June 10, 1947. T. C. SMITH 2,421,970

EARTH BORING MACHINE

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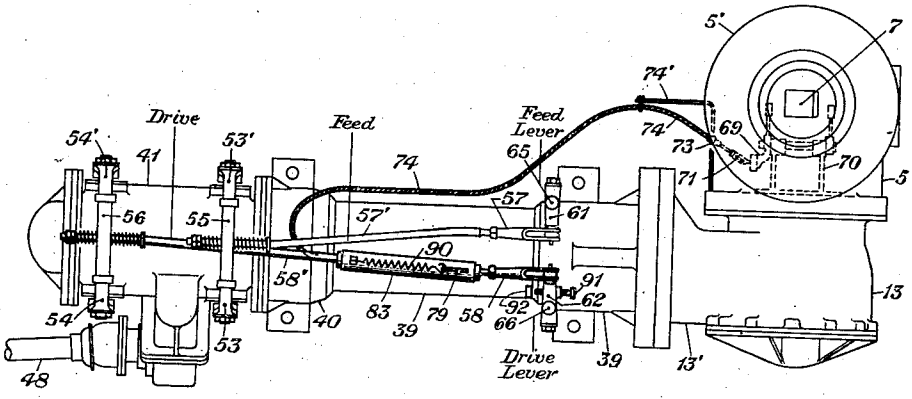


Fig. 1

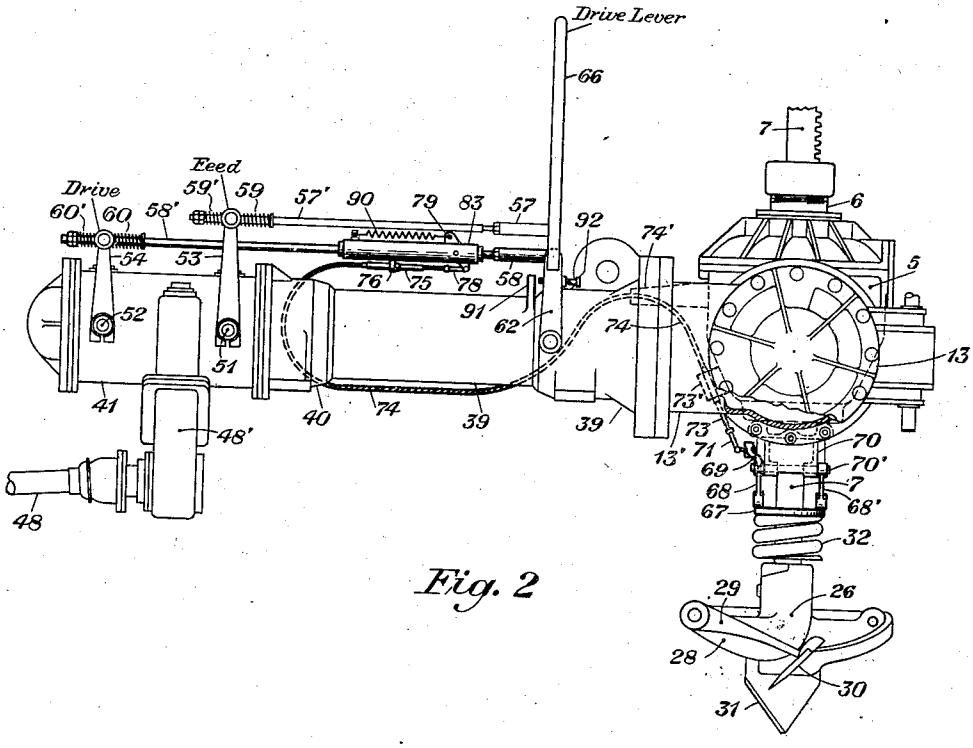


Fig. 2

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EARTH BORING MACHINE

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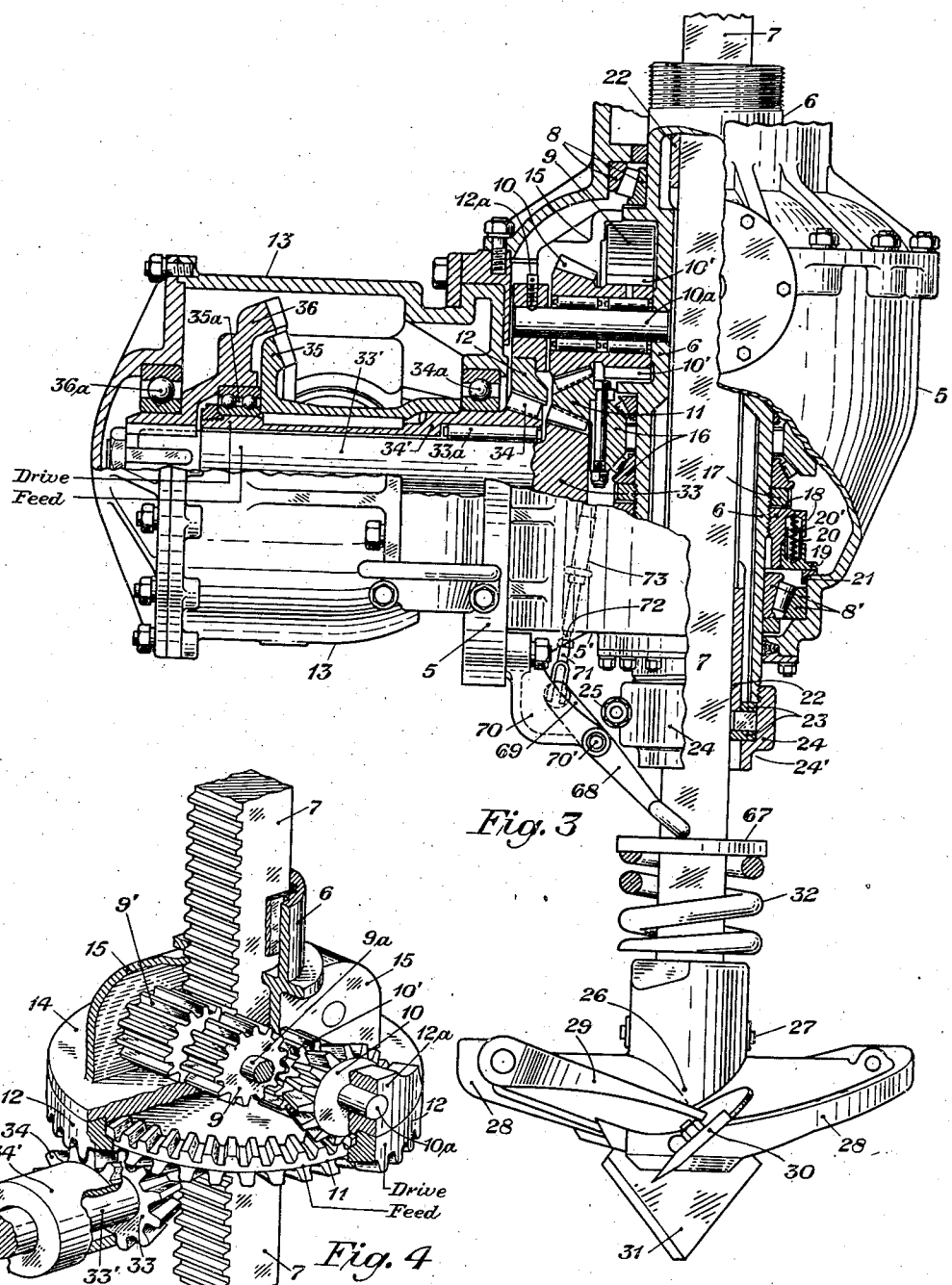


