United States Patent

[11] **3,554,303**

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[21] Appl. No. **749,641**
[22] Filed **Aug. 2, 1968**
[45] Patented **Jan. 12, 1971**

[54] **EARTH PIERCING APPARATUS AND METHOD**
7 Claims, 10 Drawing Figs.

[52] **U.S. Cl.** **175/62,** 175/19, 175/390
[51] **Int. Cl.** **E01g 3/03,** E21c 23/00; E21b 9/22
[50] **Field of Search** ..... 175/62, 53, 19—21, 390, 414, 401; 287/125, 2, 62

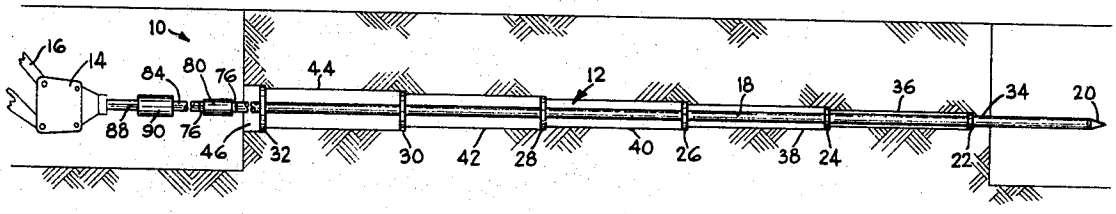
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Primary Examiner—David H. Brown
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ABSTRACT: An earth-piercing apparatus and method wherein an impactor driven nonrotary implement is provided, the implement comprising a series of rigid selectively coupled elongated sections. Cutting collars of successively larger in size are provided between adjacent sections so that the implement, when driven through the ground by the impactor, displaces successively larger volumes of earth to form a finished bore.



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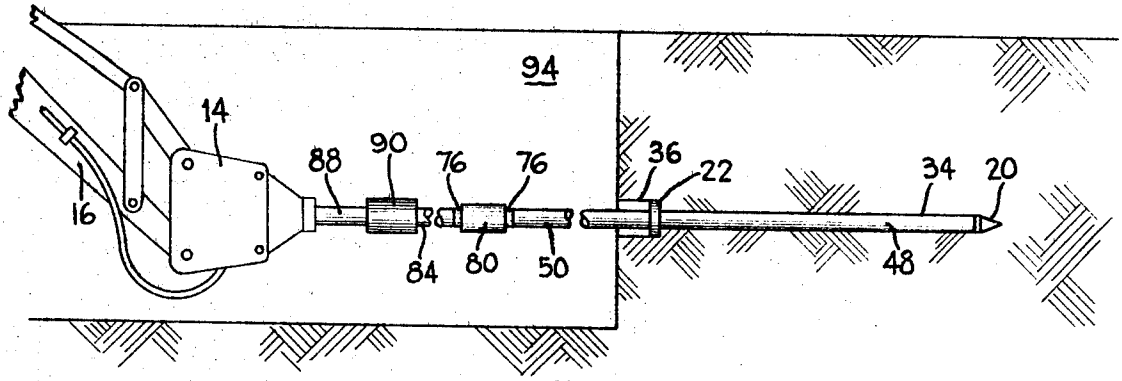


