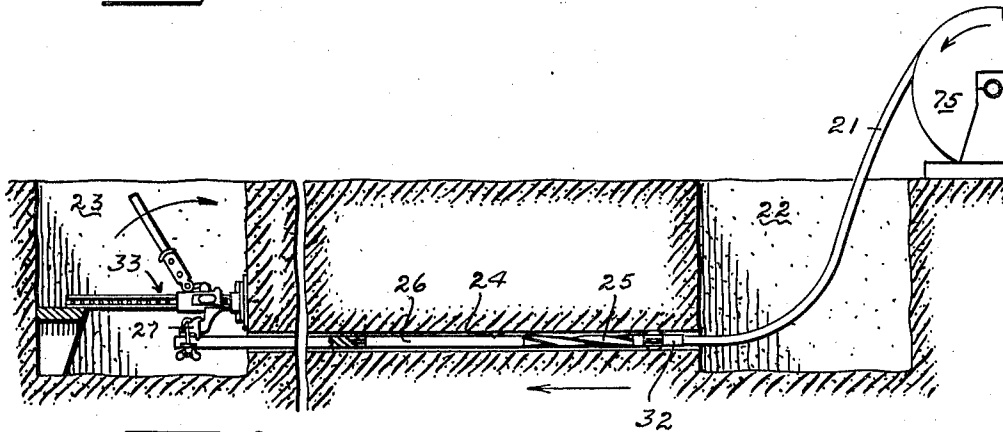


FIG. 2

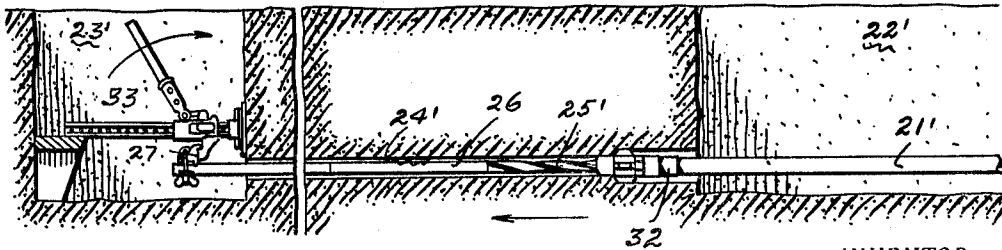


FIG. 3

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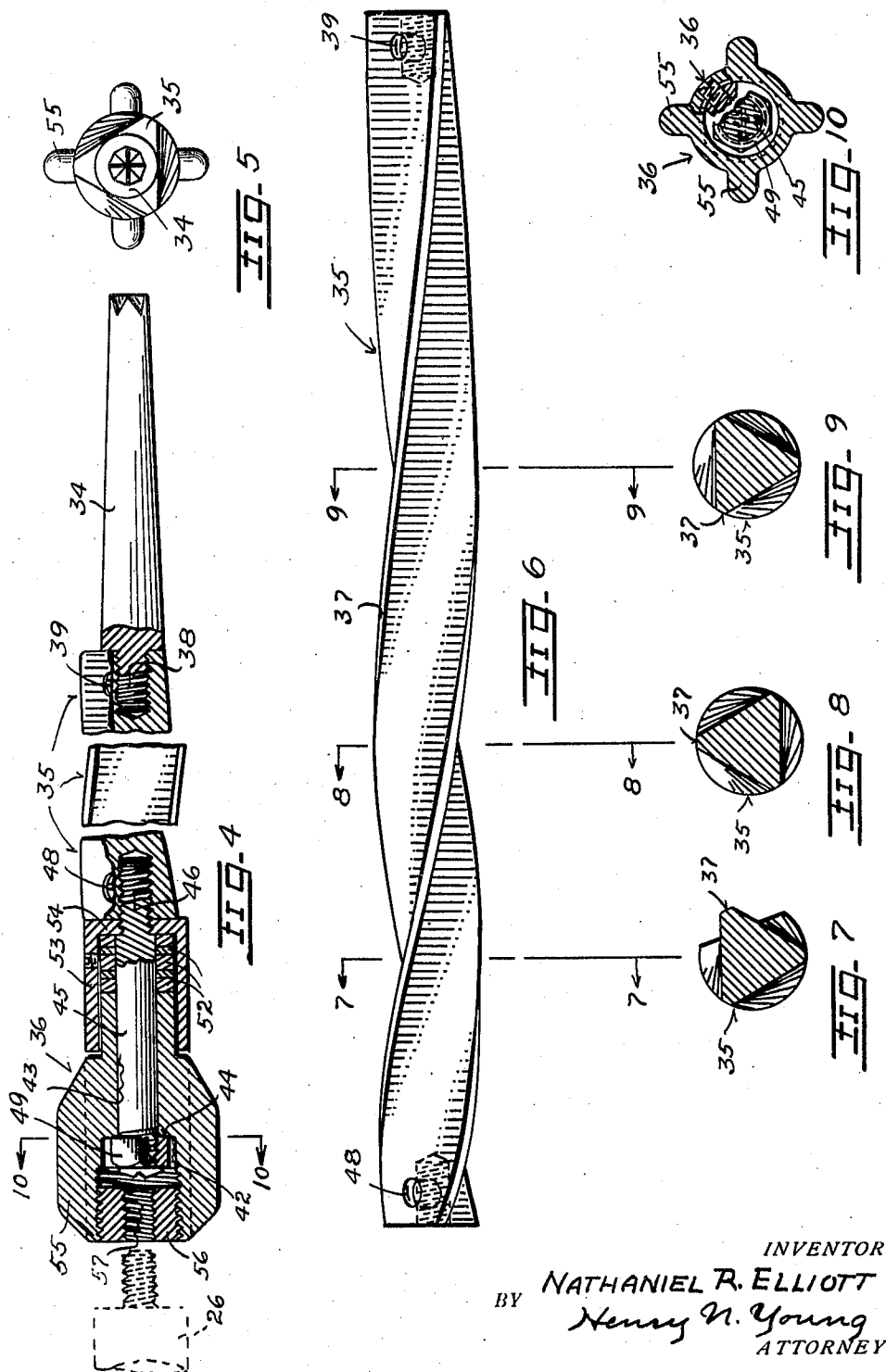
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4 Sheets-Sheet 2