Fig. 3

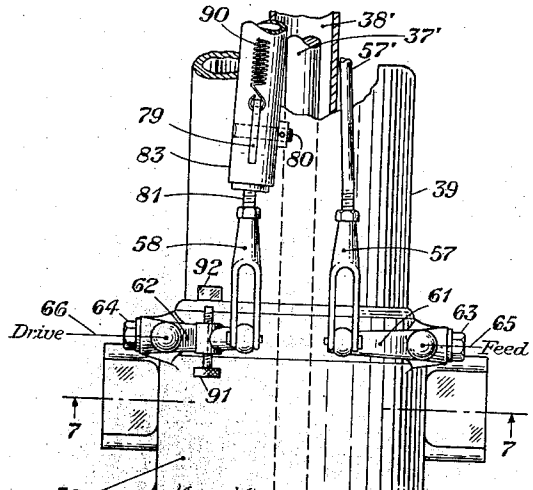
Fig. 4

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EARTH BORING MACHINE

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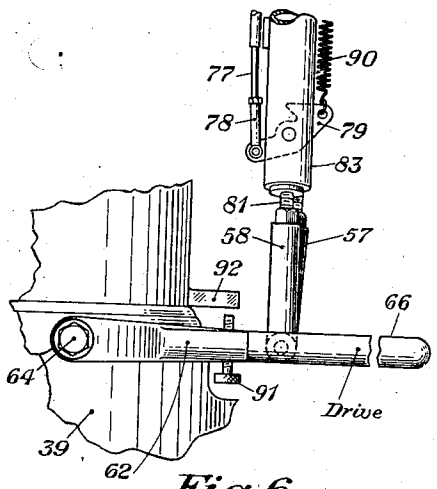
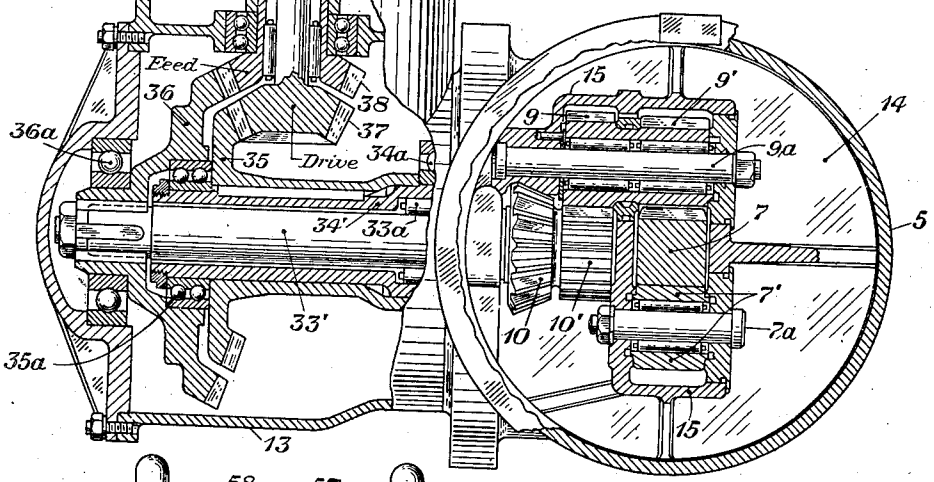


Fig. 6

Fig. 5



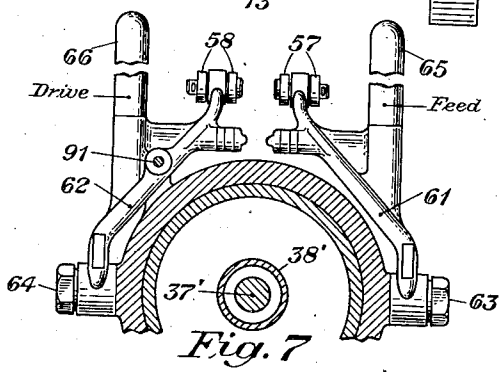


Fig. 7

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EARTH BORING MACHINE

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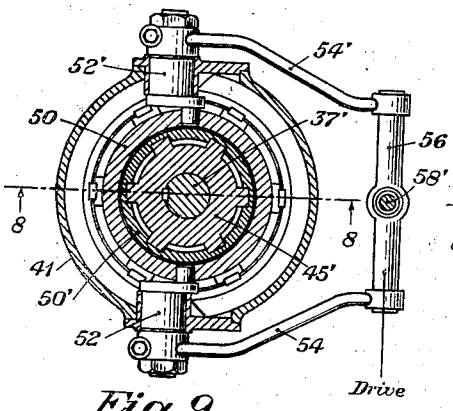


