May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 1

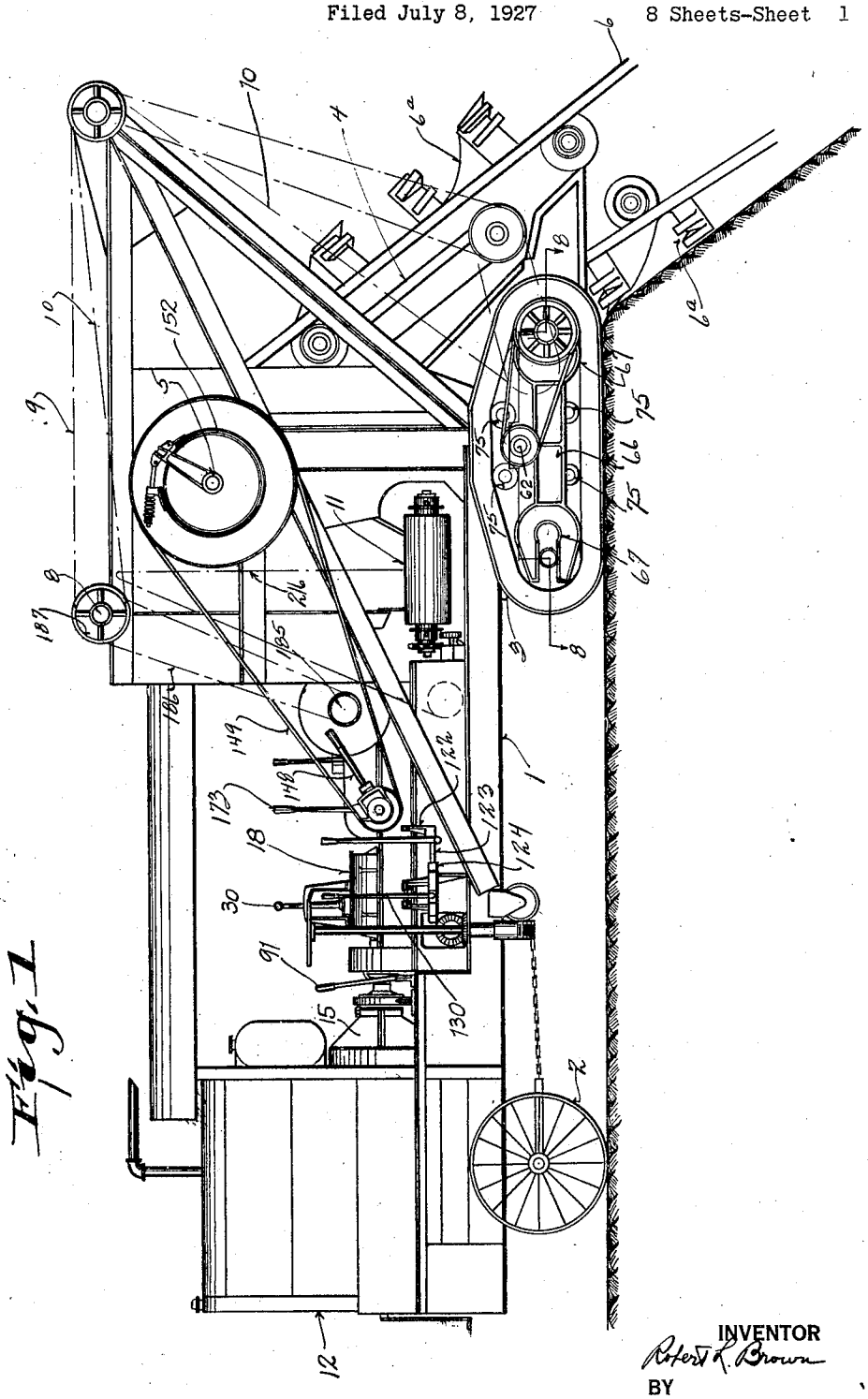


Fig. 1

INVENTOR
Robert L. Brown
BY
Bottum, Hubbell, Keeler, McNamara and Michael
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 2