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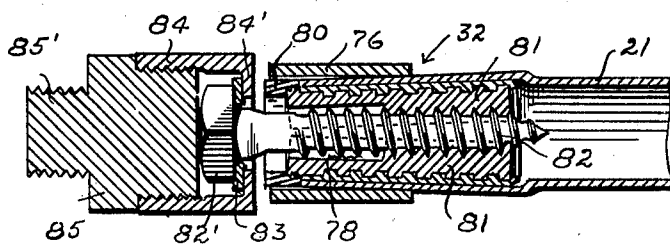
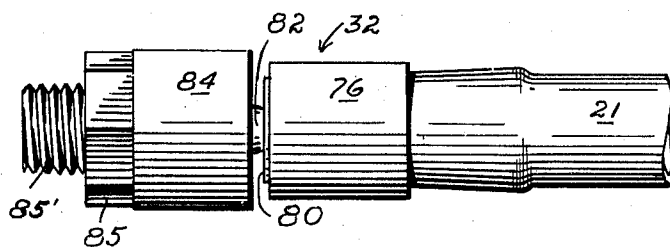
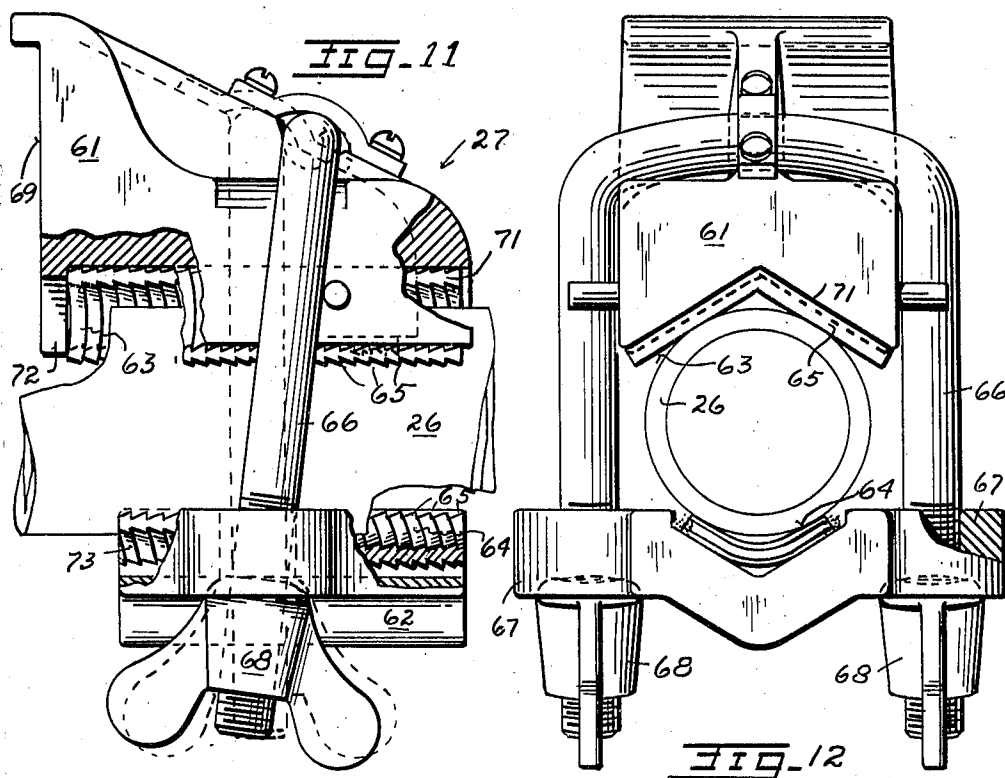
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4 Sheets-Sheet 3