Fig. 9

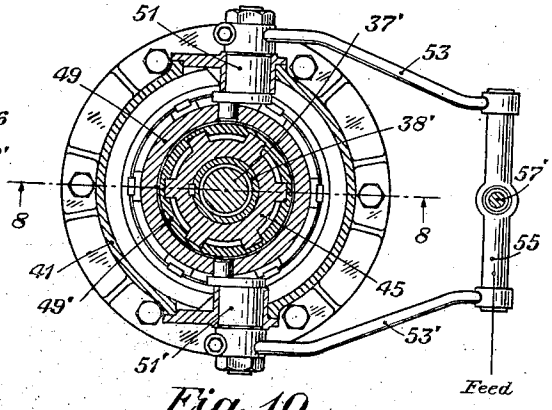


Fig. 10

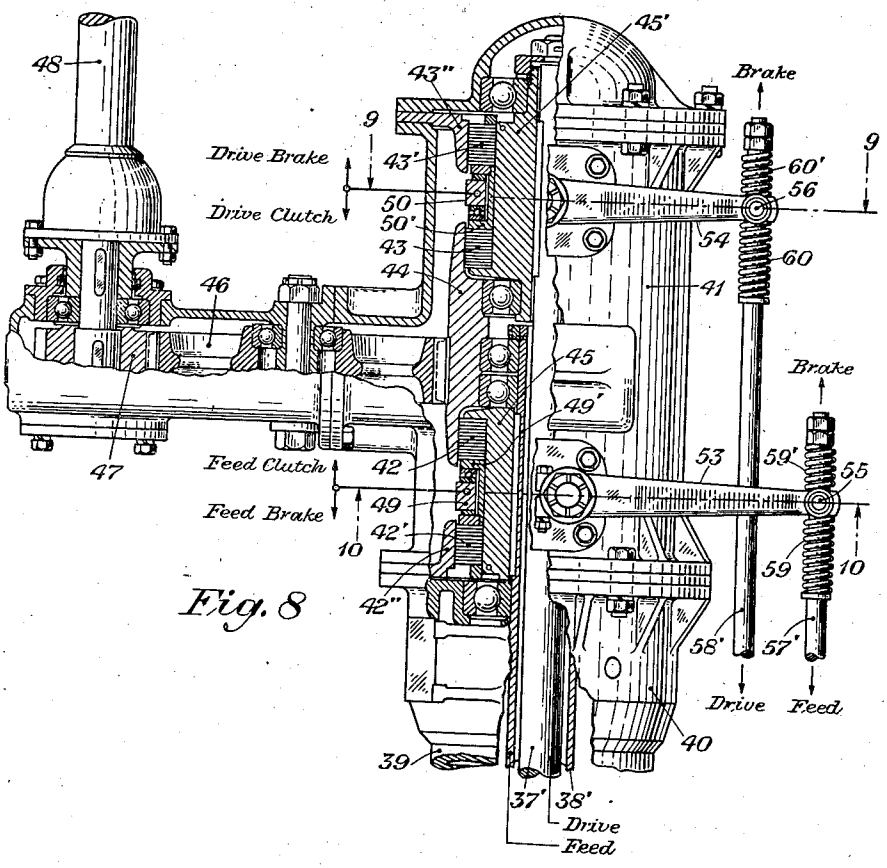


Fig. 8

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EARTH BORING MACHINE

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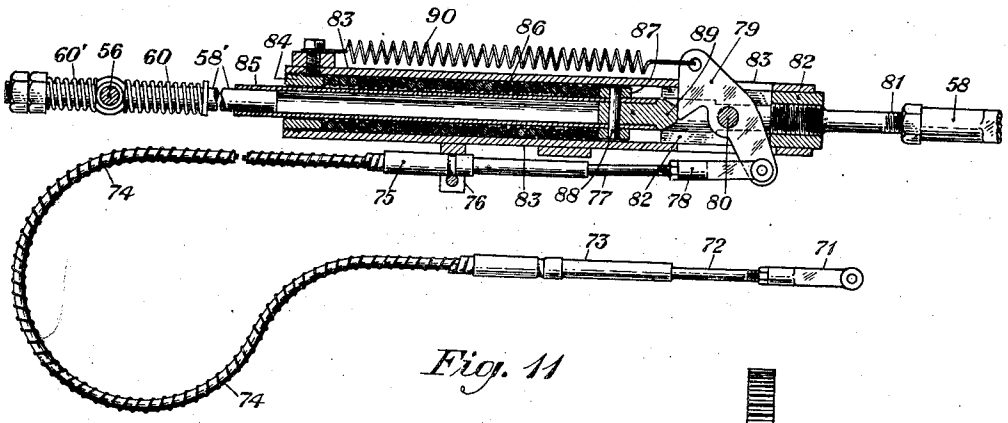


Fig. 11

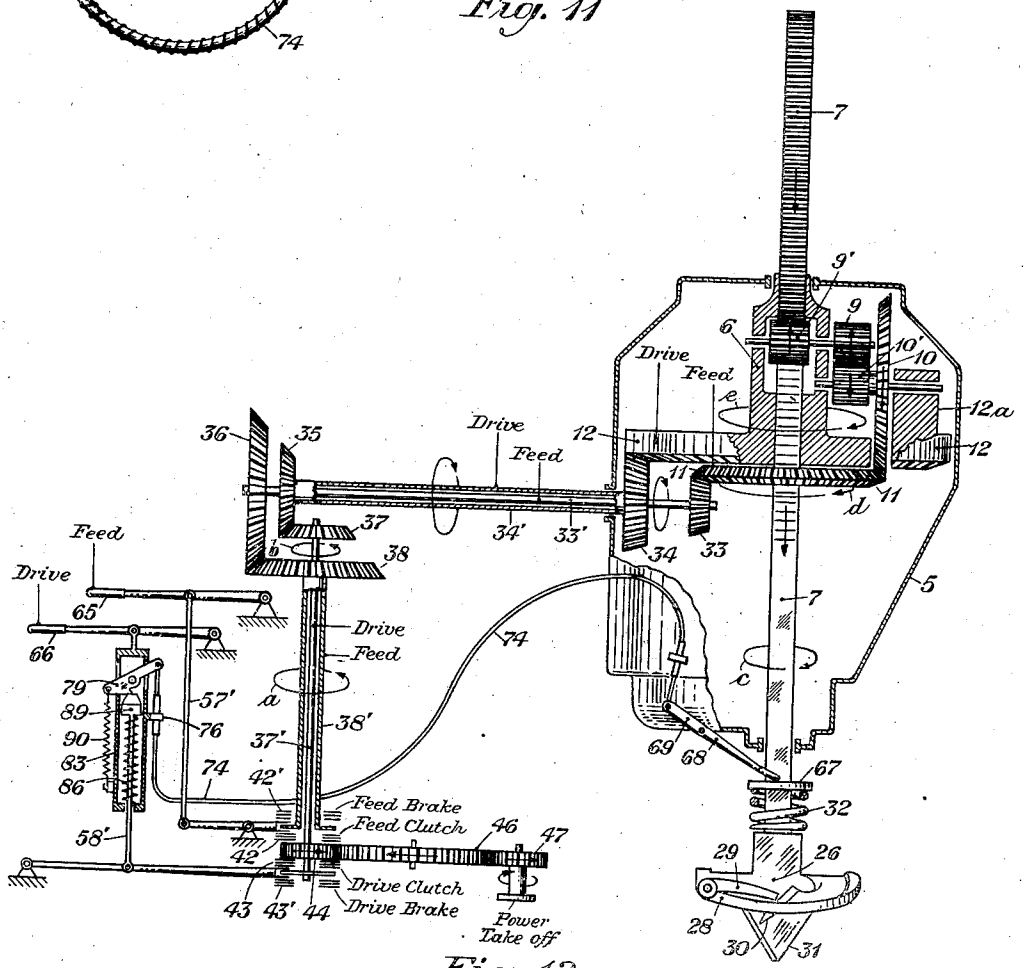


Fig. 12

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Patented June 10, 1947

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UNITED STATES PATENT OFFICE

2,421,970

EARTH BORING MACHINE

Temple C. Smith, Westfield, N. J., assignor to American Telephone and Telegraph Company, a corporation of New York

Application July 11, 1944, Serial No. 544,344

4 Claims. (Cl. 255—22)

1

This invention relates to earth boring apparatus and, more particularly, to arrangements of this character which are of the portable power-driven type adapted for boring holes in which to set poles.

One of the objects of the invention is to provide a motor-driven earth auger adapted to be mounted on a motor vehicle, and so positioned that the operating apparatus therefor may be coupled to the engine shaft or power take-off of the vehicle, whereby the apparatus may be operated by power derived from the engine.

Another object of the invention is to provide apparatus of the kind above described in which breakage of the gears and other mechanism operating the auger will be reduced to a minimum.

A further object of the invention is to provide an arrangement whereby, when the auger is rapidly raised to discharge the earth resulting from the boring operation, before the auger can strike the boring head a mechanism comes into play to automatically stop the upward travel of the auger and start it spinning, thereby throwing off the dirt.

These and further objects will be apparent from the following detailed description of the apparatus when considered in connection with the accompanying drawings which illustrate an embodiment of the improved invention.

In the drawings, in which like reference characters designate like parts throughout, the following figures appear:

Figure 1 is a plan view of the apparatus as seen from above;

Fig. 2 is a side view of the apparatus;

Fig. 3 is an end view partly in section, of the boring head which includes feeding and driving mechanism for operating the auger;

Fig. 4 is a perspective view, broken away in part, showing the gearing arrangement for rotating, raising or lowering the auger;

Fig. 5 is a plan view of the apparatus of Fig. 3, partly broken away to show the gearing and other interior mechanism;

Fig. 6 is a side view of the lever mechanism shown in Fig. 5;

Fig. 7 is a cross-section taken at the line 7—7 of Fig. 5 to furnish an end view of the operating lever mechanism;

Fig. 8 is a side view of the power feed, and associated clutch and brake mechanism partly broken away to show interior parts;

Fig. 9 is a cross-section taken at the line 9—9 of Fig. 8;

Fig. 10 is a cross-section taken at the line 10—10 of Fig. 8;

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Fig. 11 is a detail showing the telescopic arrangement of the push rod for operating the drive clutch and associated brake mechanism, and

Fig. 12 is a schematic view to show the principle of operation of the mechanism in as simple a manner as possible.