Fig. 2

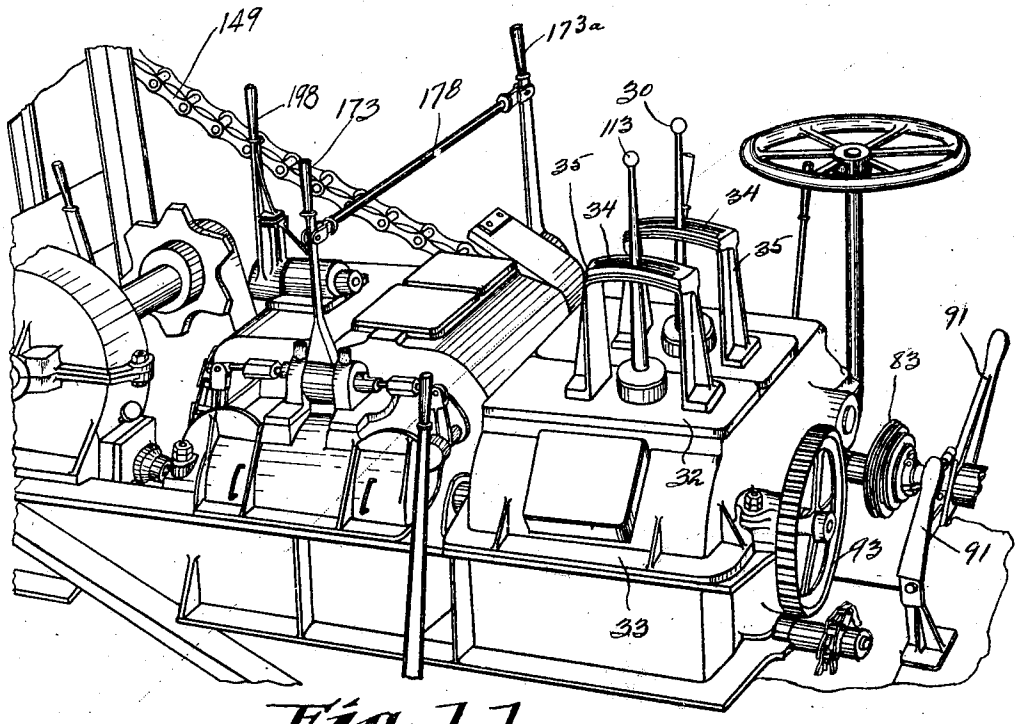
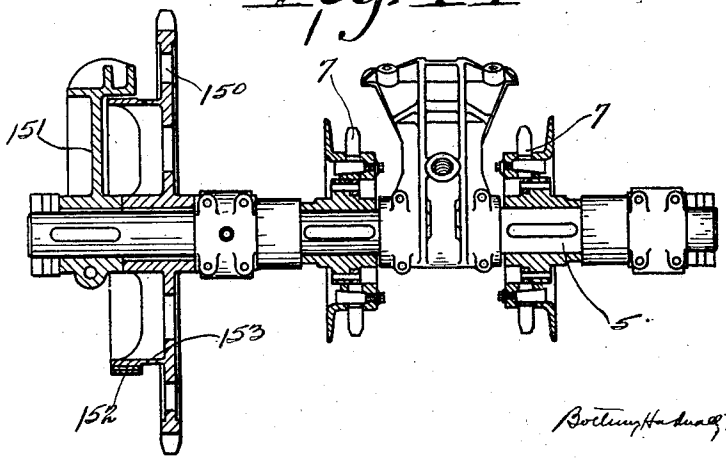


Fig. 11



INVENTOR
Robert L. Brown
BY
Bolting, Hudson & Keeler, McNamara and Mitchell
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 3