FIG. 1

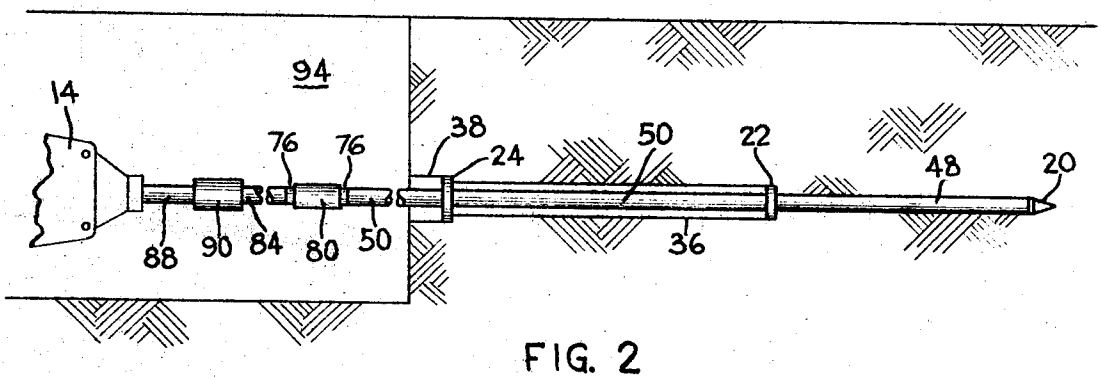


FIG. 2

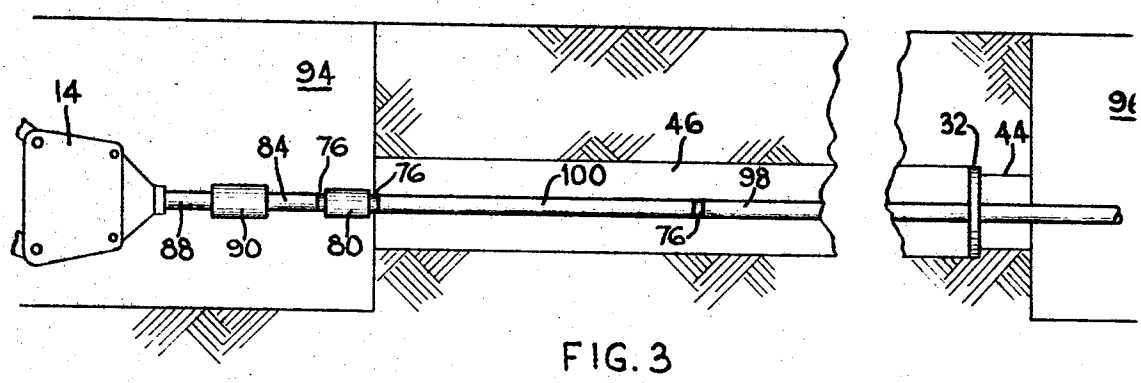


FIG. 3

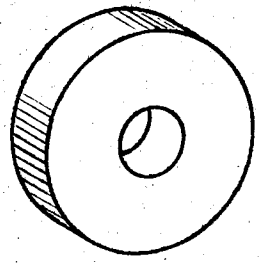


FIG. 4



FIG. 5

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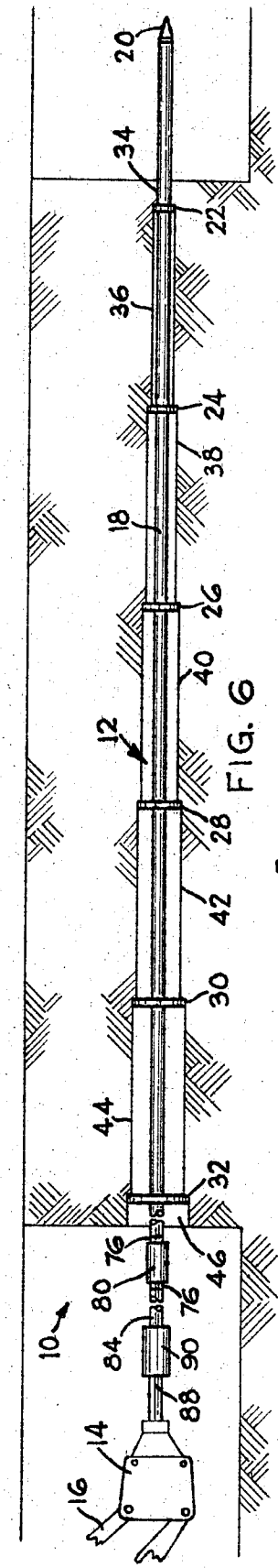


