Feb. 27, 1962 H. J. TROCHE 3,022,839

EARTH BORING APPARATUS

Filed July 7, 1959 4 Sheets-Sheet 1

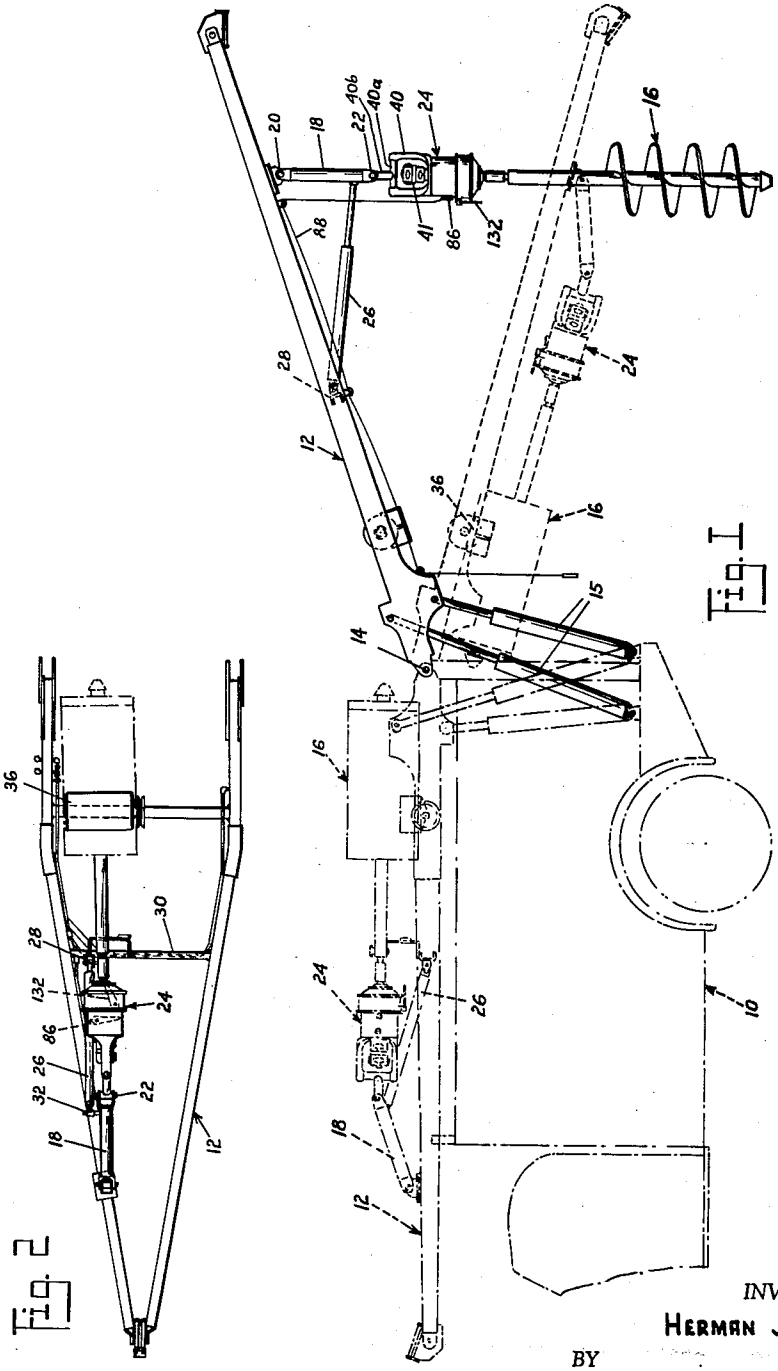


Fig. 1

Fig. 2

INVENTOR.
HERMAN J. TROCHE

BY

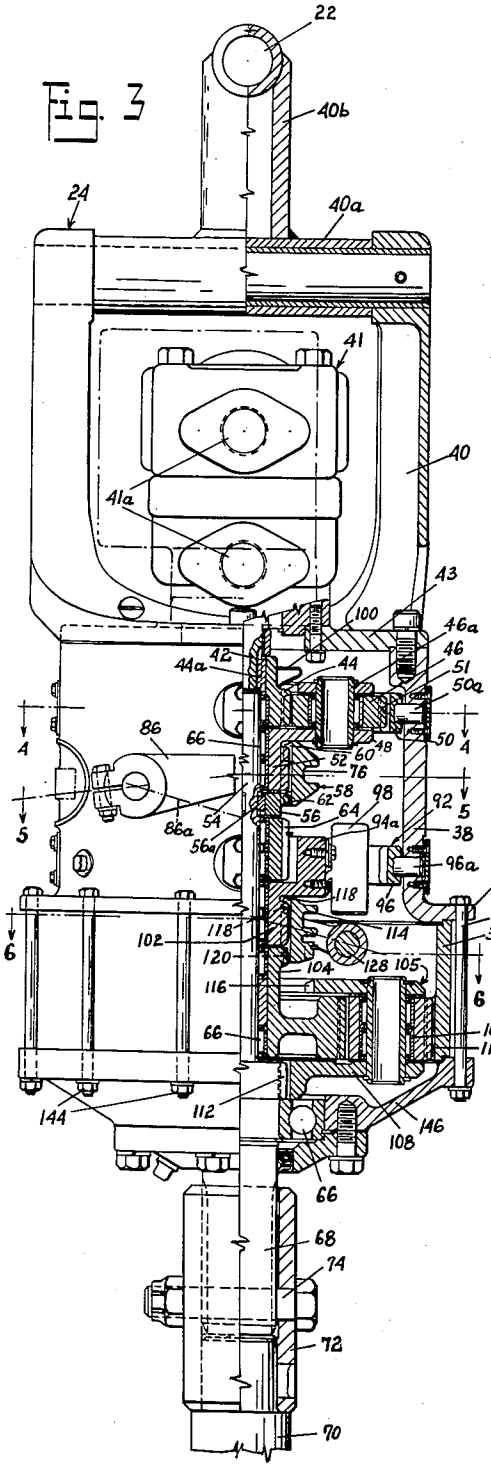
Teare, Kramer, Sturges & Fetzer
ATTORNEYS