Fig. 12

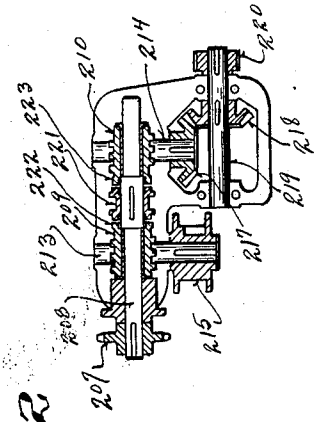


Fig. 3

INVENTOR
Robert L. Brown
BY
Bretney, Hudnall, Fischer, McNamara & Michael
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 4

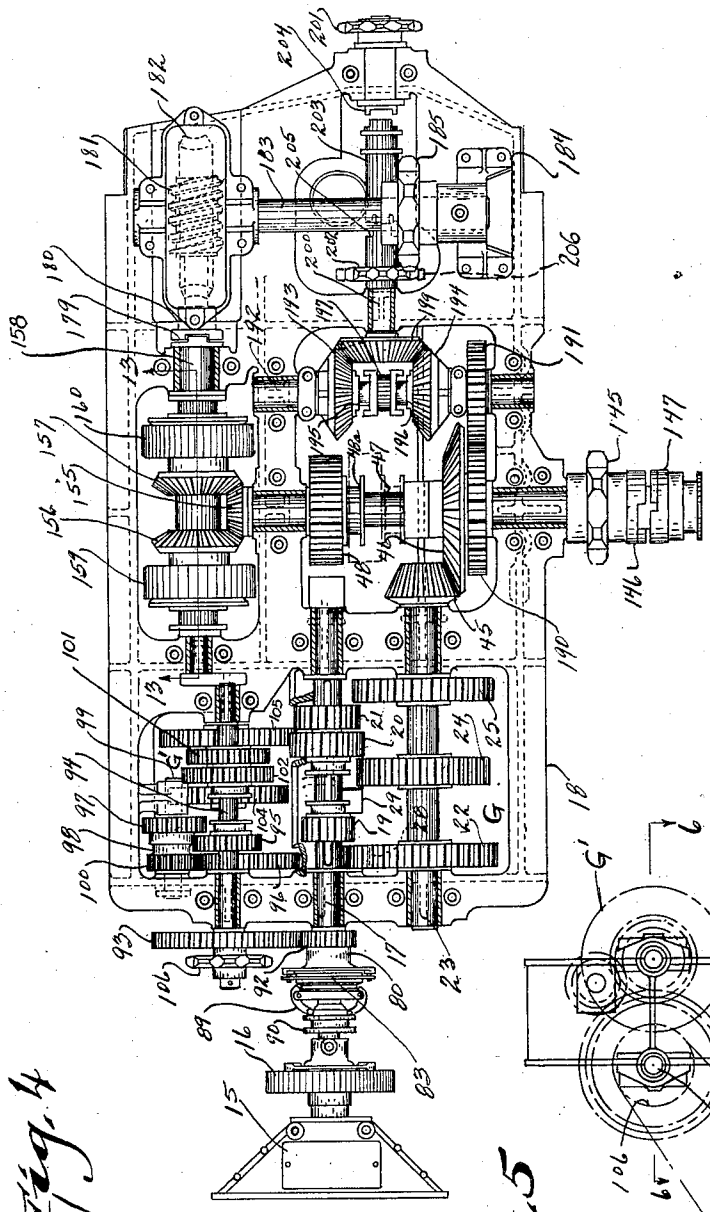


Fig. 4

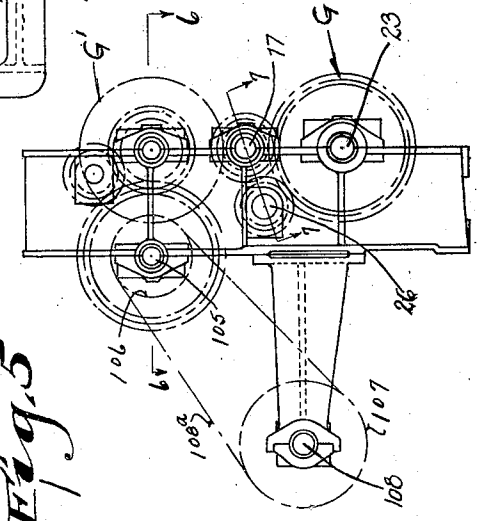


Fig. 5

INVENTOR
Robert L. Brown
BY
Bolting, Hudnall & Zachry, McNenny and Kinchel
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 5

