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EARTH BORING APPARATUS

Original Filed July 22, 1930

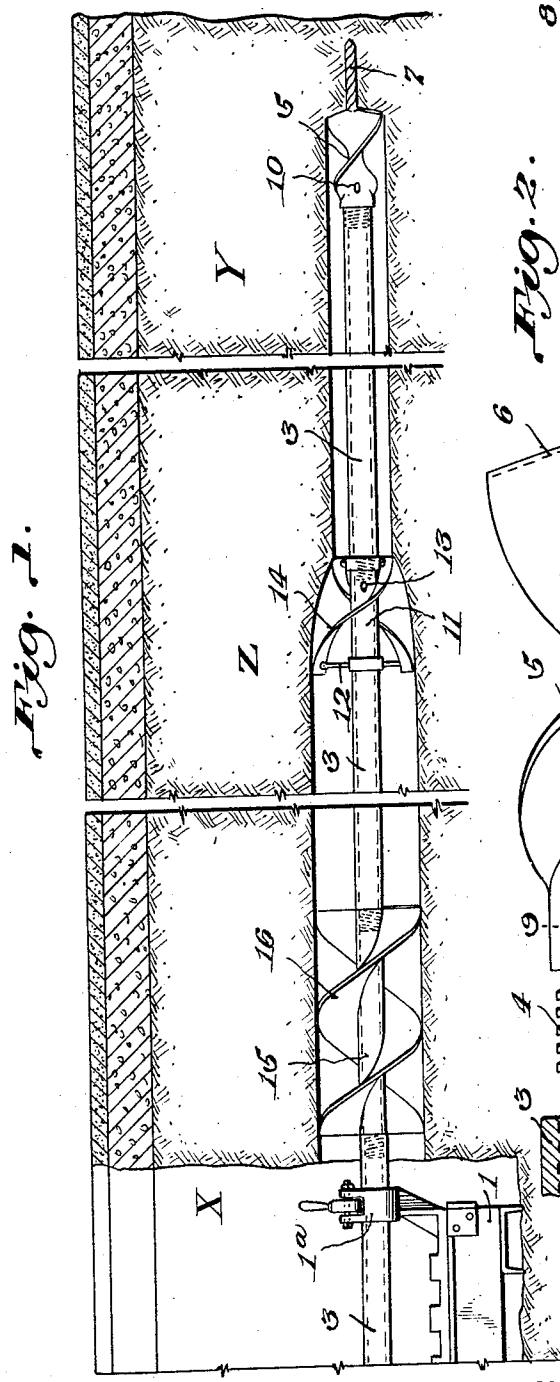

Fig. 1.

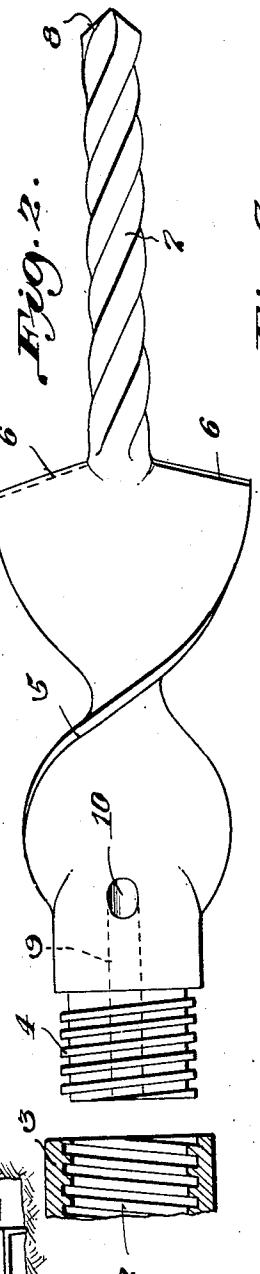

Fig. 2.

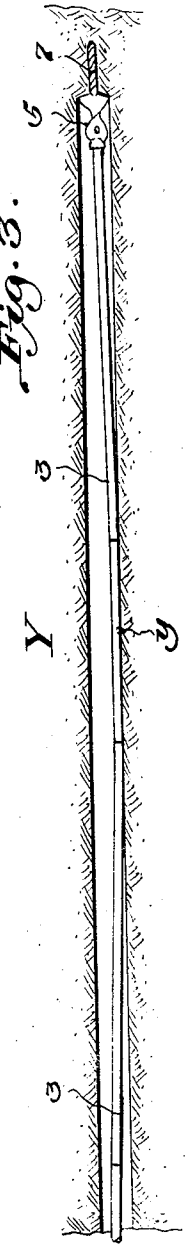

Fig. 3.