Feb. 27, 1962 H. J. TROCHE 3,022,839

EARTH BORING APPARATUS

Filed July 7, 1959 4 Sheets-Sheet 2

Fig. 3



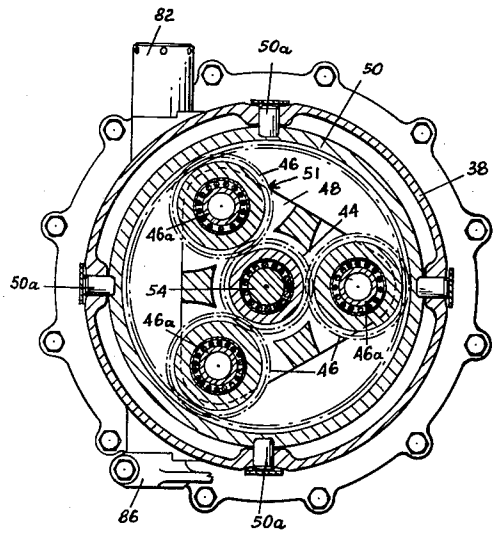


Fig. 4

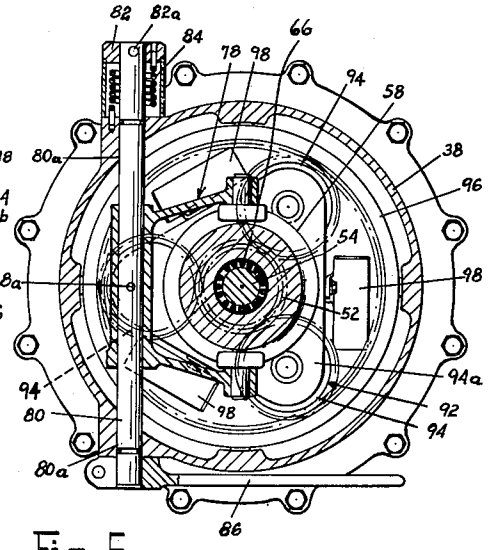


Fig. 5

INVENTOR.
HERMAN J. TROCHE

BY

Teare, Kramer, Sturges & Fetzer
ATTORNEYS

Feb. 27, 1962 H. J. TROCHE 3,022,839

EARTH BORING APPARATUS

Filed July 7, 1959 4 Sheets-Sheet 3

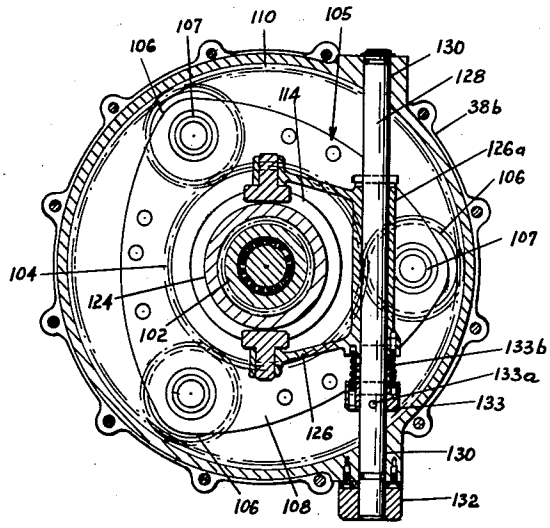


Fig. 6

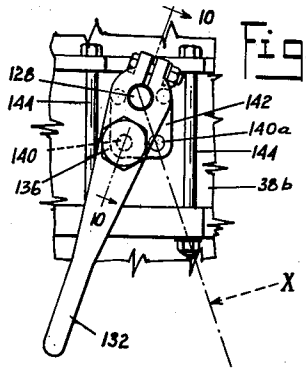


Fig. 9

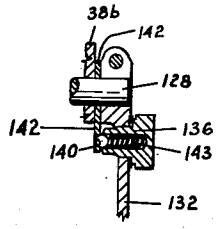


Fig. 10

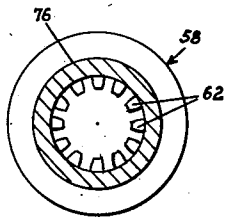


Fig. 7

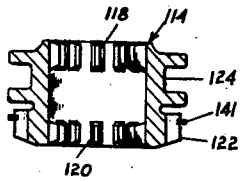


Fig. 8

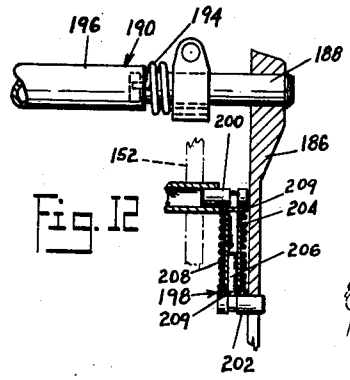
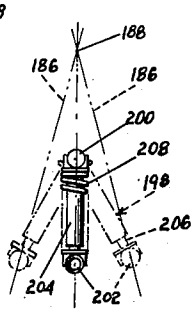