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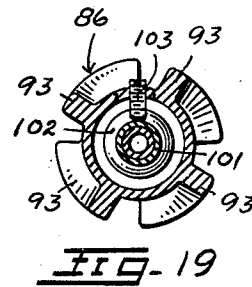
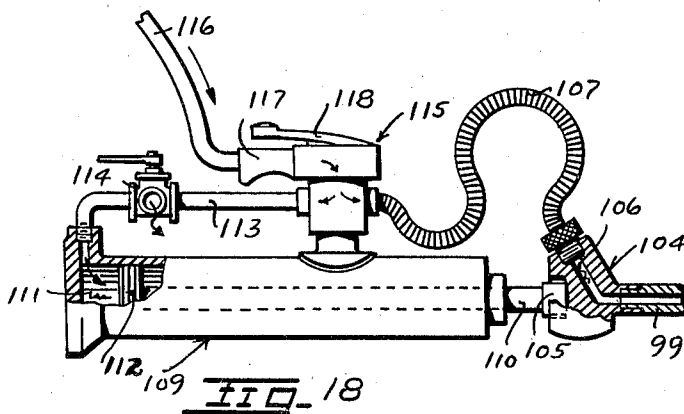
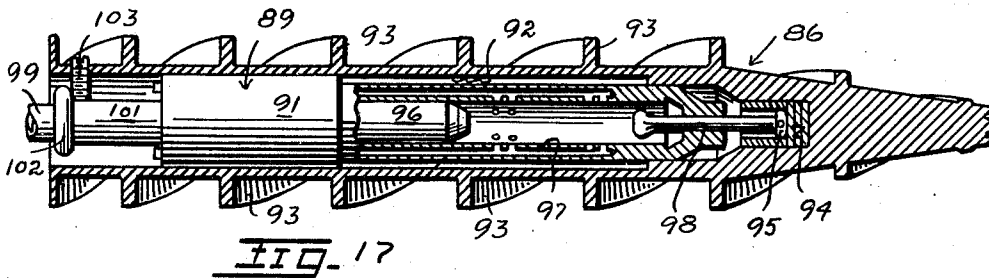
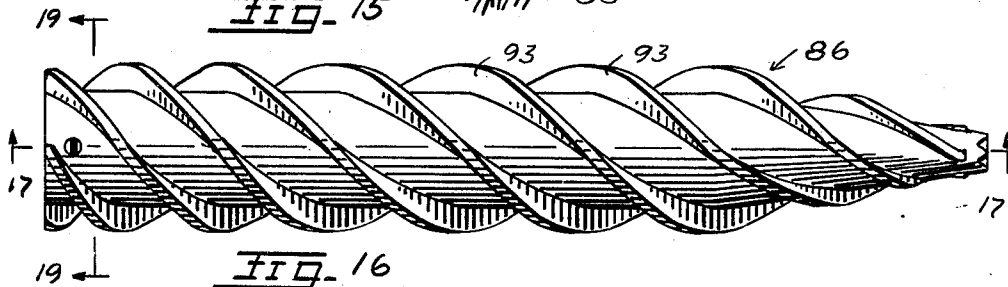
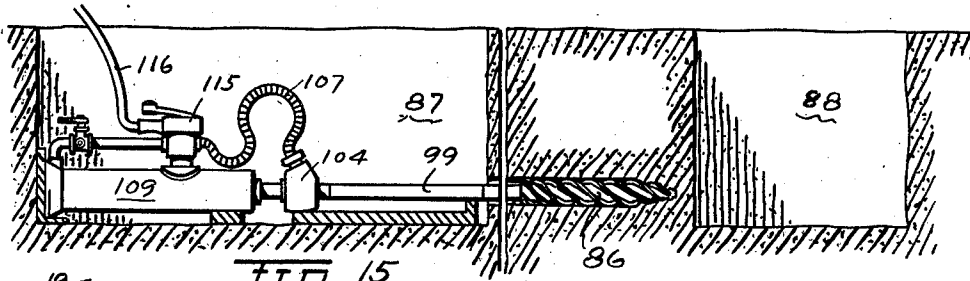
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,349,033