Fig. 7

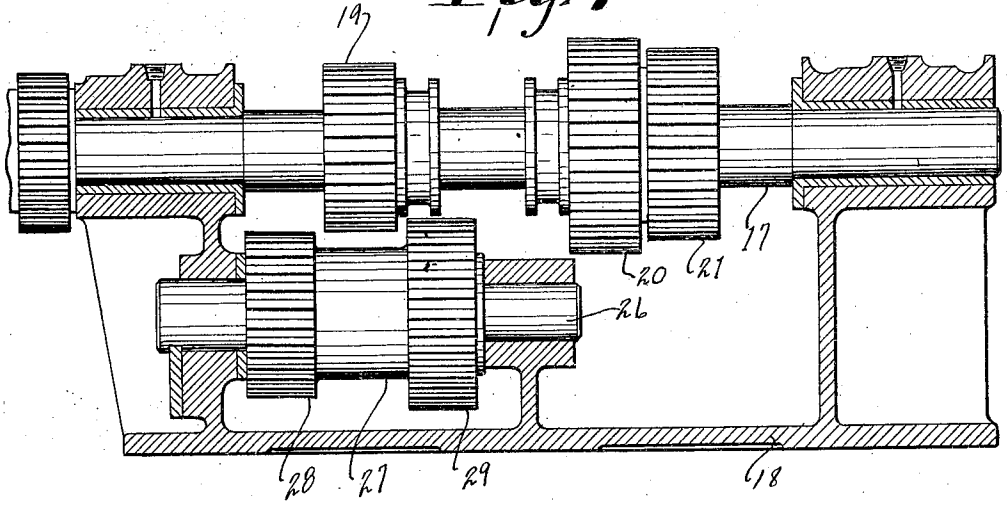
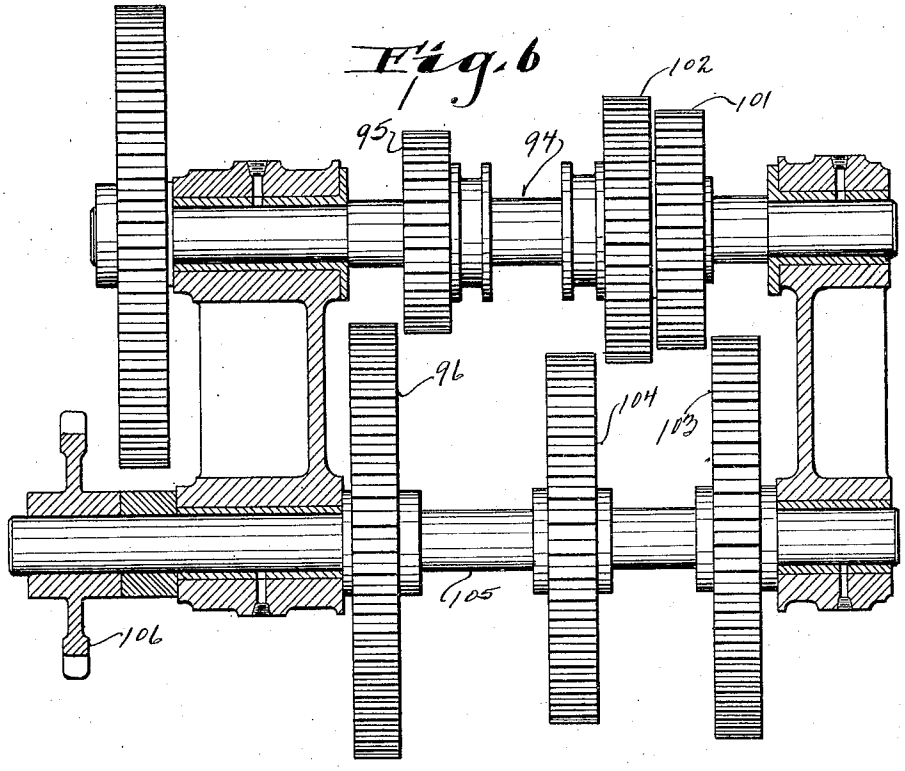