Fig. 12

Fig. 13



INVENTOR.
HERMAN J. TROCHE
BY
Teare, Kramer, Sturges & Fetzer
ATTORNEYS

Feb. 27, 1962 H. J. TROCHE 3,022,839

EARTH BORING APPARATUS

Filed July 7, 1959 4 Sheets-Sheet 4

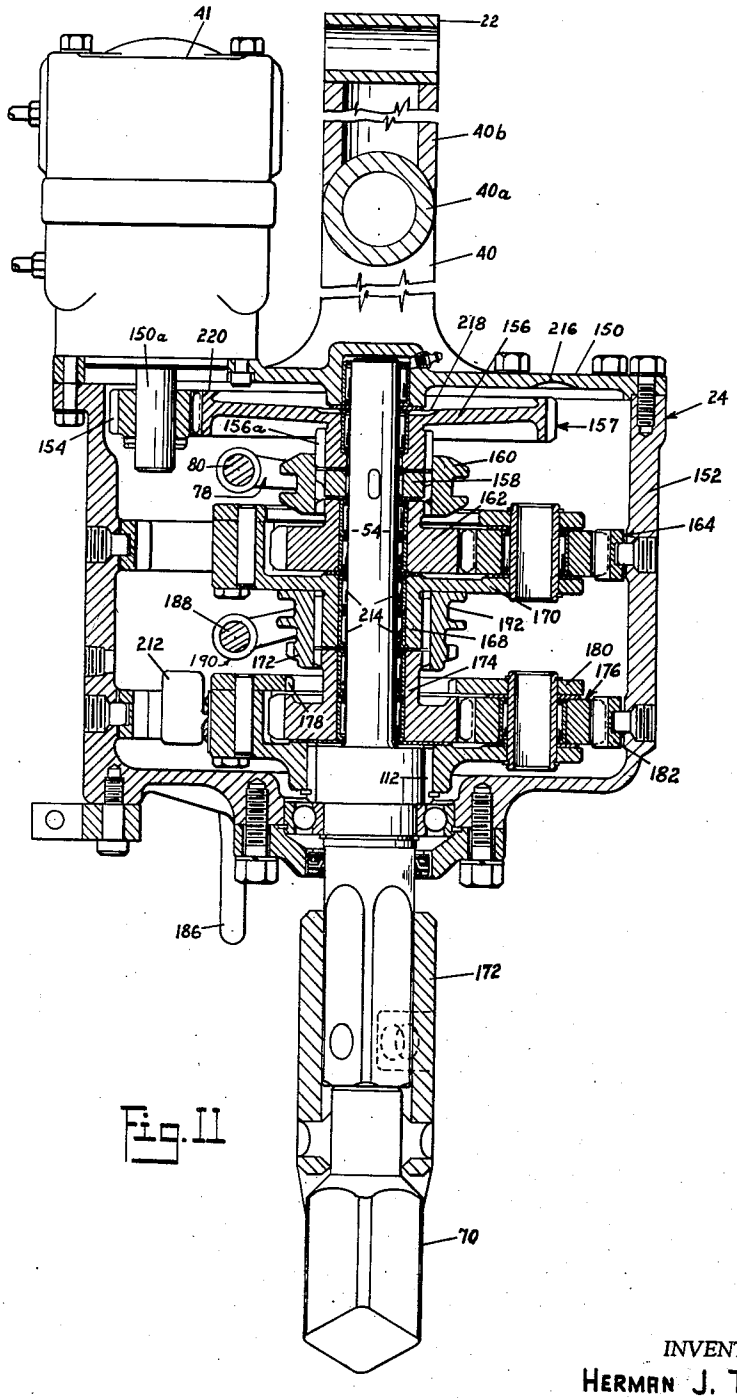


Fig. II

INVENTOR.
HERMAN J. TROCHE

BY

Teare, Kramer, Stinges & Felger
ATTORNEYS

United States Patent Office 3,022,839 Patented Feb. 27, 1962

3,022,839

EARTH BORING APPARATUS

Herman J. Troche, Fairview Park, Ohio, assignor to Holan Corporation, Cleveland, Ohio, a corporation of Ohio

Filed July 7, 1959, Ser. No. 825,610
10 Claims. (Cl. 175—201)

This invention relates generally to power operated earth boring apparatus, and more particularly to a multiple-speed, geared earth boring apparatus adapted for mounting on a vehicle for ready portability.

There has been a long felt need in the art of portable earth borers for a multiple-speed, geared unit which is rugged and compact in construction and which possesses multiple digging speeds, including a medium torque, normal digging speed for conventional type soil conditions, and a higher torque, slower digging speed for use under more difficult digging conditions, such as harder soils, etc., and which embodies some means for ready removal of borings from the auger or earth borer tool, after the auger has been retracted from the hole produced thereby. Many types of soils, such as the clays, are extremely difficult, especially when wet, to dislodge from the auger of known earth boring apparatus. Prior art arrangements of portable type earth borers are also comparatively difficult to actuate and control, thereby necessitating the use of an excessive number of personnel for operating the same.

The present invention, provides a compact, fluid powered, geared earth boring apparatus which possesses the aforementioned multiple digging speeds for effective use under varying soil conditions, and which incorporates means for providing a novel spinning speed for the auger, for effectively throwing-off borings which have adhered thereto after withdrawal thereof from the hole, and which includes a novel arrangement of control or shifting mechanism for selectively changing to one or the other of the digging speeds, and for selectively initiating the spinning speed of the auger, irrespective of the digging speed at which the apparatus is set to operate. In one embodiment of the invention, an earth boring apparatus of the above type is provided wherein the transmission digging speed gear sections and their associated housing portions, which provide for the multiple digging speeds of the apparatus, are detachably connected together as individual, separable units, such apparatus being readily changed over to a single digging speed type earth borer, instead of the multiple digging speed type, by simply removing one complete speed change gear section and its associated housing from the transmission assembly, to thereby provide a lower cost, relatively smaller size unit and without the necessity of redesigning or completely reconstructing the operating parts of the apparatus.

Accordingly, an object of the invention is to provide an improved, compact, multiple-speed earth boring apparatus for use primarily as a portable unit.

Another object of the invention is to provide an earth boring apparatus of the latter type which incorporates means for providing a readily actuatable spinning speed for the auger of the apparatus, to effect a throw-off of borings which may tend to adhere to the auger after withdrawal thereof from the hole produced thereby.

A further object of the invention is to provide an earth boring apparatus of the latter type including readily actuatable and controllable gear shifting or control apparatus, for shifting into the desired digging or spinning speed position, and including means for yieldably retaining the gear shifting apparatus in the desired digging speed setting.

A still further object of the invention is to provide earth boring apparatus of the latter type in which the digging speed gear sections for the multiple digging speeds of the apparatus are detachably connected together as individual, separable units, so that certain of such gear units can be readily removed from the apparatus without redesigning or materially reconstructing the apparatus, to thereby provide a lower cost single digging speed unit if so desired.

Other features and advantages of the invention will be apparent from the following description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevational view of an earth boring apparatus of the invention carried by a movable derrick structure mounted on a utility type vehicle; in full lines there is shown an operative position of the derrick and associated earth boring apparatus and in dotted lines there is illustrated an inoperative, clamped position of the auger with respect to the derrick, and in dot-dash lines the inoperative carried position of the derrick or boom and earth boring apparatus on the vehicle is illustrated.

FIG. 2 is a fragmentary, top plan view of the boom and earth boring apparatus shown in FIGURE 1, with the utility vehicle having been removed in the interests of simplicity.