FIG. 6

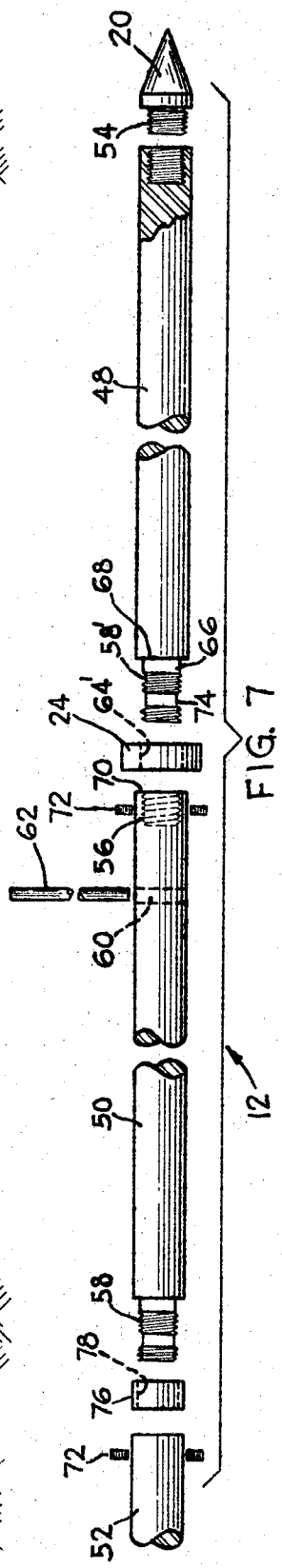


FIG. 7

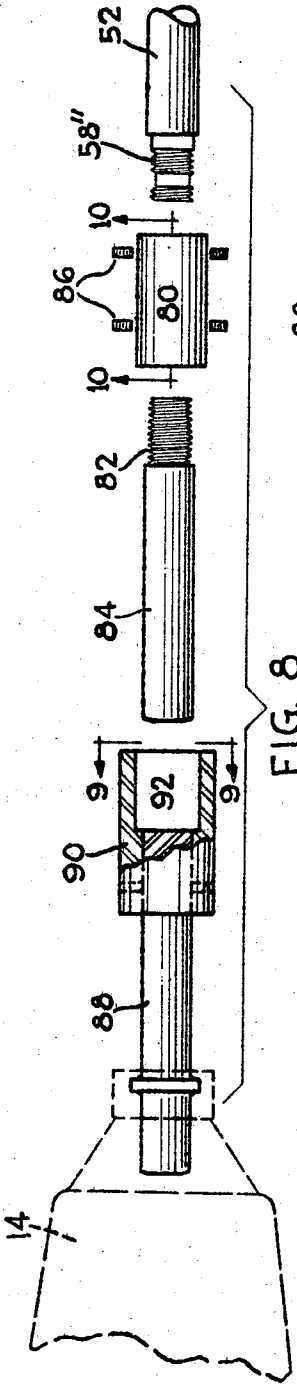


FIG. 8

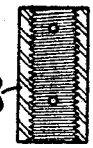


FIG. 10



FIG. 9

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EARTH PIERCING APPARATUS AND METHOD

This invention relates to an earth-piercing apparatus and method, and more particularly, to an earth-piercing apparatus and method wherein a nonrotary implement is driven through the ground to provide a bore suitable for receiving pipe, conduit, electrical cable or the like.

When laying pipe, conduit, cable or the like, it is frequently necessary to excavate under or adjacent to existing appurtenances or structures. Thus, it is frequently necessary to remove or otherwise interfere with existing roadways, driveways or sidewalks by digging open trenches. Such trenches present a serious inconvenience and hazard to passers-by, and also endanger the subjacent support of nearby structures.

It has heretofore been suggested that earth-piercing beneath existing structures be accomplished by boring therebelow. For example, in U.S. Pat. No. 2,693,345 to Martin et al., issued Nov. 2, 1954 an earth boring apparatus is disclosed wherein rotary boring tools are employed to loosen the earth. A swab member can then be passed along the course of the loosened earth, to remove the loose material. A shortcoming of rotary boring apparatus is the tendency of a rotary tool to wander from the desired direction. Thus, it is difficult with rotary apparatus to achieve cutting along a precise, predetermined path. When operating near existing underground sewage or utility lines, precise directional control is most desirable.

Nonrotary piercing apparatus have heretofore been proposed. Examples of such apparatus are seen in the U.S. Pats. to Doyle, 2,788,234, issued Apr. 9, 1957, and to Bingham, U.S. Pat. No. 3,347,521, issued Oct. 17, 1967. In each of these patents, a piercing tool is driven linearly through the earth to provide a resultant bore of a size corresponding to the diameter of the tool.

The present apparatus and method provide, by means of a nonrotary piercing implement, bores of selected sizes within a range determined by the mechanical strength of the implement components and the power available to drive the implement. Moreover, the present apparatus and method provide a virtually finished bore in a single pass of a piercing implement.

In view of the foregoing, it is a principal object of this invention to provide a novel earth-piercing apparatus and method.

It is another object of this invention to provide a nonrotary earth-piercing apparatus capable of providing bores of various selectable sizes.

It is still another object of this invention to provide an apparatus and method wherein a finished bore is made in a single piercing operation.

It is a further object of this invention to provide a novel earth-piercing implement which is easily assembled and disassembled.

Other objects will appear hereinafter.