BORING HEAD

Nathaniel R. Elliott, Alameda, Calif.

Application June 25, 1940, Serial No. 342,301

1 Claim. (Cl. 255—69)

The invention relates to a method and means for the installation of pipes and the like in the ground wherein a pipe-receiving bore is provided by and behind a head which is forced through the ground to displace and laterally compact the earth to provide the bore.

The general object of the invention is to provide an improved and particularly effective apparatus of the character described.

A more specific object is to provide a particularly effective boring head for the apparatus.

Another object is to provide an improved driving means for boring heads of the present type.

A further object is to provide an improved means for installing a flexible pipe or conduit in a ground bore provided with the apparatus.

A further object is to provide an improved and particularly effective thrust block for mounting on a rod or pipe or the like for the application therethrough of a longitudinal push or pull effort on the pipe.

Yet another object is to provide a particularly simple and compact device for gripping the forward end of a pipe of copper or other relatively soft material for its pulling through an earth bore.

An added object is to provide a pipe-installing apparatus which is particularly adapted and arranged for its pneumatic operation.

The invention possesses other objects and features of advantage, some of which with the foregoing will be set forth or be apparent in the following description of typical embodiments thereof, and in the accompanying drawings, in which,

Figure 1 is a fragmentary sectional elevation showing an application of the present apparatus to provide a bore for the return pulling of a flexible pipe therethrough.

Figure 2 is a sectional elevation illustrating the manner of installing a flexible pipe in the bore.

Figure 3 illustrates one manner of installing a rigid pipe in a bore provided therefor.

Figure 4 is a fragmentary side view of a boring head shown in Figure 1, portions of the fragments being shown in axial section.

Figure 5 is a front end view of the head.

Figure 6 is a side elevation of an intermediate element of the head.

Figures 7 and 8 and 9 are cross-sections taken respectively at the lines 7—7 and 8—8 and 9—9 of Figure 6.

Figure 10 is a cross-section taken generally at the line 10—10 in Figure 4.

Figure 11 is an enlarged side elevation of a

mounted impact block assembly which is shown in Figures 1 to 3, portions of the structure being shown in axial section.

Figure 12 is an end view of the block assembly shown in Figure 11.

Figure 13 is an enlarged elevation showing a means for attaching a flexible pipe to a pull rod of the apparatus, as in Figure 2.

Figure 14 is an axial section through the arrangement of Figure 13.

Figure 15 is a sectional elevation taken through the ground end disclosing a modification of the apparatus utilizing this form of the boring head.

Figure 16 is an enlarged elevation of the boring head shown in Figure 15.

Figure 17 is an axial section taken at 17—17 in Figure 16.

Figure 18 is an enlarged elevation of a pneumatically operated device for maintaining pressure behind the boring head of Figures 15 to 17.

Figure 19 is a cross-section at 19—19 in Figure 16.

The present device is particularly designed for a sub-surface installation of smaller pipes such as surface pipes for water and gas, and a bore for the installation of such pipes is provided by pushing a boring head through the ground from one opening to another. As a boring head of my invention is pushed through the ground, it is arranged to displace the ground laterally of its tapered working portion to compress the earth about the bore provided; in this manner, no earth need be removed and the compacted bore walls frequently stay in that condition while a pipe is being moved through the bore. It is to be understood, therefore, that the expression "boring head" as herein used applies to a displacement head as well as to a drilling head.

As shown in Figures 1 and 2, the present apparatus is applied in installing a flexible pipe 21 of copper alloy or the like to extend between ground holes or openings 22 and 23. For providing a pipe-receiving bore 24, a boring head 25 is mounted at the end of a push rod 26 by which the head is pushed through the ground from the opening 23 to the opening 22. The rod 26 is preferably made in mutually detachable sections, and the width of the hole 23 in the direction of driving of the rod 26 need be but little greater than the length of a rod section; it will be understood that as the head and rod move through the ground for the length of each added section, another rod section may be added, the process being reversed when the rod is withdrawn. The necessary force for driving the head

through the ground is applied to the rod portion which extends in the hole 23, the application of such force being made through a push block 27 which is arranged for mounting on the free rod extremity in the hole 23 and may be readily shifted to a successive rod section.