FIG. 3 is an enlarged, partially sectioned, elevational view of one embodiment of the speed change power transmission unit for the auger of the earth boring apparatus, and is of the afore-mentioned type wherein the digging speed change gear sections are detachably connected together as individual, separable units, so that one of the gear sections and its associated housing portion may be readily removed from the transmission unit, for providing a lower cost, more compact, single digging speed unit.

FIG. 4 is a horizontal sectional view taken substantially along the plane of line 4—4 of FIG. 3 looking in the direction of the arrows.

FIG. 5 is a horizontal sectional view taken substantially along the plane of line 5—5 of FIG. 3 looking in the direction of the arrows.

FIG. 6 is a horizontal sectional view taken substantially along the plane of line 6—6 of FIG. 3 looking in the direction of the arrows.

FIG. 7 is a horizontal sectional view of one of the shiftable coupling collar elements of the transmission gear train which provides for driving the transmission at its various speeds, and is particularly used for initiating the spinning speed for the auger.

FIG. 8 is a vertical sectional view of another of the shiftable coupling collar elements of the transmission gear train, and is particularly used for initiating one or the other of the digging speeds for the auger.

FIG. 9 is an enlarged, fragmentary, side elevational view of the digging speed control lever used to actuate the coupling collar element of FIG. 8, and illustrates the position of such lever when the FIG. 8 collar element is in poistion to provide a high torque low digging speed for the auger; in dot-dash lines the lengthwise axis of the control lever is shown if such lever is moved to actuate the FIG. 8 coupling collar element into its other coupling position to provide a medium torque normal digging speed for the auger.

FIG. 10 is a section view taken substantially along the plane of line 10—10 of FIG. 9, looking in the direction of the arrows, and particularly illustrates the means for yieldably retaining the control lever of FIG. 9 in its selected position.

FIG. 11 is an enlarged, sectional, elevational view of a modified arrangement of a speed change geared transmis-

sion unit for driving the auger of the earth boring mechanism.

FIG. 12 is a fragmentary, enlarged partially sectioned elevational view of the digging speed control lever of the modification of FIG. 11 for shifting or changing the digging speed of the auger, together with the means for yieldably retaining such control lever in the desired setting.

FIG. 13 is a diagrammatic illustration of the operational effect of the means illustrated in FIG. 12 for yieldably retaining the digging speed control lever in its desired or positioned setting.

Referring again to the drawings and in particular to FIGS. 1 and 2 thereof, there is illustrated a utility type wheeled vehicle **10** on which is mounted a boom or derrick **12** hinged as at **14** to the vehicle for swinging movement in a generally vertical plane. Fluid powered reciprocal motor units **15** may be provided on either side of the boom structure for actuating the latter in its vertical plane movement. An earth boring tool in the form of a power operated auger **16**, is pivotally carried by the derrick **12** for swinging movement in a generally vertical plane to provide for swinging movement of the earth boring tool with respect to the derrick structure. An arm **18** is pivotally connected to the boom as at **20** and at its lower end pivotally supports, as at **22**, the speed change power transmission unit **24** of the earth boring apparatus, and with which this invention is particularly concerned.

A fluid-powered, double acting, reciprocal type motor unit **26** may be provided for adjusting the position of the earth boring tool with respect to the boom and in a vertical plane. Motor unit **26** is pivotally connected as at **28** to cross member **30** of the boom and at the other end thereof is pivotally connected as at **32** to the arm **18**, supporting the earth boring apparatus. As shown in dotted lines in FIG. 1, the earth boring apparatus may be folded up to an inoperative position where it extends generally parallel to the boom structure, and may be detachably clamped or fastened thereto as at **36** for convenient handling, after which the boom **12** may be pivoted about its pivotal connections **14** on the vehicle to an inoperative carried position overlying the vehicle **10**, and as shown in phantom lines in FIG. **1**.

Referring now in particular to FIGS. 1 and 3, the aforementioned speed change power transmission unit **24** comprises a sectional housing or casing **38** having an upstanding carrier or handle portion **40** which rotatably mounts a cross sleeve **40***a* at its upper end for swinging movement of the transmission unit in a plane generally transverse to the vehicle **10**. Cross sleeve **40***a* is provided with an upstanding shank portion **40***b* which is pivotally connected as aforementioned at **22** to the lower end of supporting arm **18**. In FIG. 3 of the drawings, carrier portion **40** and associated cross sleeve **40***a* and shank portion **40***b* have been rotated 90° out of their actual position with respect to the underlying transmission gear train, the actual positional relationship being correctly shown in FIG. 1, so as to better illustrate the high speed, fluid powered, rotary and preferably reversible motor unit **41** mounted on the top or cover plate **43** of the transmission housing **38**, as well as the positions of the control levers for shifting the transmission into its various speed settings.

Motor unit **41** which is of conventional well known type is connected by suitable feed and return lines via ports **41***a* to a pump unit (not shown) mounted on the vehicle **10**, and suitable valve means (not shown) of conventional well known type may be provided for controlling the flow and direction of pressurized fluid to the motor, and in a manner well known in the art. The aforementioned pump may be powered from a separate source of power such as an engine mounted on the vehicle, but is preferably operatively coupled to the main power plant or propelling engine of the vehicle for actuation of the pump and in a manner well known in the art. Such pump may also be operatively connected to the other fluid powered motor units of the apparatus, such as units **15** and **26**, for actuation thereof in the conventional manner well known in the art.

The output shaft **42** of rotary motor unit **41** has a sun gear **44** secured thereto as at **44***a*, such sun gear being in meshing relation with planet gears **46** (FIG. 4) rotatably mounted as at **46***a* on rotatable planetary carrier structure **48**. Planetary gears **46** are in meshing relation with an internal ring gear **50** secured to the transmission housing, as by means of dowel pins **50***a*. Sun gear **44**, planetary gears **46** and associated carrier structure **48**, and ring gear **50** thereby provide a first speed reduction unit **51** for the transmission.

Planetary carrier structure **48** has a speed change gear **52** secured to its lower end for rotation therewith and with respect to transmission shaft member **54**. A fixed, change gear **56** is disposed adjacent gear **52** and is secured as at **56***a* to shaft **54**, and an axially movable or shiftable sliding change gear collar **58** (FIG. 7) having internal gear teeth **60** and **62** on opposite ends thereof is provided, such coupling collar **58** being movable from the coupling relation shown in FIG. 3 between gear **52** and gear **56** fixed to shaft **54**, into coupling relation between gear **52** and sun gear **64** rotatably mounted with respect to shaft **54**.