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EARTH BORING APPARATUS

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7 Claims. (Cl. 255—73)

This invention relates to earth boring apparatus, and more particularly to boring apparatus of the horizontal type.

The present application is a division of our prior application Serial No. 469,906, filed July 22, 1930, in which is disclosed a boring bar, formed of sections, an auger, a reamer, a conveyer, mechanism for feeding forward and rotating the boring devices, and power operated means for connecting and disconnecting the boring bar sections. The claims of said prior application are, however, limited to the feeding and rotating mechanism, and associated parts.

The present application is directed specifically to the improved construction and arrangement of the boring devices themselves, namely, the auger, reamer and conveyer and their relation to the boring bar and to each other.

One object of the invention is to provide apparatus of the character described in which the boring bar is formed in sections having screw threaded joints which are interchangeable with similar joints formed at the ends of reamer and conveyer sections, so that all of such sections may be assembled in any desired relation, and a reamer or conveyer section inserted at any desired point in the boring bar.

In apparatus of the type set forth, as heretofore constructed, difficulty has been experienced in holding the auger to a straight course and in preventing it from drifting downwardly, due to its own weight. A further and important object of the present invention is, therefore, to devise means for preventing such downward drift and for maintaining the auger on a level course. This, we accomplish, by suitably proportioning the relative dimensions of the boring bar and auger as hereinafter described.

With the above and other objects in view, the invention consists in the construction, arrangement and combination of parts as hereinafter described and claimed and illustrated in the accompanying drawing, forming part of this specification, in which drawing:

Figure 1 is a side elevation of the front portion of our improved apparatus as it appears when in use, and showing the auger, reamer and a conveyer section.

Figure 2 is a side elevation on an enlarged scale, showing the improved form of auger which we preferably employ; and

Figure 3 is a diagrammatic view illustrating our improved method of maintaining the auger on a straight or level course.

Referring to the drawing in detail, the feeding and driving mechanism, (not shown in the present case, but illustrated in our said prior application) is mounted on a track or runway 1, having at its forward end a guide 1^a, through which passes the boring bar 3. This boring bar is formed of sections of convenient length, as shown, each section having at one end internal threads, as illustrated at 2 in Fig. 2, and having at the other end a reduced portion formed with corresponding external threads, such as indicated at 4 in Fig. 2. The end of the power shaft (disclosed in said prior application) is formed with external threads, similar to those shown at 4, and adapted to fit into the internal threads at one end of a boring bar section.

The boring bar sections 3 are made hollow or tubular, as shown, and we contemplate feeding water under pressure to the interior thereof, as described in our said prior application.

Referring more particularly to Figure 2, the improved type of auger which we preferably employ will now be described. This auger is provided at its rear end with a shank or stud having an external thread 4 similar in all respects to the external thread formed at one end of the boring bar sections, so that the auger may be screwed into the internal threads 2 at the end of a boring bar section.

The auger itself comprises a main body 5 of the double helicoidal type, and, while shown in Figure 2 as comprising only half a turn, may, of course, consist of one or more complete turns, if desired. This auger body has at its forward end a pair of symmetrically disposed radial cutting edges 6, inclined rearwardly and outwardly from the axis.

Extending centrally and forwardly from the cutting edges 6 of the auger is a pilot 7. This is preferably similar in construction to the well known twist drill employed for boring metals, and has at its forward end a conical point 8. We have found that an angle of 45° serves best for this point. This type of drill or pilot is very effective in holding the auger to its course and is not easily deflected by encountering stones or other obstructions.

The shank of the auger is provided with a longitudinal bore 9 terminating at each side of the auger in discharge ports 10, through which water is delivered. It will be particularly noted that this water is delivered to the auger at a point adjacent the rear end thereof while the entire pilot remains dry. By maintaining the pilot dry, we find that it holds better to its course and by our improved arrangement, we are enabled

to secure the advantages of a dry pilot while at the same time utilizing water to carry away the cuttings from the rear end of the auger.

From the foregoing, it will be understood that in operation, the auger is rotated while water is supplied to it through the hollow boring bar and ports 10, and at the same time, the driving mechanism is advanced along the track 1.