The boring apparatus shown on the accompanying drawings, as will be presently described in detail, is adapted to be suitably mounted upon a truck or other type of motor vehicle and operated by the truck engine through a changeable speed transmission which is not illustrated. The boring apparatus functions to dig holes in which poles, or the like, are to be positioned. For this purpose a boring head is provided which includes mechanism for raising or lowering the auger, and for causing it to rotate at the will of an operator.

General description of apparatus

Referring to Figs. 1 and 2 which show the general exterior appearance of the mechanism, the auger **26** is carried upon a square shaft **7** which may be rotated, and raised or lowered, by means of suitable mechanism contained within the boring head housing **5**. Attached to the housing **5** is an auxiliary casing **13** in which are housed certain beveled gears which play a part in transmitting the feeding and driving power to the auger. These gears are driven by means of concentric shafts (to be described later) which are mounted within a tubular casing **39**, and both gears rotate in the same direction, one to transmit feeding power and the other to transmit driving power. The casing **39** is attached at one end to a branch **13'** extending at a right angle from the casing **13** already described. At its other end the casing **39** terminates in an end member **40** which is attached to a housing **41**, containing the clutch and brake mechanism for controlling the driving and feeding operations. A shaft **48** from the power take-off is connected to the clutch and brake mechanism through gearing contained in an arm **48'** of the housing **48**.

In order to control the clutch and brake mechanism to be described later, a feed lever **65** and a drive lever **66** are provided, these levers being suitably mounted on the sides of the tubular casing **39** as shown in Figs. 5, 6 and 7. The feed lever **65** is mounted on an arm **61** which is connected by means of a bifurcated link **57** and a push rod **57'** to operate a double-ended lever **53** and **53'** for controlling the drive clutch and drive brake, as will be described later. The arrangement is such that when the feed lever **65** is pulled to the right (see Figs. 1 and 2) the feed clutch

is actuated, but when pushed to the left the feed brake is operated.

In a similar manner the drive lever 66 is mounted on an arm 62 connected by means of a bifurcated link 58 and a push rod 58' to operate a double-ended lever 54 and 54' for controlling the drive clutch and drive brake. Here also, the mechanism is so arranged that when the drive lever 66 in Figs. 1 and 2 is pulled to the right the drive clutch is actuated and when pushed to the left the drive brake is operated. As will be described in more detail later, the telescoping arrangement shown at 83 (Figs. 1, 2, 5, 6 and 12) is introduced in the push rod 58', and is controlled by a remote control cable 74 to automatically stop the upward travel of the auger 26 and cause the auger to spin and thus throw off dirt.

Principle of operation of mechanism

Before describing in detail the apparatus above referred to, it is desirable to have a general picture of the underlying principles of the various mechanisms and their mode of operation. To this end reference is made to Fig. 12 which shows a schematic layout of the apparatus. In this figure it will be observed that there are two main gears 11 and 12 within the housing 5. These gears will be hereinafter referred to, respectively, as the feed and drive gears. Both of these gears when operated always turn in the same direction, because they are connected in substantially the same manner to the common power take-off which drives them.

The power take-off acts through gears 47 and 46 to a gear 44 which rotates always in the direction indicated by the arrow except when it is desired to reverse the direction of rotation of the auger. This gear normally rotates freely without turning either of the shafts 37' or 38'. The shafts 37' and 38' are concentrically arranged so that they rotate in the same direction on the same axis, the direction of rotation being indicated by the looped arrows *a* and *b* surrounding the two shafts. Shaft 37' is a drive shaft and shaft 38' is a feed shaft. At the upper ends of these shafts beveled gears 37 and 38 are mounted, these beveled gears meshing with beveled gears 35 and 36 on the left-hand ends of two co-axial shafts 34' and 33', the former being a drive shaft and the latter a feed shaft. Beveled gears 33 and 34 are respectively mounted on the right-hand ends of the two co-axial shafts 33' and 34' and mesh with the main feed gear 11 and the main drive gear 12, as will be evident from the diagram.

By pulling the feed lever 65 in Fig. 12 in an upward direction, feed clutch 42 will be operated to couple the gear 44 with the feed shaft 38'. If the feed lever 65 is pushed downwardly the feed brake 42' comes into play to slow down or stop the feed shaft 38'. Similarly, if the drive lever 66 is pulled upwardly the drive clutch 43 couples the gear 44 with the drive shaft 37'. By shifting the drive lever 66 downwardly the drive brake 43' may be used to slow down or stop the drive shaft 37'.

From the foregoing it is evident that either the drive shaft 37' or the feed shaft 38' may be coupled to be driven from the power take-off, either separately or both at the same time, depending upon whether the clutches 42 or 43, or both, are operated. It will also be evident that both the feed shaft and the drive shaft are turned in the same direction by the gear 44. By tracing through the various beveled gears and drive shafts to the main feed gear 11 and drive gear 12, it will be seen that both of these gears when rotated turn in the same direction.

From a consideration of the feed gear 11 and the drive gear 12, it will be evident that the latter, by reason of the fact that it carries a housing or carrier 6 within which the square shaft 7 of the auger is mounted, will, when rotated, turn the shaft 7 and hence the auger 26 in the direction indicated by the looped arrow *c*. Rotation of the feed gear 11, however, is without effect so far as rotating the shaft 7 is concerned, by reason of the fact that the gear 11, while it surrounds the shaft 7, rotates freely with respect thereto.

The feed gear 11 functions in co-operation with the drive gear 12 to raise or lower the shaft 7 of the auger, depending upon the relative speeds of the gears 11 and 12. To this end a bracket 12_a is mounted on the upper surface of the gear 12. This bracket carries a beveled gear 10 which meshes with the feed gear 11, as shown. Thus, when the feed gear 11 is driven in the direction indicated by the looped arrow *d* and drive gear 12 is stationary (or slower than 11), feed gear 11 will drive the beveled gear 10 in a direction opposite that indicated by the vertical arrow thereon. The beveled gear 10 has affixed thereto a pinion gear 10' which meshes with a pinion gear 9 to drive the latter. Upon the same axis as the gear 9 and affixed thereto, is another pinion gear 9' which meshes with a rack upon the shaft 7 to drive the shaft 7 either upwardly or downwardly, depending upon the relative speeds of the feed gear 11 and the drive gear 12, as will presently appear.

The gearing arrangement, above described, is capable of (1) moving the auger 26 upwardly (preferably rapidly) without turning it; (2) moving the auger down slowly and at the same time rotating it; (3) moving the auger down rapidly and turning it; (4) permitting the auger to drop downwardly by gravity without turning, and (5) permitting the auger to be held stationary both with respect to rotation, and movement upward or downward, by a proper manipulation of the brakes and clutches.