Fig. 6



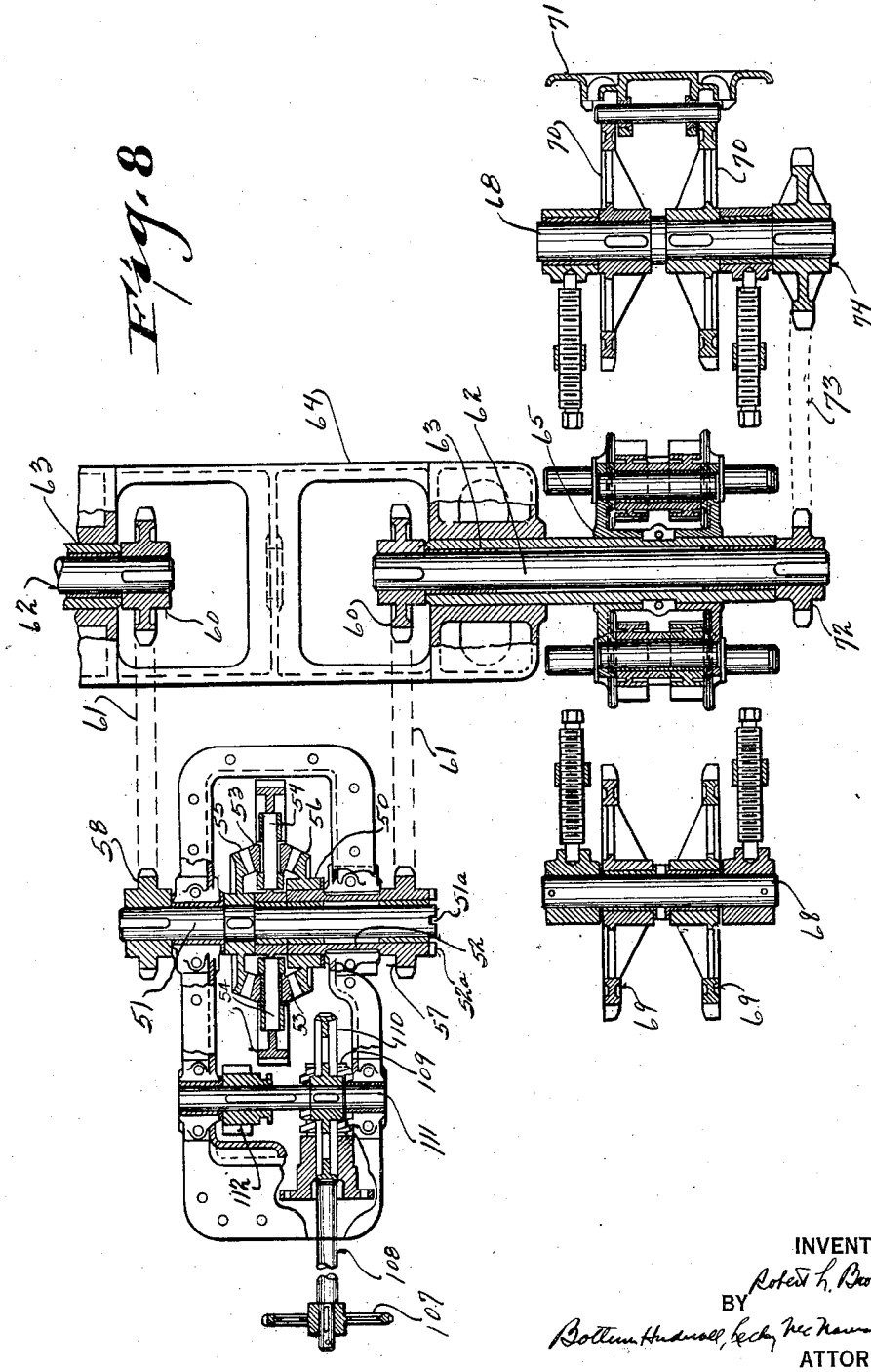
INVENTOR
Robert L. Brown
BY
Bottum, Hadwell, Becker, McManus and Michael
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 6