The foregoing and other objects of this invention are accomplished by apparatus comprising a series of rigid, interconnected, selectively coupled sections joined in end-to-end relation to form a "string." Collars of successively larger diameters are provided from the front to the rear of the string. Such collars are preferably at joints between the sections, so that each collar cuts a relatively small section of earth defined by the difference between its outer diameter and the bore cut by the preceding collar.

In its method aspect, the present invention comprises steps of driving a first piercing member into the earth, coupling a collar adjacent the rear portion of the first piercing member, coupling an end of a rigid elongated member to the first piercing member, driving an elongated member into the earth, coupling a second collar having an outer diameter greater than the first collar adjacent an end of the elongated member, coupling another elongated member in end-to-end relation with the first elongated member, and driving the second elongated member into the ground.

For the purpose of illustrating the invention there is shown in the drawing a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a side elevation view showing, in cross section, a portion of the apparatus of the present invention performing a step of the present earth-piercing method;

FIG. 2 is a side elevation view, in cross section, showing the present apparatus and method at a more advanced stage of the piercing operation;

FIG. 3 is a side elevation view, in cross section, showing the present apparatus and method at a still more advanced stage of the piercing operation;

FIG. 4 is a perspective view of a collar forming a part of the present invention;

FIG. 5 is a perspective view showing a portion of the present invention; FIG. 6 is a side elevation view, in cross section, illustrating one mode of operation of the present apparatus and method;

FIG. 7 is an exploded side elevation view, partially broken away, showing details of the present invention;

FIG. 8 is an exploded side elevation view, partially broken away, showing further details of the present apparatus;

FIG. 9 is an end elevation view taken along the line 9–9 of FIG. 8; and

FIG. 10 is a cross-sectional view taken along the line 10–10 in FIG. 8.

Referring now to the drawings in detail, wherein like elements are indicated by like numerals, there is seen in FIG. 6 an earth-piercing apparatus designated generally by the reference numeral 10. The apparatus 10 comprises an implement, designated generally by the reference numeral 12, and a means 14 for driving the implement. The means 14 may take the form of the fluid-actuated impactor known as the "Hughes Impactor," manufactured and sold by the Hughes Tool Company of Houston, Texas. The means 14 for driving the implement 12 may be mounted on the backhoe attachment 16 on a tractor, if desired. The means 14 for driving the implement 12, per se, forms no part of the present invention.

In FIG. 6, the implement 12 is shown performing an earth-piercing operation. It is seen that the implement 12 comprises a rigid elongated member 18. The member 18 includes a tapered tip 20 for penetrating the earth. Successively larger collars 22 to 32, concentric with elongated member 18, are coupled to the member 18 at spaced intervals. As is evident from FIG. 6, the smallest of the collars, namely collar 22, is disposed closest to the tip 20,

The manner in which the apparatus 10 creates a finished bore without disturbing the surface of the ground through which the bore passes is readily apparent from FIG. 6. Thus, the section of the elongated member 18 adjacent to the tip 20 creates an initial bore 34. The diameter of the initial bore 34 is determined by the diameter of the elongated member 18. The collar 22, with its outer diameter greater than the outer diameter of the elongated member 18, cuts a first intermediate bore 36. The collars 26, 28 and 30 cut further intermediate bores 38, 40 and 42, respectively. The collar 32 cuts a final bore 46.

Each of the successively larger collars 22 to 32 enlarges the previously formed bore. Each collar cuts only the volume of earth representing the increment in size between its diameter and the diameter of the collar next preceding it. Thus, cutting forces on each collar 22 to 32 and on the entire implement 12 are minimized. In one operative embodiment of the apparatus, a one inch increment in diameter for successive collars has been found adequate. Each collar clears before it all loose matter from the previous cutting. When the piercing operation is completed, only a minimum of loose material remains in the final bore 46.

Referring now to FIGS. 7 and 8, there is seen a preferred form of the implement 12. The previously described rigid elongated member 18 is fabricated of a plurality of individual sections, disposed in end-to-end relation. Thus, in FIGS. 7 and 8, there are seen sections 48, 50 and 52. Sections 48, 50 and 52 may be fabricated from steel rod. The tip 20 may take a form of a hardened insert, coupled to section 48 by a threaded connection 54.

Sections 48, 50 and 52 may also be joined by threaded connections. Considering section 50 as typical, an axially aligned threaded receptacle 56 is provided at one end of the section. The other end of the section 50 is provided with an axially extending threaded projection 58. The threads of the projection 58 are complemental to the threads of the receptacle 56. Also, the threads on each of the sections are preferably identical, thus providing interchangeability of sections. Thus the section 48 is provided with a projection 58, adapted to be threadedly received in the receptacle 56. In a preferred form, the threaded projections 58, 58' are of an outer diameter less than the diameter of the sections, and the receptacle 56 is also of reduced diameter.