The driving force against the block 27 may be variously supplied, as by a jack or a hammer. Particularly in harder ground which permits the driving of a boring head and its push-rod therethrough, the use of a jack or a sledge hammer to impel the assembly may not be entirely satisfactory, and I prefer to utilize a pneumatic hammer 28 for the purpose. As shown in Figure 1, the hammer 28 is of a type which is provided with a handle 29 at one side for its hand support to apply its reciprocable working head 30 against the block 27 for applying hammer blows to the rod in rapid succession, the hammer receiving compressed air for its actuation through a hose 31.

It will now be noted that for installing the flexible pipe 21, said pipe may be drawn into the completed bore 24 by attaching its end to the forward end of the rod 26 extending into the ground opening 22, by means of a suitable coupling 32, whereby the rod 26 now becomes a pull rod. Since the pipe 21 is to be drawn through the completed bore 24 as the rod 26 is withdrawn therethrough, the rod movement may usually be considerably faster than when the bore was being provided. I therefore prefer to use a mechanical jack 33 or some other device which may be operated to withdraw the rod at a faster rate than the pneumatic hammer could do it, the block assembly 27 being reversed on the rod.

Particularly in soil lacking in cohesive properties, I provide for the installation of the head 25 in reverse position between the pipe coupling 32 and the rod, the appropriate structural provision for this being hereinafter brought out. The rod 26 is preferably slightly smaller than the bore 24 provided by the head 25, and the use of the head 25 as a pilot for the pipe being introduced into the bore is designed to insure a ready movement of the forward pipe end through the bore by reason of the action of the head to restore and/or maintain the compacted condition of the bore wall ahead of the pipe. It is to be particularly noted that the present method of compacting the earth to provide a pipe-receiving bore insures against ground cavities along the pipe, since the compacted earth will subsequently expand to close the bore about the pipe and so not weaken the support of the ground above it, as may occur if the displaced earth has been removed as in providing a pipe-receiving bore by drilling.

In Figure 3 I have illustrated the installation of a straight and inflexible pipe 21' in a bore 24' provided between ground openings 22' and 23'. In this case, a diametrically larger head 25' is shown in use for installing the pipe 21' than was used in providing the bore 24', this device, in effect, providing the pipe-receiving bore in two stages rather than initially providing it at full required size, as might be difficult for larger pipes or in hard-packed soil, and being utilized with flexible pipes as well.

Referring now to Figures 4 to 10, it will be noted that the boring head 25 comprises a tapered nose portion 34, an intermediate portion 35 provided with a spiral external thread 37 and a rear portion 36; for reasons which will hereinafter be brought out, the head portions 34 and

35 and 36 are provided as separate elements for a unitary assembly.

The exterior spiral thread 37 of the section 35 preferably has a pitch which is uniform from its forward end to an intermediate point from which it progressively decreases toward its rear end, this section and the nose section 34 being arranged to rotate together as the head progresses through the earth. The section 35 is particularly shown as if formed by torsionally twisting a bar of triangular cross-section with its edges providing the three threads 37 having their sides making an angle of one hundred twenty degrees with each other, said edges being ground off in planes substantially tangent to the outline cylinder of the head.

As particularly shown, the nose section 34 has its point shaped somewhat as a star-drill, and at its rear end is provided with a threaded axial extension 38 for engagement in a complementarily threaded axial socket at the forward end of the section 35, a set screw 39 being operative in the section 35 against the mounted extension 38 of the nose section 34 for releasably locking said sections together. In this manner, nose piece sections 34 of various designs may be provided and utilized for work in different earth compositions and formations.

A swivel connection is provided between the head sections 35 and 36. As particularly illustrated, the element 36 is provided with an immediately stepped axial bore 41, having larger and smaller portions 42 and 43 extending from a shoulder 44. The bore portion 42 extends from the rear end of the section 36, and the bore portion 43 rotatably receives a swivel pin 45 therethrough to extend forwardly from the section 36. A forward end portion 46 of the swivel pin 45 is reduced and threaded for its limiting engagement as a stud bolt in a complementarily threaded socket provided in the opposed end of the section 35. A set screw 48 is preferably mounted in the section 35 to engage the pin portion 46 for fixing the swivel pin to the section. The rearward end portion of the pin 45 is externally threaded to mount a swivel head member 49 opposite the shoulder 44, whereby to secure the section 36 to the section 35 in swivelled relation. As shown, the member 49 comprises a nut, and is fixed in place on the pin after it has been installed.