Fig. 8



INVENTOR
Robert L. Brown
BY
Bottum Hudnall, Lecky, McNamara & Michael
ATTORNEY

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 7

Fig. 9

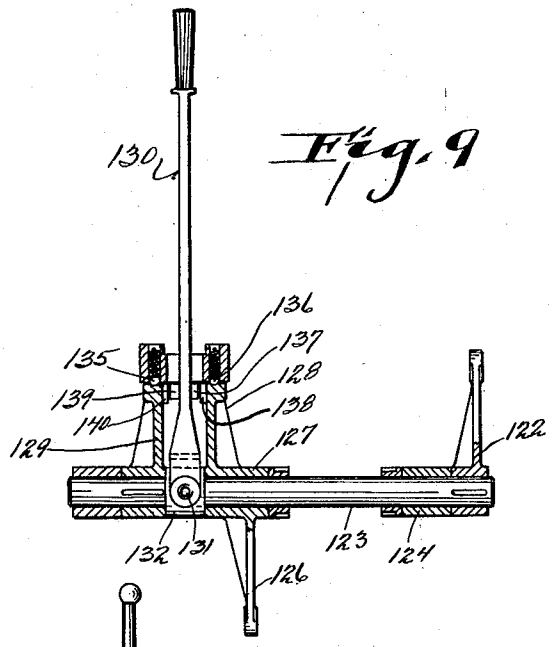


Fig. 9a

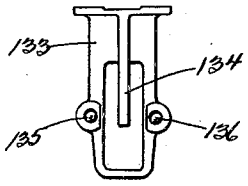


Fig. 16

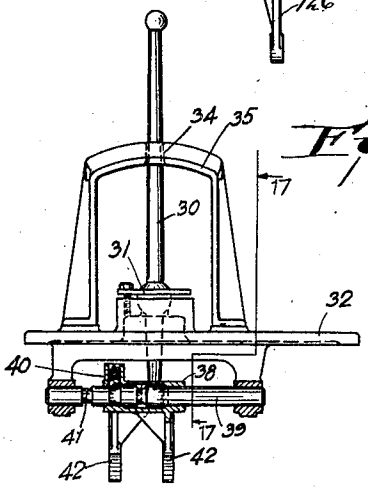
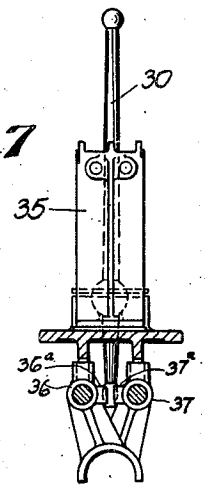


Fig. 17



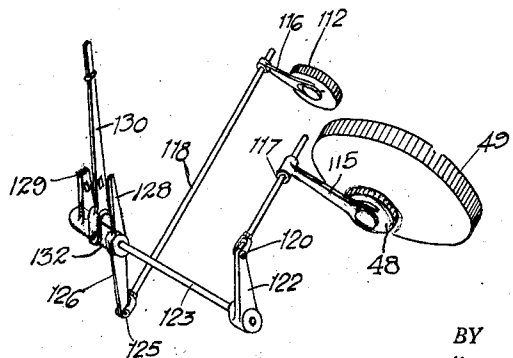


Fig. 10

INVENTOR.
Robert L. Brown
BY
Bottum, Hudnall, Lecher, McManigal & Mitchell
ATTORNEYS.