Shaft **54** is journaled for rotation with respect to housing **38**, as by means of bearings **66**, and has its output end **68** secured to shank **70** of the auger **16**, the latter securement in the arrangement illustrated being accomplished by means of sleeve **72** secured to the upper end of auger shank **70** and a bolt and nut assembly **74** extending through complementary openings in the output shaft **68** and sleeve **72**. Thus it will be seen that when the coupling collar **58** is in coupling relation between gear **52** and gear **56**, the latter being fixed to shaft **54**, such shaft is rotated at a relatively high speed depending on the speed reduction of the motor unit **41** due to the planetary speed reduction unit **51**. This relatively high speed is the aforementioned spinning speed for the auger and is adapted for use to throw off borings that may have stuck or adhered to the auger after withdrawal thereof from the drilled hole.

The mechaniss for actuating change gear collar **58** will now be described:

The collar **58** has a circumferentially extending groove **76** (FIGS. 3 and 5) which receives therein a shifter fork element **78** (FIG. 5). Shifter fork element **78** is secured as at **78***a* to a shaft or rod **80** extending horizontally and transversely of the casing **38** and which is rotatably mounted with respect thereto, as at **80***a*. A cap **82** is secured as at **82***a* to one end of shaft **80** exteriorally of casing **38**, and a torsion spring element **84** is secured at one end to the cap **82** and at the other end to casing **38** for yieldably resisting rotary movement of the shaft **80**. The other end of the shaft **80** has an operating handle **86** secured thereto for selectively actuating shaft **80** and associated shifter fork **78**.

The torsion spring **84** is so disposed with respect to the shaft **80** and casing **38** that the sliding change gear collar **58** is normally maintained out of coupling relation with gear **56** fixed to shaft **54**. In other words, the position of collar **58** and associated control lever **86** illustrated in FIG. 3 is that when the handle or lever **86** has been pivoted upwardly from its normal position to rotate the shaft **80** against the resistance of spring **84** to move gear collar **58** into coupling relation between gear 52 and fixed gear **56**. It will be seen therefore that the transmission is normally not in condition for providing the spinning speed to the auger, but such spinning speed is only provided upon pivoting of control handle **86** upwardly.

Referring now to FIG. 1, in order to actuate handle **86** from ground level to provide the aforementioned spinning

speed to the auger, a cord 88 is provided, such cord being secured to one end of handle 86 and then movingly connected to the derrick structure 12 and then extended downwardly toward ground level. Therefore by merely pulling down on cord 88 which can be accomplished from ground level, the transmission 24 can be readily shifted into spinning speed, and upon release of the cord, the torsion spring 84 actuates rod 80 and associated shifting fork 78 to automatically move coupling gear collar 58 downwardly into coupling relation between gear 52 and the aforementioned gear element 64 rotatably mounted on the transmission shaft 54. The lengthwise axis of the operating handle 86 in such normal non-actuated position is illustrated by the dot-dash line 86*a* in FIG. 3.

Gear 64 constitutes the sun gear of a second speed reduction unit 92, the latter comprising sun gear 64, planetary gears 94 rotatably mounted on rotatable planetary carrier structure 94*a*, and a ring gear 96, secured as by means of dowel pins 96*a* to housing 38. It will be seen therefore that change gear collar 58 normally couples gear 52 to speed reduction unit 92, unless shifted into spinning speed operation by actuation of cord 88 and associated handle 86.

Also attached to planetary carrier structure 94*a* are a plurality of curved lube vanes 98 (FIGS. 3 and 5) which revolve with the gear reduction unit 92 and splash liquid lubricant, such as oil, contained in casing 38 upwardly against the top wall 43 of housing 38 from whence it drains down to lubricate the parts of the transmission disposed in the upper portion of the housing. An oil collecting device 100, mounted on the top of the first planetary speed reduction unit 51 collects such splashed oil and aids in lubricating the upper portions of the transmission.

Secured to planetary carrier structure 94*a* is an underlying speed change gear 102 for rotation with such carrier structure. Disposed below gear 102 and rotatably mounted with respect to transmission shaft 54 is a sun gear 104. Sun gear 104 constitutes a part of the third planetary speed reduction unit 105, the latter unit being comprised of sun gear 104, planetary gear 106 (FIGS. 3 and 6) rotatably mounted as at 107 on rotatable planetary carrier structure 108, and an internal ring gear 110, which in the embodiment shown is formed as a unit with housing portion 38*b* of the sectional transmission housing 38.

Planetary carrier structure 108 is drivingly coupled to transmission shaft 54 as at 112, and it will be seen therefore that upon power rotation of such planetary carrier structure 108, the output transmission shaft 54 will be driven thereby.

An axially movable slidable change gear collar 114 (FIGS. 3 and 8) is provided for selectively coupling gear 102 on speed reduction unit 92 to sun gear 104 of speed reduction unit 105, or coupling gear 102 to gear portion 116 on planetary carrier structure 108 of speed reduction unit 105.

When slidable gear collar 114 is in coupled relation between gear 102 and sun gear 104, and as shown in FIG. 3 of the drawings, the transmission is positioned for high torque, low digging speed operation, with the power from gear 102 being fed to sun gear 104, planetary gears 106 to planetary carrier structure 108 and thence to transmission shaft 54 by way of connection 112. This relatively low speed high torque arrangement is for use during difficult digging operations, such as in hard soil conditions or when a larger size auger is being used to drill a bigger hole.

Referring now to FIG. 8, which illustrates in vertical section the sliding gear collar 114, it will be seen that the latter comprises spaced internal gear teeth 118 and 120 at opposite ends thereof and external gear teeth 122 on the lower end thereof. It also embodies a circumferentially extending groove 124 which receives shifter fork element 126 (FIG. 6) for actuating the gear collar. Shifting fork element 126 comprises a cylindrical sleeve portion 126*a*

which is rotatably mounted on a horizontally extending, transverse operating rod 128 which in turn is rotatably journaled as at 130 in casing portion 38*b*. One end of the rod 128 has a control handle element 132 (FIGS. 1, 2 and 6) secured thereto. An anchor member 133 is secured as at 133*a* to rod 128 and a helical torsion spring 133*b* is provided, one end of which is secured to anchor member 133 and the other end of which is secured to sleeve portion 126*a*, the purpose of such an arrangement being hereinafter described.