The means for thus advancing the driving mechanism along the track may comprise the manually operated pawl and ratchet mechanism illustrated and described in said prior application. This advancing mechanism exerts a strong thrust against the boring bar, and serves to push the auger against the formation being bored.

In prior attempts which have been made to drill relatively long holes or tunnels through earth by means of a horizontal auger, difficulty has been experienced in keeping the auger on a level course, due to its tendency to sink or drift downwardly, owing to its own weight. We have made the important discovery that this tendency to drift downwardly can be overcome by so proportioning the dimensions of the auger, pilot and boring bar, that the sagging of the boring bar in the hole serves to direct the pilot upward to an extent sufficient to counteract the "dipping" of the auger. This is illustrated in Figure 3, in which it will be seen that the boring bar 3 is relatively small compared with the diameter of the auger 5. This results in providing a clearance around the boring bar, which permits it to sag until it rests upon the bottom of the hole, the bar, of course, being capable of bending slightly. In the drawing, X designates the material being bored through, Y the bore or hole, and *y* (Fig. 3) illustrates the point at which the boring bar engages the lower side or bottom of the hole. It will be understood that after the bar has thus engaged the bottom of the hole, it can sag or bend no further, and that from this point onward, the inclination of the forward portion of the bar, and consequently of the auger and pilot, remains constant. This bending or sagging of the bar is a result both of its weight and of the thrust exerted against it. The thrust tends to make the bar buckle or bend, and gravity causes this bending to be downward, rather than upward, or laterally.

It is difficult, if not impossible, to give accurate and definite figures regarding the relative dimensions of the auger and boring bar necessary to produce the result referred to, because these will necessarily vary to some extent with the nature of the material being bored through, but we may give examples of figures which have been successfully used by us in actual practice.

In one of the smaller sizes of machines, constructed in accordance with the present invention, the standard boring bar has a diameter of 1 and 1⅛ inches and with this size boring bar, we find that an auger having a diameter of 2¾ inches gives a satisfactory result. In fact, under different conditions, the diameter of the auger may vary from 2 and ¼ to 3¼ inches. In this case, we prefer to employ a cylindrical pilot of from ½ to 1 inch in diameter, preferably ¾ of an inch, and of a length varying from 2 and ¼ to 5 inches, preferably 4 inches. A little consideration will show that the above figures mean that the boring bar must have a diameter of from one-half to two-thirds of tnat of the auger, while the pilot should have a diameter of from one-fourth to one-third of that of the auger, and a length equal to from one to two times the diameter of the auger.

Again, in a larger machine, the standard size of boring bar is 2 and ¾ inches. With this boring bar, we can use an auger of from 4 to 5 and ¼ inches in diameter, (preferably 4 and ½ inches) and a pilot having a diameter of from 1 to 1½ inches (preferably 1 and ¼ inches) and a length of from 4 to 7 inches (preferably 5 inches).

Here, again, when reduced to comparative figures, it will be seen that the boring bar, as in the first case, has a diameter of from one-half to two-thirds that of the auger while the pilot has a diameter of from one-fourth to one-third that of the auger and a length equal to from one to two times the diameter of the auger.

We believe that the above formulæ express the relation as accurately and definitely as it is possible to express it in view of varying conditions met with in actual practice, and we find that an adherence to the relative dimensions given will result in substantially, if not absolutely, preventing the downward drifting of the auger and in substantially, if not absolutely, maintaining it on a straight course.

In boring relatively large holes, we find that it is easier and requires less power to produce such a hole by means of an auger and a reamer than it does to have the auger itself of the required size. The reamer which we preferably employ is constructed somewhat after the manner of the revolving arms employed in an ordinary lawn mower, except that these arms are tapering or inclined. Such a reamer is shown at 11 in Figure 1 and comprises spiders or end pieces 12 and a plurality of relatively narrow helical tapering blades 14. The core or body 11 of the reamer is of course hollow, like the boring bar, and may be provided with two or more discharge ports 13 for delivering water to the cutting blades for carrying away the material. It will be understood that the reamer body 11 is provided at its respective ends with internal and external threads idenical with the threads 2 and 4, shown in Figure 2, so that this reamer may be connected between any two sections of the boring bar.

We find, further, that it is highly desirable to dispose the reamer at a considerable distance from the auger itself, in order to assist in holding the auger on a straight course. To state it as accurately as possible, we may say that the reamer should be spaced from the auger a distance at least equal to from four to six times the diameter of the auger. This is illustrated in Figure 1, in which a boring bar section 3 is shown as interposed between the auger 5 and the reamer 11.