For example, if the drive gear 12 is held stationary by applying the drive brake 43' to hold the drive shaft 37' stationary, and at the same time the feed gear 11 is rotated in the direction of the arrow *d* by the feed clutch 42, the beveled gear 10 will rotate in a direction opposite to that indicated by the vertical arrow appearing upon said gear. In other words, beveled gear 10 and its associated pinion gear 10' will be rotated in a clockwise direction when viewed from the right of Fig. 12. This will cause the coupled pinions 9 and 9' to rotate in a counter-clockwise direction. Pinion 9' therefore operates the rack carried by the shaft 7 to drive shaft 7 upwardly. The speed at which the shaft is driven upwardly will depend upon the speed of the drive shaft 37' which, in turn, will depend upon whether the feed clutch 42 is fully applied or is allowed to slip. If the clutch is fully applied, of course, the shaft is driven upwardly at the highest possible speed, which in turn can be changed by operating the engine throttle.

If, on the other hand, both the feed clutch and the drive clutch are applied so that both shafts 37' and 38' are operated, the feed gear 11 and drive gear 12 will be rotated in the direction indicated by the respective looped arrows *d* and *e*. The design of the gearing is such that when both clutches 42 and 43 are fully applied, drive gear

12 rotates a little faster than feed gear 11. The result is that the beveled gear 10 by meshing with the feed gear 11 is driven in a counter-clockwise direction as seen from the right of Fig. 12, i. e., in the direction indicated by the arrow appearing on the gear 10. As a consequence, the gear 9' rotates in a clockwise direction as indicated by the vertical arrow appearing upon it, and therefore it drives the shaft 7 slowly downward. At the same time the drive gear 12 by its rotation causes the shaft 7 to turn. This enables the auger to be driven slowly downward as it bores into the earth.

If the feed brake 42' is applied to slow down or stop the feed gear 11, and the drive clutch 43 is actuated, the drive gear 12 will rotate very fast with respect to the feed gear 11, thereby causing the beveled gear 10 to rotate in a counter-clockwise direction at high speed. The highest speed of the beveled gear 10 in a counter-clockwise direction is attained when the feed gear 11 is stationary and the drive gear 12 rotates at full speed. The result is that the shaft 7 is driven downward rapidly and is rotated at the same time. Thus, by suitable manipulation of the feed brake 42' and the drive clutch 43, the boring auger may be rotated and driven downwardly at any desired speed depending upon the nature of the earth or other material being operated upon.

If the feed lever 65 and the drive lever 66 are both in neutral position so that neither the feed brake nor drive brake is applied, and neither the feed clutch nor the drive clutch is actuated, the shaft 7 and the auger 26 will not be rotated. However, the weight of the shaft and the auger will cause the auger to slowly drop by gravity. This action, of course, causes the rack on the shaft 7 to rotate the pinion 9' slowly in a clockwise direction, thus causing the beveled gear 10 to slowly rotate the feed gear 11 in a direction opposite to the looped arrow *d*. The feed gear 11 operating through the beveled gear 33, shaft 33', beveled gear 36, beveled gear 38 and feed shaft 38', causes the latter to rotate in a direction opposite to that indicated by the looped arrow *a*. The inertia and friction of these various gears, shafts and borings, of course, acts to retard the speed with which the squared shaft 7 drops by gravity.

If both the feed brake 42' and the drive brake 43' are applied, the feed gear 11 and the drive gear 12 will be held stationary and the auger will neither rotate nor be fed upward or downward.

The foregoing operations are summarized in the following table:

Drive	Feed	Resultant motion
Brake	+Clutch	=Moves auger up without turning.
Clutch	+Clutch	=Moves auger down slowly and turns.
Clutch	+Brake	=Moves auger down fast and turns.
Neutral	+Neutral	=Moves auger down by gravity without turning.
Brake	+Brake	=Auger stationary.

Turning now to the structure of the various pieces of apparatus in detail, let us first consider the gearing arrangement encased in the housings 5 and 13 (see Figs. 3 and 4) whereby the auger may be rotated, raised or lowered.

The boring head

Referring to Figs. 3 and 4, the numeral 5 designates the main housing of the boring head. It serves as a casing for the gearing about to be described, and for a rotatable carrier or sleeve 6. A rack shaft or shank 7 is mounted in the carrier 6 in such a manner that it may be rotated with the carrier 6 when the carrier rotates or, if desired, it may be moved either upwardly or

downwardly with respect to the carrier. To permit of rotation the carrier 6 is mounted in the housing 5 on roller bearings such as indicated at 8 and 8'. It serves to house, in addition to the rack shaft 7, spur gears 9 and 9'. These are enclosed within an auxiliary casing 15 forming a part of the carrier 6 but mounted upon a disc or plate 14. The pinion gears 9 and 9' are arranged to rotate together upon a common shaft 9_a and for this purpose are preferably constructed as parts of a unitary structure, as shown particularly in Fig. 5. The casing 15 in which these pinion gears are enclosed is carried by a circular plate 14 on the underside of which the annular beveled drive gear 12 is mounted.

The pinion gear 9' is in mesh with the rack on shaft 7, and its associated pinion 9 is in mesh with the pinion gear 10'. The latter is integrally connected with a beveled spur gear 10 and is arranged to rotate therewith upon a common axle 10_a. The axle 10_a is mounted in the bracket 12_a at one end, and in a portion of the casing 15 at the other end. The beveled gear 10 is in mesh with the upper teeth of the double beveled feed gear 11 so as to be rotated thereby.

The double beveled feed gear 11 is annular in shape and surrounds the carrier member 6, but is made rotatable with respect thereto by means of a supporting roller bearing 16. This is kept in position by means of lock nuts 17 and 18, as shown in Fig. 3. The disc 19 lies adjacent to the lock nut 18 and both are provided with cooperating chambers containing tubular members, such as 20, which serve as guides for springs 20'. The tubes 20 also cause the disc 19 to rotate with the carrier 6. The springs 20' press the disc 19 against the annular disc 21 which effects a seal at this point to prevent the escape of an excess of oil or other lubricant from the gear case just above it.

The carrier 6 is provided at each of its ends with thrust plates, such as 22, which extend longitudinally thereof. These plates are four in number at each end of the carrier 6, and lie against the four sides of the rack shaft 7 to serve as a slideable bearing therefor. The thrust plates have splines inserted in ways cut in the carrier 6, and are retained by a cage such as 23, which holds them in position.

Each end of the carrier 6 is threaded for the reception of a collar. Only the collar 24 for the lower end of the carrier is illustrated. The similar collar for the upper end of the carrier 6 is omitted in order to better show the thread. The collar 24 is preferably split and, after being properly positioned, may be clamped to the carrier by means of a bolt 25 to hold the collar securely in place.

The rack shaft 7 is provided with an auger 26 secured to its lower end by means of the pin 27. The auger is provided with auger blade supports 28 which are slightly inclined and may be substantially in the form shown in Fig. 3. A trap or gate 29 may or may not be hinged to each support as desired. Only one of these is shown. These traps or gates 29 are pivotally mounted on the auger so that when the latter bores into the earth, the traps rise under the pressure of the loose earth and permit it to pile up on the top surfaces of the traps and supports. When the auger is raised out of the hole these traps automatically close under the weight of the loose earth accumulated on top of the auger to prevent it from falling back into the hole. The auger 26 is also provided with a blade such as 30 bolted

to each support, and a drill point 31 is suitably affixed to the auger base.

A spring 32 is positioned about the shaft 7 between the top of the auger 26 and a disc 67 which is slideable upon the shaft 7. When the rotating auger is raised from the earth by elevating the shaft 7, the disc or washer 67 may come in contact with the collar 24, in which case the spring 32 serves as a shock absorber.