Thrust bearings are provided between the forward end section 36 and the opposed end of the section 35; as shown, bearing rings 52 of any suitable composition and form are engaged about the pin 45 to provide an anti-friction bearing between the opposed ends of the connected sections. In the present structure, the rings 52 have the same external diameter as the adjacent cylindrical portion of the section 36, and are enclosed in a guard sleeve 53 which extends rearwardly and integrally from a centrally perforated disc 54 which is mounted between the rings 52 and the opposed end of the section 35. As shown, the disc 54 is locked between the rear and sides of the section 35 and the shoulder at the base of the threaded portion 46 of the swivel pin whereby the sleeve comprises part of the section 35.

It will be understood that the described swivel connection between the head sections 35 and 36 provides for a rotation of the sections 34 and 35 together as the head is pushed through the ground, such rotation being caused by the action of the threads 37 in the bore being provided.

When the head is pushed or pulled forwardly through the ground, as in Figure 1, the bearing rings 52 transmit the effort between the portions 35 and 36. If the head is to be backed out of the bore, the effort will be transmitted from the section 36 to the section 35 at the bearing provided between the shoulder 44 and the swivel pin head 49.

In the use of the head 25, it will generally be preferable that the head portion 36 and rod 26 do not rotate in the bore provided by the head. While friction may generally be depended on to prevent such a rotation, the portion 36 is preferably provided with a series of radial fins 55 extending axially of the portion for like distances therefrom. The fins 55, together with the relatively long and narrow head structure are of material aid in guiding and directing the boring head in a straight line in which it is originally started.

A member 56 is threadedly engaged in the outed end of the bore portion 42 in the section 36 beyond the member 59, and is provided with a threaded axial bore 57 having the same size and thread pitch as the nose-mounting sockets at the forward end of the section 35. It will now be noted that the rod sections are each provided with threaded studs at one end and complementary sockets at the other, and that said studs are arranged for threaded engagement in the bore 57 or engagement in the threaded socket in the forward end of the portion 35; in this manner the head may be secured to a push rod 26 in the relations shown in Figures 1 and 2 respectively, it being understood that the nose-section 34 would not be used in drawing a pipe through a previously provided bore therefor.

Referring to the spirally threaded head section 35, it will be noted that the forward portion of its thread will effect its threaded and rotative engagement in a bore being formed by the forward progress of the head, and that the rearward threaded portion of decreasing pitch will operate to wedgedly smooth the bore sides so that the bore is truly cylindrical behind said section. As the head advances in the bore, the fins 55, which have tapered front end portions wedgedly provide longitudinal grooves or flutes along the bore sides. It will thus be understood that the bore 24 is provided entirely by a compression of the displaced material laterally thereof, and that the bore will thereafter tend to contract about an installed pipe.

The push block 27 through which a longitudinal pushing or pulling force may be exerted on the rod 26, must be of such a structure that it grips an engaged rod section against its longitudinal movement therealong. By particular reference to Figures 11 and 12, it will be noted that the present member 27 essentially comprises a pair of V-blocks 61 and 62 having pipe-gripping faces 63 and 64 respectively which are provided with teeth 65 extending circumferentially of a rod which they are to engage. The blocks 61 and 62 are connected by a U-bolt 66 which engages across the outer face of the block 61 at a bearing socket provided therefor, and has its legs straddling the block 61 and engaged freely through lateral ears 67 of the block 62, the extremities of said legs being threaded to mount wing nuts 68 upon the ears 67.

For installing the assembly 27, the blocks 61 and 62 are placed against opposite sides of the rod portion with the plane of the U-bolt 66 substantially perpendicular to the rod axis, and the

nuts 68 are applied and screwed up on the bolt legs until moderately tight. If, now, either block is urged axially of the rod, a movement thereof relative to the other block will tend to swing the U-bolt 66 away from a perpendicular relation to the rod and so force the teeth 65 of both blocks into the rod by shortening the effective distance between the blocks. The aforesaid action is illustrated in Figure 11 by a dotted line showing of the block 61 and the U-bolt in original positions before the force is applied to an end 69 of the block 61. The block end 69 comprises a flat working face against which impact and/or pressure are to be applied for locking the assembly 27 to the rod and thereafter effecting its longitudinal movement.