The construction of the reamer, formed as it is with an open center, not only permits the material cut by the reamer to fall down through it, and be carried away by the water, but also affords free passage for the stream of material flowing rearwardly from the auger itself.

Under some conditions, we find it desirable to employ, in addition to the reamer, one or more spiral or helical conveyor sections. One of such sections is illustrated in Figure 1, and comprises a core or body 15, and one or more helical flanges 16. It will be understood that the body 15 of each conveyor section is provided at its ends with internal and external threads similar in every respect to the threads 2 and 4 shown in Figure 2, so that these conveyor sections are interchangeable with the boring bar sections, and with the reamers. By thus employing an auger, boring bar sections, reamers, and conveyor sections, all having standard interchangeable

couplings, it is possible to connect these various elements together in any desired relation whatsoever. Thus, a plurality of conveyor sections may be connected together or a conveyor section may be connected directly with a reamer, without the interposition of any boring bar section, and the auger itself may be connected directly to the reamer or to a conveyor section, if desired.

What we claim is:

1. Earth boring apparatus of the horizontal type comprising a hollow boring bar, and an auger mounted on the end of said bar, said auger comprising a main body and a pilot projecting from the front end thereof, the main body of said auger having a port adjacent its rear end communicating with said hollow boring bar, and means whereby water may be supplied through said port to the body of the auger while said pilot is maintained in dry condition.

2. Earth boring apparatus of the horizontal type comprising a helicoidal auger, a pilot projecting from the front end of said auger and having a length at least equal to the diameter of said auger, and a smooth relatively long boring bar to which said auger is secured, the diameter of said boring bar being from one half to two thirds that of said auger, whereby the sagging of said boring bar transversely into contact with the wall of the hole will cause said pilot to be directed upwardly to an extent sufficient to counteract the tendency of the auger to drift downwardly.

3. Earth boring apparatus of the horizontal type comprising a helicoidal auger, a cylindrical pilot projecting from the front end of said auger and having a diameter of one-fourth to one-third that of said auger, and a boring bar to which said auger is secured, said boring bar having a diameter from one-half to two-thirds that of said auger, whereby the sagging of said boring bar transversely of the hole will direct said pilot upwardly to an extent just sufficient to compensate for the tendency of the auger to tip, and thus maintain said auger on a level course.

4. Earth boring apparatus of the horizontal type comprising a helicoidal auger, a pilot projecting from the front end of said auger, and a relatively long somewhat flexible boring bar smaller than said auger to which said auger is secured, and a fixed guide adjacent the hole for centering the bar, the proportion of the parts being such that the sagging of the boring bar transversely into contact with the lower side of the hole will serve to direct said pilot upwardly to an extent just sufficient to counteract the tendency of the auger to tip downwardly, and thus maintain said auger on a straight course.

5. In the boring of horizontal holes through earth and the like by means of an auger carried at the end of a relatively long boring bar, the method of maintaining such an auger on a substantially level course which comprises so proportioning the diameters of the auger and boring bar that the sagging of the bar into contact with the lower side of the hole will serve to direct the point of the auger upwardly to an extent just sufficient to counteract its tendency to drift downwardly, due to gravity.

6. In the boring of horizontal holes through earth and the like by means of an auger carried at the end of a relatively long boring bar, the method of maintaining such an auger on a substantially level course, which comprises exerting a forward thrust on said boring bar constructing said bar of material capable of bending slightly, and making it of a diameter sufficiently smaller than that of the auger so that the bending of the bar into contact with the lower side of the hole, due to the combined action of its weight and the thrust exerted upon it will serve to direct the point of the auger upwardly to an extent just sufficient to counteract its tendency to drift downwardly, due to gravity.

7. Earth boring apparatus of the horizontal type comprising an auger, a relatively long boring bar smaller than said auger to the forward end of which said auger is secured, a fixed guide adjacent the hole, through which guide said boring bar passes, and means for rotating said bar and for exerting a thrust against the rear end thereof, the diameter of said boring bar relative to that of the auger being such that the downward bending of the bar transversely of the hole between said guide and auger, due to the joint action of the thrust and of gravity, will serve to direct said auger upwardly to an extent just sufficient to counteract its tendency to drift downwardly, and thus maintain said auger on a substantially level course.

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