Reducing gearing

The auxiliary casing 13 shown in Figs. 3 and 4, is attached to the housing 5. The beveled pinion gears 33 and 34 are in mesh with the lower side of the feed gear 11 and with the drive gear 12, respectively. A solid shaft 33' extends from the pinion 33 into the auxiliary casing 13 and terminates in a beveled gear 36 which is made rotatable with respect to the casing 13 by means of a ball bearing 36_a. A sleeve 34' surrounds the solid shaft 33' and extends from the pinion 34 to a beveled gear 35 which rotates with respect to the gear 33 by means of a ball bearing 35_a. The end of the shaft 34' adjacent the gear 34 is mounted in a ball bearing 34_a so as to be rotatable with respect to the auxiliary casing 13. A roller bearing 33_a is interposed between the solid shaft 33' and the tubular shaft 34' so that the two shafts may readily rotate with respect to each other.

The pinions 33 and 34 and the gears 35 and 36, with their respective shafts and bearings, form an intermediate reduction unit to determine the relative speeds at which the feed gear 11 and the drive gear 12 may be driven. To this end the beveled gears 35 and 36 are, as shown in Fig. 5, in mesh with pinions 37 and 38, respectively, and mounted on concentric shafts 37' and 38'. In order to house the gears 37 and 38 and their respective concentric shafts, the auxiliary casing 13 is provided with a right-angular branch 13' as shown in Fig. 5, and suitable bearings are mounted therein, as shown to permit of the relative rotation of the shafts 37' and 38'.

Clutch and brake mechanism

To the right-angular branch casing 13' another tubular casing 39 is attached as shown in Fig. 5. The opposite end of the tubular casing 39 terminates in an enlarged flanged structure 40. This is bolted to a cylindrical housing 41 within which suitable clutch and brake mechanism is mounted, as shown in Figs. 8, 9 and 10.

This mechanism includes a feed clutch 42 associated with the end of the shaft 38' and a drive clutch 43 associated with the end of the shaft 37'. The clutches 42 and 43 each consist of a series of plates or discs of well-known type. Certain discs of clutch 42 slide alternately on keys or splines forming a part of drum 45 and similarly, discs of clutch 43 slide on splines of drum 45'. These splines are best shown in Figs. 9 and 10 particularly. The drum 45 is keyed to the shaft 38' and the drum 45' is keyed to the end of the shaft 37'. Others of the plates of the clutches 42 and 43, respectively, slide on splines (not shown) at opposite ends of a tubular gear 44 as shown in Fig. 8. When the plates of the clutch 42 are pressed or clamped together the gear 44 will cause rotation of the drum 45 and the shaft 38'. Similarly, when the plates of the clutch 43 are pressed together the gear 44 will cause rotation of the drum 45' and the inner shaft 37'.

In addition to the clutches 42 and 43 which serve as feed and drive clutches, respectively, a feed brake 42' and a drive brake 43' are provided. These brakes are similar in structure to the clutches and each consists of a plurality of annular plates or discs, part of which are slideable upon splines on the drums 45 and 45', respectively, and the others of which are slideable upon keys carried by annular collars 42'' and 43'', respectively, mounted within the casing 41. When the discs of the feed brake 42' are pressed together a braking action is exerted upon the drum 45 and the shaft 38'. Similarly, when the discs of the drive brake 43' are pressed together a braking action is exerted upon the drum 45' and the inner shaft 37'.

A clutch throw collar 49, as shown in Figs. 8, 9 and 10, is arranged between the flanges of a grooved ring 49' interposed between the plates of feed clutch 42 carried by the drum 45 and the feed brake plates 42' carried by said drum. A bronze ring is provided on either side of the clutch throw collar 49 and the flanges of the grooved ring 49', to take up the thrust of the brake. Similarly, a clutch throw collar 50 is arranged between the flanges of a grooved ring 50', which is interposed between the plates of the drive clutch 43 and the drive brake 43'. When the feed clutch throw collar 49 is moved upwardly, as in Fig. 8, the feed clutch 42 is actuated, but when the collar 49 is moved in the opposite direction the feed brake 42' is applied. Similarly, when the drive clutch throw collar 50 is moved downwardly, as in Fig. 8, the clutch 43 is actuated, and when said collar is moved upwardly the drive brake 43' is applied.

The gear 44 within whose opposite end the clutches 42 and 43 are mounted, as shown in Fig. 8, is driven by a gear 46 which in turn is driven by a pinion gear 47. This latter derives its power from an engine carried by a motor truck or other source of power connected to a propeller shaft 48. The clutch throw collar 49 is moved by clutch throw cams 51 and 51', as shown particularly in Fig. 10, to compress the clutch plates 42 and so transmit power from the shaft 48 to the shaft 38'. Similarly, the clutch throw collar 50 is moved by cams 52 and 52', as shown in Fig. 9, to compress the clutch plates 43 and transmit power from the shaft 48 to the shaft 37'.

In order to operate the cams 51 and 51', a yoke including a pair of arms 53 and 53' and a cross-member 55 is connected to the cams 51 and 51', respectively, as shown in Fig. 10. Similarly, the cams 52 and 52' in Fig. 9, are operated by a yoke including arms 54 and 54' which are connected together through a cross-member 56. Clutch push rods 57' and 58' are connected to the centers of the cross-members 55 and 56, respectively. Equalizing springs 59 and 59' are mounted on the rod 57', and similar springs 60 and 60' are mounted on the rod 58', as shown in Figs. 2 and 8. These springs enable operating pressures from the rods 57' and 58' to be gradually applied to the yokes 55 and 56, respectively, to operate the clutches or brakes as the case may be.

As previously pointed out, the feed clutch push rod 57' is attached at its opposite end through a bifurcated link 57 to a lever arm 61 mounted upon the casing 39, as shown in Figs. 5, 6 and 7. Similarly, the drive clutch push rod 58' is connected through a telescoping arrangement shown at 83 in Fig. 11 to a bifurcated link 58 which is connected to a lever arm 62 pivotally mounted upon the casing 39, as shown in Figs. 5, 6 and 7. Hand-operated levers 65 and 66 are fixedly mounted upon the lever arms 61 and 62, respectively, as shown in Figs. 5 and 6 particularly.

Earth boring operations

By pulling the feed lever **65** toward the operator (that is, to the right in Figs. 1 and 2) the rod **57'** will actuate the feed clutch **42** through cams **51** and **51'** of Fig. 10. By pushing the lever in the opposite direction the feed brake **42'** will be applied. Similarly, if the operator pulls the drive lever **66** to the right in Figs. 1 and 2, the rod **58'** will be pulled to the right, and through the cams **52** and **52'** of Fig. 9 will actuate the drive clutch **43**. When the drive lever **66** is moved in the opposite direction the brake **43'** will be applied.

The operator in order to dig a hole may, by pushing the drive lever **66** away from him (to the left in Fig. 1) and pulling the feed lever **65** toward him, actuate the drive clutch **43** and apply the feed brake **42'**, respectively. The feed brake **42'**, acting through the shaft **38'**, gears **38** and **36**, shaft **33'** and gear **33**, holds the feed gear **11** in Fig. 3 from rotating. The drive clutch **43** upon being actuated, however, causes the shaft **37'** to rotate and, acting through gears **37** and **35** and through shaft **34'**, causes the gear **34** to rotate the drive gear **12** and the carrier **6** in the direction indicated by the looped arrow *e* in Fig. 12. The rotation of the carrier **6** turns with it the shaft **7** and the auger **26**. The rotation of the drive gear **12** at full speed, while the feed gear **11** is held stationary, causes the beveled gear **10** to rotate rapidly. Through the pinion gears **10'** and **9**, the pinion gear **9'** is thus rotated rapidly in such a direction as to move the shaft **7** downwardly at high speed.