In accordance with the invention, means is provided for yieldably retaining handle element 132 in a selected digging speed position, or in other words retaining change gear coupling collar 114 in coupled relation between gear 102 and sun gear 104, or in coupling relation between gear 102 and gear portion 116 on planetary carrier structure 108. This means takes the form of a spring loaded detent 136 (FIGS. 9 and 10) mounted on the upper portion of a handle 132 and adapted for holding coaction in one or the other of recesses 140, 140*a* disposed in a plate 142 secured to the exterior of housing portion 138*b*. Thus it will be seen that means is provided for yieldably resisting free pivotal movement of operating handle 132, to thereby retain the change gear collar 114 in its selected coupling position.

If, handle 132 is pivoted so that the detent 136 is in retaining coaction with recess 140*a* and with the lengthwise axis of the handle 132 in the position illustrated by dot-dash line X in FIG. 9 and thus shifting coupling collar 114 into coupling relation between gear 102 and gear portion 116 on planetary carrier structure 108, then the power from the gear 102 is transmitted through carrier structure 108 direct to transmission shaft 54 via connection 112, to provide a medium torque normal digging speed for the auger. This speed is for use for digging or drilling holes in conventional types of soils, and represents the speed for which the earth boring apparatus is conventionally adapted for use. A stop 141 limits such shifting movement of collar 114.

Referring now again to FIGS. 6, 9 and 10, the compression spring 143 of spring loaded detent 136 is stronger than the torsion spring 133*b*, so that when handle 132 is moved from low digging speed position to higher or normal digging speed position or vice versa, the operating handle 132 will be retained in its new selected position even though shifting collar 114 might be tightly meshed with gears 102 and 104, or with gears 102 and 116, thereby preventing the desired shifting movement of collar 114. In such event, torsion spring 133*b* will be deflected as rod 128 rotates thereby applying a force on shifter fork 126 via sleeve portion 126*a*. Then when the load is subsequently removed from the gear train by either a forward or reverse motion of motor unit 41, the coupling collar 114 will be freed up to automatically move into meshing relation with the speed gear (i.e. gear 104 or 116) selected, due to the force being applied by deflected torsion spring 133*b*, to thereby provide a semi-automatic gear shifting arrangement. It will be seen therefore that with such an arrangement it is not necessary to immediately accomplish digging speed shifting of the transmission upon actuation of the control lever or handle 132, but such is automatically accomplished subsequently upon subsequent actuation of the motor power unit.

A feature of the invention in the FIG. 3 embodiment is that if so desired, the housing portion 38*b* and its associated speed reduction unit 105 and accompanying sliding coupling collar 114 may be readily removed by merely removing bolt and nut assemblies 144 which hold the latter transmission section in assembled relation with the main housing portion 38. Thereupon, after replacing transmission shaft 54 with a shaft to suit so as to couple gear 102 to the shaft and then attach bottom cover plate 146 directly to the flange portion 148 of the main housing 38, a smaller more compact lower cost

power transmission unit will be provided, which will possess the aforementioned auger spinning speed and a single digging speed. It will be seen that such an arrangement will be readily accomplished with the structure shown and without any necessity for a reconstruction of the upper portion of the transmission gear train arrangement.

Referring now to FIGS. 11 to 13 inclusive of the drawings, there is shown a modification of the invention. This modification operates generally similarly to the first described embodiment and possesses a spinning speed and two digging speeds (a high torque, relatively low speed and a medium torque normal or higher speed) the same as in the first described embodiment, but does not possess the feature whereby the transmission unit can be readily revised into a single digging speed unit, as discussed immediately above, and in addition utilizes a different arrangement of means for yieldably retaining the operating shift handle, which controls the digging speeds of the earth boring apparatus, in its selected positions.

Referring now to FIG. 11, the rotary, fluid powered motor unit **41** is mounted on the top cover plate **150** of the power transmission unit **24** and output shaft **150***a* thereof extends into the transmission chamber defined by the housing member **152**. A pinion gear **154** is secured to the output shaft **150***a* of the motor and is disposed in meshing relation with a spur gear **156** rotatably mounted on transmission shaft **54**. Spur gear **156** has a gear portion **156***a* secured thereto, and immediately below gear portion **156***a* there is disposed a speed change gear **158** fixed to the transmission shaft. It will be seen therefore that pinion gear **154**, spur gear **156** and gear **156***a* comprise a speed reduction unit **157** of the transmission. A coupling gear collar **160** of the same general arrangement as collar **58** of the first described embodiment is provided for selectively coupling gear **156***a* to either gear **158** fixed to transmission shaft **54** or to sun gear **162** of the second speed reduction unit **164**. If the collar **160** is moved upwardly from the position shown into coupling arrangement between gear **156***a* and gear **158**, the aforediscussed high spinning speed for the auger is provided. The position of the coupling collar **160** shown in FIG. 11 is the normal position therefor, and a shifter fork element **78**, operating rod **80** associated torsion spring **84**, and operating handle **86**, the same as in the first described embodiment, is provided for shifting coupling collar **160** from the position shown into its auger spinning speed position, and for automatically returning the collar **160** and associated control lever to normal coupling position, upon release of the operating handle.

It will be seen therefore that the coupling collar **160** is normally held out of spinning speed position, the same as in the first described embodiment of the invention, and the operating handle **86** therefor may be provided with a cord for operating the handle from ground level, the same as in the first described embodiment of the invention.

When the coupling collar **160** is in the coupling position shown in FIG. 11, or in other words coupling gear **156***a* to sun gear **162** of the planetary gear speed reduction unit **164**, the power is transmitted from gear **156***a* through gear reduction unit **164** to the gear **168** formed integrally with the planetary carrier structure **170** of reduction unit **164**, and being rotatably mounted with respect to transmission shaft **54**.

A coupling collar member **172** which is substantially identical to collar **114** of the first described embodiment of the invention is provided for selectively coupling gear **168** to sun gear **174** of the planetary speed reduction unit **176** or to the internal tooth gear portion **178** of the planetary carrier structure **180** of speed reduction unit **176**, the latter unit being substantially identical in construction to the planetary speed reduction unit **105** of the first described embodiment, except that the internal ring gear portion **182** of reduction unit **176** is not formed as a unit with the transmission housing **152**, as is the internal ring gear **110** of the first described embodiment. In all other respects however, it is substantially identical.