The teeth 65 for the block 61 comprise continuous ridges extending across the angularly related working faces of the block, and are preferably provided by a removable facing member 71 which fits within the block V groove. The teeth of the member 71 slope forwardly with respect to the locking and driving movement for the block 61, and a stop ridge 72 is provided at the rear end of the block groove for engaging the rear end of the member, the member being removable and replaceable. The teeth 65 for the block 62 are provided on the inner face of a facing member 73 which is welded or otherwise secured in the V groove of its block. The facing members 71 and 73 may be conveniently shaped of pieces of highly tempered files to insure a greater hardness for their teeth 65 than that of the rod or pipe to be gripped, this type of facing member being particularly illustrated.

For loosening the push block unit 27 on the rod 26, it is merely necessary to move the block 61 back on the block 62 to dispose the U-bolt 66 more nearly perpendicular to the rod axis. When the block is loosened it may be slid along the pipe, or the wing nuts 68 may be removed if complete disassembly is desired. When, as at present, the rod 26 is formed without enlargements at the section joints, the loosened block may be slid along from section to section as the rod is increased or decreased in length.

Recalling the general softness of copper and lead alloy tubes or pipes which are frequently installed in the ground in lieu of iron pipes because of their resistance to corrosion and very much longer life, means are provided for gripping an end of such tubing for longitudinally pulling it through an only slightly larger bore in the earth. The flexible pipe 21 of Figures 1 and 2 is shown as provided on a spool 75 from which it may be unrolled as it is pulled through a bore 24. In general terms, the coupling 32 comprises a device which is expended within the leading pipe end portion to taper and back the same within and behind a ring or sleeve 76 in an arrangement in which the expanding device is attached to the rod 26 for pulling the pipe.

As particularly brought out in Figure 14, an initially one-piece cylindrical block of uniform cross-section is provided with a stepped axial bore having its smaller bore portion tapered from its inner end and provided with threads with a uniform pitch, the larger and unthreaded bore portion 78 being of uniform cross-section and having a greater diameter than the thread base diameter of the bore portion 78. The original diameter of the block is slightly less than the normal bore diameter for the pipe 26, and the sides of the block may be provided with facing members 79 of brass or other moderately soft

material. At the end thereof from which the bore portion 78 extends, a relatively short block portion is externally threaded for engagement in a complementarily threaded counterbore provided at one end of a ring member 80 which has an external diameter approximating that of the pipe and is slidable in the sleeve 76. The block formed as described is longitudinally split to provide complementary section 81, and said block may be unitarily referred to as an expansion block 81—81.

With the block sections 81 held together in mutual opposition, they are arranged to be threadedly engaged in the counterbore of the ring 80 and inserted in the pipe end with the threaded end of the ring 80 close to or adjacent the pipe extremity. With the expansion block 81—81 installed as described, the point of a lag bolt 82 is inserted through the ring 80 and bore portion 78 for engaging the threaded bore portion 77 and having the same thread form and pitch as provided in the latter bore portion is screwed into said portion. The effect of screwing the lag bolt 82 into the expansion block 81—81 is to angularly separate the sections 81 about their mutual anchorage in the ring 80 to stretch the pipe within and beyond the sleeve 76 which has been mounted on the pipe end to extend for substantially half of the length of the block 81—81. In this manner, the screwing-in of the bolt 82 may spread the pipe behind the sleeve 76 as may be required to firmly and wedgedly grip the pipe between the block sections 81 and the sleeve 76, particularly at the rear end of the latter.

A bearing ring 83 encircles the shank of the bolt 82 between its head 82' and inturned flange 84' of a coupling sleeve 84 which freely receives the bolt head 82' for its turning therein as by a socket wrench (not shown), the other end of the sleeve 84 being arranged to threadedly receive a connector block 85 which has a threaded extension 85' for connection with the rear nozzle member 36 as shown in Figure 2, or for use in direct connection with the rod 26. The arrangement is understood to provide for the required gripping of a pipe 21 in a positive manner and by a means which is no larger than the bore into which the pipe is arranged to be drawn. A further feature is the swivel connection provided between the bolt head 82' and the flange 84' of the coupling sleeve 84, except when a bolt is screwed into a limiting degree to positively clamp the bearing ring 83 between the head and flange.