When the auger **26** approaches the surface of the earth the operator may desire to move the auger downwardly at a slower speed. To accomplish this the operator while still pushing the drive lever **66** away from him (that is, to the right in Figs. 1 and 2) will also push the feed lever **65** away from him, thus releasing the feed brake **42'** in Fig. 8 and actuating the feed clutch **42**. Power is now transmitted through gear **44** and through the feed clutch **42** to the shaft **38'**, and thence through gears **38** and **36**, and through shaft **33'** and gear **33**, to rotate the feed gear **11** in the direction of the looped arrow *d* as shown in Fig. 12.

We now have both the feed gear **11** and drive gear **12** rotating in the same direction. As was pointed out earlier, the ratios of the various gears are such that under the condition where both gears **11** and **12** are rotating at full speed the drive gear **12** will rotate slightly faster than the gear **11**. This will cause the train of gears **10**, **10'**, **9** and **9'** to rotate in the same direction as described before, but relatively slowly. Consequently, the pinion **9'** operating on the rack of the shaft **7** moves the shaft **7** downwardly at a slower rate than before. We now have the shaft **7** turning rapidly but moving downward slowly, which is a normal earth boring condition.

After the operator has driven the auger into the earth a certain distance, he will want to remove the excavated material. To do this the auger **26** should first be elevated rapidly without turning until it comes above the level of the ground, after which it should stop rising and should rotate rapidly to throw off the dirt.

To accomplish these results the operator will first shift the drive lever **66** to braking position, thus applying the drive brake **43'**, and at the same time he will hold the feed lever **65** in its clutch-actuating position to continue actuating the feed clutch **42**. The application of the drive brake **43'** causes shaft **37'**, and hence the drive gear **12**, to cease rotating. The feed clutch **42** being still applied, causes the shaft **38'** to continue rotating and this, acting through the train of gearing previously described, causes the gear **33** to rotate the feed gear **11** in the direction indicated by the looped arrow *d* in Fig. 12.

We now have the drive gear **12** stationary and the gear **11** rotating so that the beveled gear **10** will be driven in the opposite direction to that before described. The beveled gear **10** acting through the pinions **10'** and **9** causes the pinion **9'** to turn at full speed in the opposite direction from that indicated by the arrow in Fig. 12. This causes the shaft **7** to rise rapidly without rotating.

When the shaft **7** has been elevated to the desired position the operator will leave the feed lever **65** in its clutch-actuating position to actuate the feed clutch **42** and will move the drive lever **66** to its clutch-actuating position. This releases the drive brake **43'** and actuates the drive clutch **43**. Under these conditions, as previously described, both feed gear **11** and drive gear **12** are rotated (the former at slightly slower speed) so that the shaft **7** is moved slowly downward and at the same time is rapidly rotated by the turning of the drive gear **12**. This throws off the accumulated dirt after which the operations previously described for rapidly lowering the auger **26** and then causing it to be lowered more slowly and at the same time turned, will be repeated.

Automatic safety mechanism

A difficulty encountered with earth boring machines of the type so far described is that when the operator raises the auger rapidly by pushing the feed lever **65** in Figs. 1 and 2 to the right and pulling the drive lever **66** to the left, he sometimes fails to stop the upward movement of the shaft in time. The result is that the auger **26** drives the disc or washer **67** up against the collar **24** and fully compresses the spring **32** before operating the drive lever **66** to its right-hand or clutch-actuating position to stop the elevation of the auger. In the past, this action might, if the operator were not careful, result in breaking the second reduction gear **33** or its shaft **33'**. This is because when this particular condition occurs, the drive gear **12** is stationary while the feed gear **11** is being rotated by means of the feed shaft **33'** and the second reduction pinion gear **33**. Therefore, when the shaft **7** is suddenly brought to a full stop with power applied through the shaft **33'** to the second reduction gear **33**, an opposite force is at the same time applied by the shaft **7** to gear **33** through the gears **9'**, **9**, **10'**, **10** and feed gear **11**. As the force of the engine and the inertia of the parts tend to continue to drive the gears and the feed shafts, after the bumping of the auger against the case has prevented further gear turning, a breakage sometimes occurs.

That such breakages would occur with improper operation, can readily be seen from the fact that even at an engine speed of only 1,000 revolutions per minute the auger will rise at the rate of about 140 ft. a minute. At higher engine speeds the auger will rise at a correspondingly greater rate unless, of course, the clutches in the earth boring machine are slipped. A speed of even 140 ft. a minute requires quick action upon the lever by the operator in order to stop the upward movement of the auger after it leaves the ground and before it bumps the collar **24** at

the bottom of the boring head. This quick action is entirely practicable with experienced operators, but new operators or careless operators occasionally do not synchronize their motions quickly enough to prevent trouble.

In order to prevent the above trouble, a safety device is herein provided to automatically stop the upward travel of the auger and start it spinning to throw off the dirt. This automatic safety device is so arranged that when it operates, the drive brake 43' is released and the drive clutch 43 is quickly actuated. As the feed clutch is already actuated, the auger is not only caused to spin and throw off the dirt, but also to start moving slowly in a downward direction. This eliminates the possibility of bumping the bottom of the boring head and causing the gear or shaft breakage trouble.

In order to accomplish this result, as the auger rises the disc or plate 67 is caused to engage levers 68 and 68'. As shown in Figs. 1, 2 and 3, these levers are mounted upon a common shaft 70' in such manner that they move together. The shaft 70' is carried by a bracket 70 which is bolted to a part of the housing 5 as shown more clearly in Fig. 3. Also fixed upon the shaft 70', and preferably forming an integral part of the lever 68, is an operating arm 69 (see Figs. 1, 2 and 3).

This arm 69 is connected by a bifurcated link 71 to a rod 72 which passes through a sleeve 73, as shown more clearly in Fig. 11. The sleeve 73 is attached by a bracket to housing 5 and is part of a flexible remote control cable 72, 73, 74, 75, 77 of well-known type, which enables the rod 72 to pull or push a flexible wire back and forth through the tubular part of the cable 74 to operate rod 77. Rod 77 moves within sleeve 75 which is attached by means of a bracket 76 to the outer casing 83 of the telescoping arrangement shown in Fig. 11. The sleeve 73 within which the rod 72 is guided, is affixed by means of a bracket 73' to the housing 5 as shown in Fig. 2. Another bracket 74' attached to said housing is also used to limit the amount of movement of flexible shaft 74 as shown in Fig. 1.

The rod 77 at the distant end of the flexible cable 74 is attached by means of a bifurcated link 78 to a trigger 79 pivoted at 80 within a slot extending transversely through the sleeve 83 of the telescoping arrangement. This telescoping arrangement includes a rod 81 connected by means of the bifurcated link 58 to the drive lever arm 62. At its other end rod 81 is connected through a collar 82 to one end of the outer sleeve 83 of the telescopic device.

The opposite end of the sleeve 83 is closed by means of a collar 84 within which an inner sleeve 85 of the telescoping arrangement is permitted to slide. One end of the inner sleeve 85 is connected by the drive rod 58' to the yoke operating the drive clutch and drive brake as shown particularly in Figs. 8 and 9. The other end of the inner sleeve 85 is closed by means of a plug 89 having a beveled end arranged to co-operate with the trigger 79 in a manner to be later described. A collar 87 surrounds the sleeve 85 near the end containing the terminal plug 89. Between said collar and the collar 84 at the opposite end of the outer sleeve 83 a heavy compressed spring 86 is inserted.