In order to facilitate coupling of the various sections 48, 50 and 52, means may be provided for rotating the sections. In FIG. 7, there is seen a transverse bore 60 in the section 50. A rod 62 may be inserted in the transverse bore 60 to rotate section 50 with respect to section 48. Such rotation is effective to thread the projection 58' into the receptacle 56.

The connections between adjacent sections provide a convenient means for coupling the collars 22 to 32 to the rigid elongated member 18. Referring to FIG. 4, wherein the collar 28 is illustrated as an example, it is seen that the collar includes a concentrically placed bore 64. Referring again to FIG. 7, the therein illustrated collar 22 includes a similar bore 64', shown in dotted lines. The axially extending projection 58' is provided with a threadless land portion 66. The diameter of the land portion 66 is equal to or slightly greater than the outer diameter of the threads on the projection 58'. Also, the diameter of the land portion 66 is less than the diameter of the bores 64, 64', etc. in the collars. Thus, the collar 22 may be received and retained on the land portion 66 as the threaded projection 58' is threaded into the receptacle 56.

In the illustrated embodiment, movement of the collar 24 axially with respect to the rigid elongated member 18 is precluded by abutment shoulders 68 and 70, located respectively on the sections 48 and 50. The abutment shoulder 68 is defined by the step down in diameter to the land portion 66. The illustrated embodiment abutment shoulder 70 is simply the end face of the section 50.

It is also desirable to provide positive means to prevent inadvertent disconnection of the sections 48, 50 and 52. For this purpose, one or more set screws 72 may be provided in association with the receptacle 56. The threaded projection 58' may be provided with a threadless relief portion 74 for contact by the set screws 72. In this manner, damage to the threads by the set screws is precluded.

When it is desired to couple sections of the rigid elongated member 18 without placing a collar therebetween, the sections may simply be joined in the above-described manner with a cylindrical spacer 76, as seen in FIG. 5, may be substituted for the collar. In FIG 7, a spacer 76 is seen disposed between sections 52 and 54. The spacer 76 has an internal bore 78, and may be associated with the threaded projection 58 in precisely the same manner as a cutting collar.

Referring now to FIGS. 8 and 10, the manner in which the implement 12 may be coupled to a drive means 14 is seen. The axially extending threaded portion of the section 52, denoted for convenience as 58'', is adapted to be received in an internally threaded coupling sleeve 80. Also, adapted to be received in the coupling sleeve 80 is the threaded end 82 of a drive stud 84. Set screws 86 in the coupling sleeve 80 secure the connections the sleeve 80, section 52 and drive stud 84.

A drive shaft 88 may be coupled to the drive means 14 in any known manner. coupled to an end of the drive shaft 88 is a drive socket 90. With reference to FIG. 9, the drive shaft 90 includes a receptacle 92 adapted to receive an end of drive stud 84. The transverse section of receptacle 92 is somewhat larger than the diameter of the drive stud 84. Hence, the receptacle 92 normally transmits little or no rotary motion to the drive stud 84. Also, because of the loose connection between the receptacle 92 and drive stud 84, only forces tending to advance the implement 12 are transmitted to the drive stud 84. Successive driving impulses produced by the drive means 14 and the thrust provided by the backhoe attachment 16 thus tend to drive the implement 12 through the ground. The sides of the receptacle 92 maintain proper alignment between the drive means 14 and the implement 12.

FIGS. 1 to 3 and 6 serve to illustrate the present novel earth piercing method.

Referring first to FIG. 1, the drive means 14 is shown in position in an operating trench 94. The operating trench 94 may need only be large enough to receive the backhoe attachment 16 and the drive means 14 supported thereby. The depth of the trench 94 must be sufficient to permit alignment of the drive means 14 with the intended bore.

In FIG. 1, the step of a making an initial bore 34 is being performed. In the illustrated embodiment, such step is accomplished by the driving section 48, to which the tip 20 is secured, into the earth. Section 48 may be about three feet in length. When about one foot of section 48 remains out of the earth, the backhoe 16 and drive means 14 may be backed off, and the collar 22 inserted on the rear end of section 48. A further section 50 may then be coupled to the section 48 and driven in the same manner as the section 48 until about one foot remains exposed. In FIG. 1, the step of making the intermediate bore 36 of greater diameter than the initial bore 34 has been initiated. In the illustrated embodiment this is accomplished by coupling the collar 22 to the section 48 and continuing to drive the implement 12 through the earth.