When coupling collar **172** is in the position shown in FIG. 11, or in other words is coupling gear **168** to sun gear **174** of unit **176**, a relatively high torque low auger digging speed is provided, for use as aforementioned in difficult digging conditions such as hard soils or when using a larger sized auger. When collar **172** is moved downwardly into coupling relation between gear **168** and gear portion **178** on planetary carrier structure **180**, a medium torque, normal digging speed is provided as in the first described embodiment, for use under conventional digging conditions, with the planetary carrier structure **180** being secured to the transmission shaft **54** as at **112**, the same as in the first described embodiment of the invention.

An operating handle **186** (FIGS. 11 and 12) is provided for actuating the control shaft **188** on which is rotatably mounted a shifter fork element **190** the same as in the first described embodiment, with fork element **190** coacting in the circumferential external slot **192** of sliding collar **172** for shifting the collar from one to the other of its digging speed positions. A torsion spring **194** is provided coacting between the rotatable sleeve portion **196** of shifter fork **190** and the shaft **188**, the same as in the first described embodiment to make the shifting of collar **172** a semi-automatic operation the same as in the first described embodiment.

Means **198** is also provided for yieldably retaining the operating handle **186** in the selected digging speed position.

In this embodiment of the invention, such means takes the form of an over-center spring mechanism comprising a pin **200** projecting from the exterior of housing **152** and a pin **202** mounted on the innerside of handle **186**. An elongated guide member **204** is pivotally mounted on pin **200** and an elongated guide member **206** is pivotally mounted on pin **202** and in axially movable relation to guide **204**, and a compression spring **208** encircling such guide members is disposed intermediate abutments **209** mounted on the respective guide members. Spring **208** is stronger than torsion spring **194** and thus maintains the operating lever **186** in either of the selected digging positions, with the spacing between abutments **209** decreasing against the resistance of spring **208** upon pivoting of handle **186** from one digging speed position to the other digging speed position, and as can be best seen from FIG. 13 of the drawings, while the distance between the axis of rotation of rod **188** and the axis of pin **202** remaining the same during such pivotal movement of the operating handle **186**. As can be seen from FIG. 13 of the drawings, the axis of spring **208** is normally disposed obliquely with respect to a plane passing through the pivotal axis of lever **186** and the axis of pin **202**, in either of the lever's digging speed settings.

Carrier structure **180** of speed reduction unit **176** also carries curved lube vanes **212** to splash lubricant up against the top cover plate **150**, especially during the spinning speed of the transmission, for effective lubrication of the upper portion of the gear train and bearings **214** rotatably mounting shaft **54**. A deflecting groove **216** is provided in top coverplate **150** for deflecting such splashed lubricant downwardly into upwardly facing concave face **218** while gear **156** is revolving, the latter is provided with a reverse draft **220** on the upper section of its outer rim to thereby in effect form a circular storage chamber which retains the liquid lubricant until the rotary motion stops, at which time the lubricant drains toward center down through the bearings.

From the foregoing description and accompanying drawings it will be seen that the invention provides a novel, compact, multiple speed earth boring apparatus

which incorporates a spinning or rapid speed for throwing off borings which may adhere to the auger after withdrawal from the drilled hole, as well as a plurality of digging speeds for effective use of the apparatus under varying digging conditions or with different sizes of augers. The invention also provides an earth boring apparatus of the above type which incorporates means for yieldably retaining the gear shifting apparatus in the desired setting and providing a semi-automatic shifting operation upon actuation of the digging speed control lever as well as an apparatus which may be easily revised into a reduced speed unit of relatively smaller size and lower cost, without the necessity of materially reconstructing the apparatus. The invention also provides an earth boring apparatus of the above type which is adapted to be actuated by pressurized fluid power for effective and smooth ground drilling operations.

The terms and expressions which have been used are used as terms of description and not of limitation and there is no intention in the use of such terms and expressions of excluding any equivalents of any of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. In an earth boring apparatus of the type adapted for mounting on a derrick carried by a vehicle for ready portability thereof, the combination including a speed-change geared transmission unit including an external housing, means on said housing for operatively mounting said unit on the derrick, said unit including an output shaft, an earth boring auger operatively coupled to said transmission shaft and adapted to be rotated at a speed determined by said transmission unit, a fluid powered rotary type motor mounted on said housing and including an output shaft extending into the interior of said housing, a first geared speed reduction unit rotatably mounted on said output shaft interiorally of said housing and being in coupled relation with said motor, means for selectively coupling said first speed reduction unit to said transmission shaft whereby the latter is rotated at a high spinning speed for throwing off borings which may adhere to said auger, control means for actuating said last mentioned coupling means, said control means including means for yieldably urging said coupling means out of coupling relation between said shaft and said first speed reduction unit, a second planetary type geared speed reduction unit rotatably mounted on said transmission shaft, said coupling means being normally disposed in coupling relation between said first speed reduction unit and second speed reduction unit, a third planetary type geared speed reduction unit including a sun gear and rotary planetary gear carrier structure, said planetary gear carrier structure of said third speed reduction unit being secured to said transmission shaft for rotition therewith, second coupling means selectively coupleable between said second speed reduction unit and said sun gear and between said second speed reduction unit and said planetary gear carrier structure whereby said transmission shaft is provided with a medium torque normal digging speed and a high torque lower digging speed depending on the coupling position of second coupling means, control means for selectively actuating said second coupling means to either of its digging speed coupling positions, and means for yieldably retaining said second control means in its selected position.

2. In an earth boring apparatus in accordance with claim 1 including vane means fixed to one of said speed reduction units for rotation therewith and adapted to splash lubricant upwardly from the lower portion of said transmission housing to the upper portion thereof for lubricating the various parts of said transmission unit.