With the parts in the position shown in Fig. 11, the spring 86 is under compression and the plug end 89 of the sleeve 85 is held in position against the pressure of this spring by means of the trigger 79. The trigger 79 is in turn held in the position shown in Fig. 11 by means of a coiled tension spring 90 attached to one end of the outer sleeve 83. If, therefore, the trigger 79 is moved in a clockwise direction by means of the remote control cable 74, it will release the beveled end 89 of the inner sleeve 85, so that the latter will be moved to the right within the outer sleeve 83 under the pressure of the spring 86. This, in effect, telescopes the connection between the drive lever 66, shown in Fig. 5, and the drive clutch and drive brake mechanism shown in Fig. 8.

Operation of safety mechanism

With this arrangement, when the operator throws the drive lever 66, in Figs. 1 and 2, to the left to apply the drive brake 43' and at the same time moves the feed lever 65 to the right to actuate the feed clutch 42. the auger commences to rise rapidly without turning. As soon as the auger rises to such a position that the plate or washer 67 carried by the shaft 7 engages the levers 68 and 68', said levers will be moved upwardly toward the collar 24. This action moves the arm 69 and thus pulls on the remote control cable.

When the washer 67 has risen about one-third of its travel, the remote control cable pulls the trigger 79 in Fig. 11, and thus releases the beveled end 89 of the inner sleeve 85 of the telescoping arrangement. The inner sleeve 85 is now moved to the right within the outer sleeve 83 under the pressure of the heavy compression spring 86 and thus, in effect, the two members telescope together. This action pulls the rod 58' in Fig. 11 to the right and thus operates the drive yoke 54—54' in Fig. 8 to release the drive brake 43' and actuate the drive clutch 43. As the feed lever 65 is already in such position that the feed clutch 42 is actuated, we have both the feed gear 11 and drive gear 12 of Fig. 3 rotating in the same direction. This, as previously described, causes the auger to rotate rapidly to throw off the dirt and at the same time to move slowly downward.

The foregoing actions, therefore, normally stop the upward travel of the auger before it strikes the boring head. It should be noted that the lower part of the collar 24 on the bottom of the boring head is recessed slightly as shown at 24'. Therefore, if the arrangement above described should fail to function for any reason, the levers 68 and 68' will be moved upwardly within this recess when the washer 67 bumps against the bottom of the collar 28. Consequently, the release levers 68 and 68' will not be damaged.

It will also be observed that an adjustable set screw 91 is provided on the drive lever 66 (see Figs. 5 and 6) and a stop lug 92 is formed on the casing 39. When the telescoping action above described takes place, the set screw 91 is pulled up against the stop lug 92. Consequently, the movement of the inner sleeve 85 of the telescoping device shown in Fig. 11, due to the expansion of the spring 86, will cause rod 58' to operate the drive clutch 43.

It will be evident that if, after the above automatic action takes place, the operator pushes the drive lever 66 to its clutch actuating position, the connection between the drive lever 66 and the drive clutch operating mechanism in Fig. 8 will be, in effect, lengthened. This is because, when the sleeves 83 and 85 are in telescopic position, a movement of the sleeve 83 to the right in Fig. 11 carries the trigger 79 with it. while the beveled

head 89 of the sleeve 85 remains stationary. As soon as the sleeve 83 has been moved a suitable distance to the right, the trigger 79 will snap behind the head 89 due to the force of the coiled spring 90, so that the parts again assume the position shown in Fig. 11. Thereafter the earth boring machine may be operated in the usual manner to raise, lower or revolve the auger, until such time as the auger again raises high enough to again trip the safety device.

It will be evident that the operator may use the automatic safety device above described, to automatically stop the upward travel of the auger and cause it to rotate to discharge the dirt without any further action on his part. However, if he prefers, he may operate the control levers manually to stop the upward movement of the auger and cause it to rotate, as has been the practice with earth boring machines not equipped with the automatic release device. In such case, the safety device merely acts to safeguard the machine against damage, whereas in the former case the auger rotates to discharge dirt automatically.

While this invention has been disclosed in certain specific arrangements which are deemed desirable, it will be obvious that the general principles herein set forth may be embodied in many other organizations, widely different from those illustrated, without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In an earth boring machine, an auger, a boring head having a casing, a drive gear in said casing operating when rotated to rotate said auger, a feed gear in said casing rotatable in the same direction as said drive gear and adapted to feed said auger up or down depending upon its speed relative to said drive gear, whereby said auger may be elevated or lowered, independent manually operable levers and actuating links for each of said gears to cause either or both of them to rotate at desired speeds, one of said links having means to in effect adjust its length so that it may affect the action of the corresponding gear independently of its manual lever, and means automatically operable when said auger is elevated to a certain height to produce a change in the effective length of said adjustable link in a direction to defeat manual control by the operator tending toward further elevation of said auger and to cause a relative action of said gears, such as to reverse the direction of travel of said auger before it bumps the bottom of said boring head casing.

2. In an earth boring machine, an auger, a boring head having a casing, a drive gear in said casing operating when rotated to rotate said auger, a feed gear in said casing rotatable in the same direction as said drive gear and adapted to feed said auger up or down depending upon its speed relative to said drive gear, whereby said auger may be elevated or lowered, independent manually operable levers and actuating links for each of said gears to cause either or both of them to rotate at desired speeds, one of said links having means to in effect adjust its length so that it may affect the action of the corresponding gear

independently of its manual lever, and means automatically operable when said auger is elevated to a certain height to produce a change in the effective length of said adjustable links in a direction to defeat manual control by the operator tending toward further elevation of said auger and to cause a relative action of said gears such that said auger will start rotating to throw off accumulated dirt without bumping the bottom of the boring head.

3. In an earth boring machine, an auger, a boring head having a casing, a drive gear in said casing operating when rotated to rotate said auger, a feed gear in said casing rotatable in the same direction as said drive gear and adapted to feed said auger up or down depending upon its speed relative to said drive gear, whereby said auger may be elevated or lowered, independent manually operable levers and actuating links for each of said gears to cause either or both of them to rotate at desired speeds, one of said links having means to in effect adjust its length so that it may affect the action of the corresponding gear independently of its manual lever, and means automatically operable when said auger is elevated to a certain height to produce a change in the effective length of said adjustable link in a direction to defeat manual control by the operator tending toward further elevation of said auger and to cause a relative action of said gears such as to stop the elevation of said auger and cause it to start rotating to throw off accumulated dirt without bumping the bottom of said boring head casing.

4. In an earth boring machine, an auger, a boring head having a casing, a drive gear in said casing operating when rotated to rotate said auger, a feed gear in said casing rotatable in the same direction as said drive gear and adapted to feed said auger up or down depending upon its speed relative to said drive gear, whereby said auger may be elevated or lowered, independent manually operable levers and actuating links for each of said gears to cause either or both of them to rotate at desired speeds, one of said links having means to in effect adjust its length so that it may affect the action of the corresponding gear independently of its manual lever, and means automatically operable when said auger is elevated to a certain height to produce a change in the effective length of said adjustable link in a direction to defeat manual control by the operator tending toward further elevation of said auger and to cause a relative action of said gears such that said auger will rotate to throw off accumulated dirt and be slowly lowered without bumping the bottom of the boring head.

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The following references are of record in the file of this patent:

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