May 6, 1930. R. L. BROWN 1,756,971

TRENCHING MACHINE

Filed July 8, 1927 8 Sheets-Sheet 8

Fig. 13

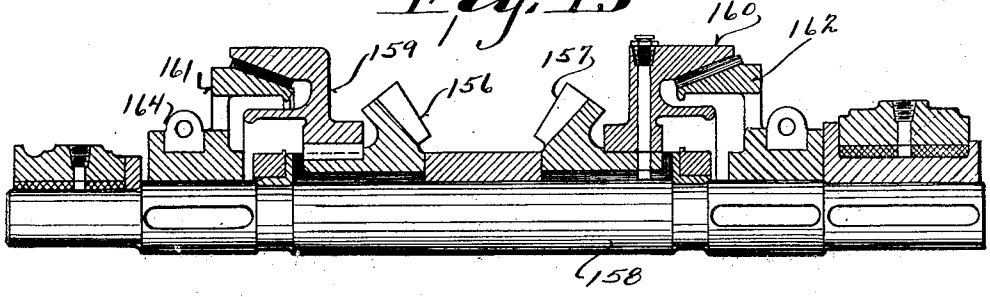


Fig. 14

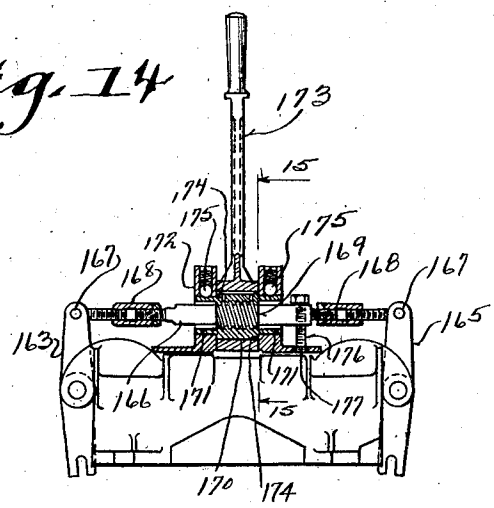
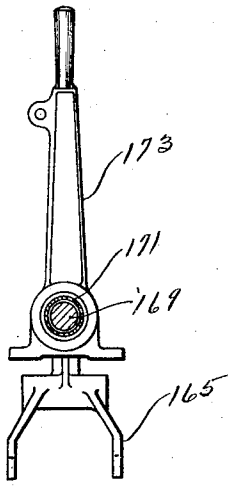


Fig. 15



INVENTOR
Robert L. Brown
BY
Bosby, Hudnall, Lacher, McKenna and Michael
ATTORNEY

Patented May 6, 1930 1,756,971

UNITED STATES PATENT OFFICE

ROBERT L. BROWN, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO HARNISCHFEGER CORPORATION, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN

TRENCHING MACHINE

Application filed July 8, 1927. Serial No. 204,225.

This invention relates in general to trenchers and more particularly to the so-called ladder type trenchers.

Trenchers of this type comprise, in general, a frame mounted on suitable running gear or traction means. At one end of the frame a boom is supported for pivotal movement. The buckets which effect the digging or excavating are mounted on endless chains supported at the ends of the boom and the dirt or spoil which is picked up by these buckets is deposited on a lateral or spoil conveyor by which it is carried off to one side of the machine. The problem which the drive and control of these several instrumentalities presents is broadly six-fold, in that; first the buckets must be suitably actuated for digging; second, the traction means must have a feeding movement imparted thereto while the digging is progressing; third, the boom which carries the buckets should be crowded during the digging and must be hoisted or elevated when the machine is traveling from place to place; fourth, the conveyor must be suitably actuated to carry away the dirt delivered thereto by the buckets; fifth, the conveyor should be power shifted from one side of the machine to the other and also hoisted out of the way when traveling from place to place; and, sixth, the traction means should be actuated at a relatively high speed for the so-called high traction or road traction which must be had when the machine is traveling from one job to another or from place to place.