FIG. 2 illustrates the step of cutting an additional intermediate bore 38. This is accomplished by collar 24 which is coupled adjacent the rear portion of the section 50. Steps similar to those described above may be performed until the entire implement 12, comprising the rigid elongated member 18 defined by various sections 50, 52, etc., and successively larger collars 22 to 32, passes through the earth to be pierced.

FIG. 6 illustrates a stage of the piercing operation wherein all of the collars are in the earth.

When the collar corresponding in diameter to the finished bore has been to the elongated member 18, driving of the implement 12 is continued by simply adding sections to the elongated member 18. Thus, in FIG. 3, the final bore 46 has been cut by the collar 32. The collar 32 remains in the earth, but the remainder of the collars have emerged from the bore into a clearance trench 96. Additional sections 98, 100 serve as spacers between the drive means 14 and the collar 32 of the final diameter. The previously described spacer 76 may be placed between the additional sections 98 and 100.

Although FIG. 6 discloses the present process being performed with each of the collars 22 to 32 in the earth simultaneously, it is within the scope of the present invention to space the individual collars so that only one or more collars are so placed. The resistance on the implement 12 can thus be controlled. It is within the scope of the present invention to provide one or more additional sections, similar to the additional sections 98 and 100, between cutting collars. Thus, the resistance on the implement 12 can be tailored to the thrust available from the backhoe attachment 16 and drive means 14. The resistance on the implement 12 is determined in large measure by the soil condition and the size and number of cutting collars used. One embodiment of the invention employs a first collar 22, 3inches in diameter, and other successive collars 1inch larger in diameter than their preceding collars.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. A method of making a generally horizontally disposed bore in the ground between spaced trenches comprising the steps of driving a rigid elongated member partly into the earth to form an initial bore, leaving an exposed end of the member protruding out the earth, coupling a cutting collar having an

outer transverse dimension greater than the member on the exposed end of the member, coupling a further rigid elongated member in end-to-end relation with the first-mentioned member, driving the further member into the earth to cut a bore having a diameter corresponding to the transverse dimension of said cutting collar, leaving an exposed end of the further member protruding from the earth, and repeating the steps of coupling a cutting collar, coupling a further elongated member, and driving the further elongated member into the earth repetitively until a bore of desired diameter is achieved, then coupling an additional elongated member to the further elongated member, and driving the additional elongated member into the ground, so that the length of the bore is increased without increasing the diameter thereof, the last-coupled cutting collar serving to form a finished bore.

2. A method in accordance with claim 1, wherein the driving steps are performed by pushing the elongated members and applying an intermittent impact thereto.

3. In earth-piercing apparatus comprising an earth-piercing implement and means for driving the implement through the earth to form a generally horizontally disposed bore, said implement comprising a rigid elongated member having a tip thereon for penetrating the earth and comprising a plurality of sections coupled in end-to-end relation, spaced concentric cutting collar members of successively increasing diameter and having peripheral cutting edges thereon coupled to said elongated member between adjacent sections of said elongated member, the smallest of said cutting members being disposed closest to said tip, whereby said cutting collar members cut successively larger bores as said implement is driven through the earth, the last of said cutting collar members providing a finished bore having a diameter corresponding to the diameter of said last cutting collar member.

4. In earth-piercing apparatus in accordance with claim 3, couplings between adjacent sections comprising a threaded receptacle on one of said adjacent sections and concentric therewith, and a projection on the other of said adjacent sections and concentric therewith, said projection including a threaded portion adapted to be received in said receptacle, and a land portion having an outer diameter less than the outer diameter of said sections, and said cutting collar members having internal bores therein complemental in size with said land portion, whereby said cutting collar members may be clamped between said adjacent sections.

5. In earth-piercing apparatus in accordance with claim 4, means on said sections to facilitate rotation of said sections for engaging said projection and said receptacle.

6. In earth-piercing apparatus in accordance with claim 4, a relief portion on said threaded portion of said projection, and lock means associated with said receptacle and adapted to contact said relief portion for locking said projection and said receptacle in interengaged relation.

7. In earth-piercing apparatus in accordance with claim 4, a spacer member having an internal bore therein, said bore having a diameter complemental to the diameter of said land portion, and said spacer having an outer dimension corresponding to the outer dimension of said sections whereby said spacer and said sections form an elongated member having a continuous outer dimension.