In the embodiment of the invention shown in Figures 15-19, a boring head 86 is provided for driving through the ground, as between holes 87 and 88, by means of a pneumatic hammer 89 mounted within it. The hammer 89 has its body 91 slidably and rotatably engaged within a complementary bore 92 provided in the head 86. The head 86 has a tapered nose portion and is provided on its exterior with spiral threads 93 which have a uniform pitch at the forward portion of the head and a progressively decreasing pitch for the balance of their length. The action of the threads 93 as the head 86 is pushed forwardly to provide a bore is similar to that of the head 25 of the previously described embodiment. At its closed forward end, the cavity 92 of the boring head is more or less reduced and provides a seat for impact discs 94 of fiber, leather, or the like against which the working head 95 of the hammer 89 is arranged to strike.

The pneumatic hammer 89 is of a usual type of

structure and includes a piston 96 repetitively operative within a cylinder 97 under the influence of compressed air to strike a rod 98 which carries the head 95 and is freely slidable and rotatable in an axial guide bore provided at the head end of the cylinder 97. It will be understood that the position of the piston controls the valves of the hammer through which the operating air is supplied to the cylinder. The maximum working stroke for the hammer head would be as required for driving the boring head, and the hammer is fixed to the forward end of a pipe 99, which pipe is arranged to supply the operating air to the hammer and also function as a push or pull rod therefor.

The pipe 99 is connected to the hammer 89 at a reduced and tubular rear extension 101 of its body 91 which has a radial flange 102 at said extremity. A screw 103 or the like is mounted at a rear point of the rotary boring head 86 and extends into the space between the body 91 and the flange 102 as a stop means to provide for a withdrawing of the boring head with the hammer, while permitting the operation of the hammer within the boring head to drive the same. It will be understood that the necessary swivel connection between the rotary boring head 86 and the push pipe 99 is provided by the rotative engagement of the impact rod 98 of the hammer 89 in the forward cylinder end.

Means are provided for constantly urging a forward movement of the hammer and boring head, said means being pneumatic. As particularly illustrated in Figures 15 and 18, the rear end of the pipe 98 threadedly mounts a thrust block 104 which is provided with a seat socket 105 in the axial line of the pipe and a duct 106 for connecting the pipe passage with a hose 107 suitably connected to the block at a coupling 108.

A pneumatic jack 109 is mounted in the hole 87 with its piston rod 110 extended in the axial line of the pipe 99 and seated in the socket 105 of the block 104, the rear end of the jack being seated against the opposite side of the hole 87 or otherwise held. Compressed air is supplied to the rear end of the jack cylinder 111 behind the piston 112 through a pipe 113 having a relief valve 114 for manual opening interposed therein. The hose 107 and the pipe 113 are arranged to receive compressed air for operating the hammer and jack respectively through a normally closed air distributing valve 115 which receives air through a hose 116 which is connected with a suitable source (not shown) of compressed air.

As shown, the distributing valve 115 is conveniently mounted on the jack 109 and is provided with a handle extension 117 at the free end of which the hose 116 is connected. A valve control lever 118 extends opposite the handle 117 whereby an operator gripping the handle may rock the lever to open the valve and simultaneously effect the operation of the hammer and jack, under the same air pressure. When a full working stroke of the jack piston 112 has been completed, the relief valve 114 is opened to permit a return of the piston 112 and its rod 110 to their starting positions, and a new section is inserted in the pipe 99 at the thrust block. The closing of the valve 114 and the opening of the valve 115 then permits the driving of the boring head 86 for the length of the inserted pipe section.

While it will not generally be necessary to withdraw the head 86 through the bore provided by it, this may be accomplished by hand or by reversing the pneumatic jack 109 to act against the installed

pipe 99; in the latter case the push block assembly 27 might be utilized on the pipe in using the pneumatic jack 109 or a mechanical jack 33 to withdraw the pipe and the boring head assembly.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the construction and operation of the present device will be readily understood by those skilled in the art to which this invention appertains. While I have described the features and principles of operation of apparatus which I now consider to comprise preferred embodiments of my invention, I desire to have it understood that the showing is primarily illustrative, and that such changes may be made, when desired, as fall within the scope of the following claim. 15

What I claim is:

A ground-piercing apparatus comprising a boring head for axial propulsion through the earth to provide a bore by earth displacement laterally thereof, and a helical thread on said head having a forward portion of uniform pitch and a rearward portion of progressively changing pitch whereby said forward thread portion is threadedly engageable with the engaged earth to effect a rotation of said head and the rear portion is progressively operative to smooth the bore thereat by reason of the propulsion of the head through the earth.

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