3. A multiple-speed compact geared transmission unit adapted for use with a portable earth boring auger for driving the latter at various speeds comprising in combination, a housing, a transmission output shaft adapted for connection to said earth boring auger, said transmission unit being adapted to be activated by a high speed rotary fluid powered motor, a first geared speed reduction unit rotatably mounted on said transmission shaft and adapted to be coupled to said motor, a second geared speed reduction unit rotatably mounted on said transmission shaft, a shifting coupling element normally coupling said first speed reduction unit to second speed reduction unit, said coupling element being shiftable into coupling relation between first speed reduction unit and said transmission shaft, control means movable from an inactive to an active position for so shifting said coupling element, said control means including resilient means for yieldably resisting shifting of said coupling element and for automatically returning said control means to inactive position and thus returning said coupling element into coupling relation between said first speed reduction unit and said second speed reduction unit, a third speed reduction unit drivingly coupled to said transmission shaft, said third speed reduction unit including means for providing a medium torque normal digging speed for said transmission shaft and a higher torque lower digging speed for said transmission shaft, a second shifting coupling element coacting between said second speed reduction unit and said third speed reduction unit for driving said transmission shaft at either of its selected digging speeds, control means for actuating said second coupling element into either of its coupling positions, and means for yieldably retaining said second control means in its selected position.

4. A transmission unit in accordance with claim 3 where in said second control means includes a rotatable operating shaft extending transversely of said sousing, a shifter fork element pivotally mounted on said operating shaft, an exteriorally accessible pivotal operating handle for rotating said operating shaft, a torsion spring coacting between said shifter fork and said operating shaft for actuation of said shifter fork upon rotation of said operating shaft, said shifter fork being operatively coupled to said second coupling element for actuation thereof into either of its digging speed coupling positions, said retaining means for said second control means comprising a compression spring having a greater capacity than said torsion spring and coacting with said handle to maintain the latter in its selected digging speed setting, said torsion spring upon deflection thereof by pivoting of said handle operating to actuate said second coupling element to its desired digging speed coupling position sequentially with pivoting of said handle and actuation of said speed reduction units whereby a semi-automatic shifting of said second coupling element is accomplished.

5. In an earth boring apparatus of the type adapted for suspension mounting on a derrick carried by a vehicle, the combination comprising a change speed gear transmission unit including an output shaft, a rotary fluid powered motor mounted on said unit and operatively coupled to said unit for actuating the same, said output shaft being adapted to be coupled to an earth boring auger for rotation of the later, said unit comprising first gear means coupled to said motor, second gear means drivingly engageable with said shaft, coupling means selectively movable to connect the first gear means and the shaft for providing a relatively high spinning speed for the auger, or to couple said first gear means to said second gear means for providing at least one digging speed to the shaft, control means for shifting said coupling means, spring means connected to said control means normally urging said coupling means to a position for coupling said first gear means to said second gear means, and means for shifting said control means to a position to connect said first gear means to said shaft against the action of said spring means.

6. In an earth boring apparatus of the type adapted for suspension mounting on a derrick carried by a vehicle, the combination comprising a change speed gear transmission unit including an output shaft, a rotary fluid powered motor mounted on said unit and operatively coupled to said unit for actuating the same, said output shaft being adapted to be coupled to an earth boring auger for rotation of the latter, said transmission unit comprising first gear means coupled to said motor, second gear means adapted to provide a plurality of digging speeds to said shaft, first coupling means between the first gear means and the shaft and between said first and second gear means, adapted to selectively couple said first gear means to said shaft for providing a relatively high spinning speed for the auger or to couple said first gear means to said second gear means, second coupling means selectively operable to adjust said second gear means to provide a desired digging speed at which the auger will operate, a control means for shifting said second coupling means, a second control means for shifting said first coupling means, spring means connected to said second control means normally urging said first coupling means to a position for coupling said first gear means to said second gear means, and means for shifting said second control means to a position to connect said first gear means to said shaft against the action of said spring means.

7. An earth boring apparatus in accordance with claim 6, wherein the first mentioned control means includes means for yieldably retaining said first control means in its selected setting.

8. An earth boring apparatus in accordance with claim 7 wherein said first control means includes an operating handle externally accessible of said transmission unit and said retaining means comprises a spring loaded detent operative between said handle and the exterior of said transmission unit and engageable in complementary recesses defining the operating positions of the handle for providing the various digging speeds for said auger.

9. An earth boring apparatus in accordance with claim 7 wherein said first control means includes an operating handle pivotally mounted with respect to the exterior of said transmission unit, said retaining means comprising a resilient member of the compression type coacting between an abutment on the exterior of said transmission and an abutment on said handle, said abutments being in spaced relation to the pivotal axis of said handles, said resilient member being normally disposed in generally oblique relation with respect to the lengthwise axis of said handle.

10. In an earth boring apparatus of the type adapted for suspension mounting on a derrick carried by a vehicle, the combination comprising a change speed gear transmission unit including an external housing and a removable output shaft disposed in said housing, said housing being of sectional construction comprising an upper portion and a lower portion, said shaft being adapted for coupling to an earth boring auger for driving the latter, said transmission unit being adapted to be activated by a high speed rotary fluid powered motor, the latter being adapted to be supported by said unit, said transmission unit comprising a first gear assembly mounted on said shaft and being adapted for coupled relation to the motor, shiftable means for selectively coupling said first assembly to said shaft for providing a relatively high spinning speed for the auger for throwing off borings which may adhere to the auger, control means for actuating said last mentioned coupling means, a second gear assembly rotatably mounted on said shaft, said coupling means normally coupling said first assembly to said second assembly, said first and second assemblies being disposed in said upper portion of said housing, said second assembly including gear means disposed adjacent the lower end of said upper portion of said housing, a third gear assembly disposed in said lower portion of said housing, said third assembly including means coupling said third assembly to said shaft, second coupling means selectively operable between said second and said third assemblies to provide a plurality of digging speeds for said shaft, whereby the latter is provided with a medium torque normal digging speed and a higher torque lower digging speed depending on the position of said second coupling means, control means for selectively actuating said second coupling means, the last mentioned control means including a handle member mounted on the exterior of said lower portion of said housing, means detachably connecting said housing sections together whereby said lower housing section and associated third gear assembly and said last mentioned control means and associated second coupling means and said shaft may be removed, and a second shaft adapted to replace said first mentioned shaft, said replaceable shaft being of reduced length and having means thereon adapted to be coupled to said gear means of said second gear assembly and to said first gear assembly.

References Cited in the file of this patent

UNITED STATES PATENTS

2,248,133	Snow	July 8, 1941
2,415,572	Jaques	Feb. 11, 1947
2,472,788	Burrus	June 14, 1949