Various attempts have been made to solve this problem or portions thereof but the solutions proposed have not dealt with and satisfied all of the phases of the problem and moreover, have been characterized for the most part by a maze of exposed chains and sprockets or a multiplicity of loosely organized units of mechanism, dangerous and unsatisfactory in operation, and expensive and difficult to produce and maintain in operative condition.

The resistance presented to the operation of the digging means varies greatly, not only when the so-called tough digging, such as boulders, hard-pan or frost, is encountered, but also when cave-ins occur. The trenchers heretofore proposed have met these difficulties in a very unsatisfactory manner and, in general, have not had the capacity to cope with the various situations, especially the more difficult ones. Thus, when cave-ins are encountered, the trenching machines heretofore proposed become stalled and the work is held up until laborers have cleared away the cave-in.

One object of the invention is to provide a trencher in which the buckets or digging means are driven at variable speed and power ratios from the power plant so that a high power low speed ratio is readily available to enable the trencher to work itself out of cave-ins and to deal effectively with tough digging, such as boulders, hard-pan or frost. The feed traction is also under the control of a variable speed mechanism of the selective type which is independent of the variable speed mechanism controlling the actuation of the buckets thereby making the selective change speed feature entirely practical and workable.

Another object of the invention resides in the provision of a compact and highly organized arrangement for carrying out the six broad trencher operations, and also the subordinate operations thereof. In fact, all of the main machinery is mounted in single piece case and is fully enclosed and yet every motion has three forward speeds and one reverse without any changing of sprockets or without any material interruption in the operation beyond a simple gear shifting which is easily and quickly carried out.

Another object of the invention resides in the provision of interlocking controls for related or conflicting operations. The organization and arrangement is such that the trencher may be easily and quickly controlled and this feature is enhanced by the duplications of the control levers which permits of convenient control by the operator from either side of the machine.

A further object resides in the provision of a differential lock for the traction drive which is not only accessible but readily and easily manipulated.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawings, forming a part of this specification, and in which:

Figure 1 is a fragmentary view in side elevation showing a trencher embodying the present invention;

Figure 2 is a fragmentary perspective view of the main machinery unit of the trencher and showing the control levers which regulate the various operations;

Figure 3 is a view in side elevation looking at the opposite side from that viewed in Figure 2, parts being broken away and shown in section for the sake of illustration;

Figure 4 is a plan view of the parts shown in Figure 2, the upper sections or cover sections of the casing or housing and the parts carried thereby being removed to illustrate the mechanism within the housing;

Figure 5 is a view in front elevation of the parts shown in Figure 4;

Figure 6 is a fragmentary view in section taken on line 6—6 of Figure 5 and illustrating the construction of the speed change mechanism;

Figure 7 is a similar view taken on line 7—7 of Figure 5;

Figure 8 is a fragmentary group view partly in horizontal section and partly in plan, the sections being taken partly on line 8—8 of Figure 3 and partly on line 8—8 of Figure 1, the view illustrating the operative connection between the traction drive and one of the traction devices, parts being omitted for the sake of illustration;

Figure 9 is a view partly in side elevation and partly in section showing the interlocking control for the shift pinions of the traction drive which alternately engage the master gear of the differential of the traction drive;

Figure 9a is a detail view of the bracket of the interlocking control;

Figure 10 is a diagrammatic perspective view illustrating the mechanism of the Figure 9 and the associated parts;

Figure 11 is a view partly in elevation and partly in section showing the shaft and the parts associated therewith for driving the digging chains upon which the buckets are carried;

Figure 12 is a fragmentary sectional view on line 12—12 of Figure 3 the casing being broken away and parts below the plane of section also being shown in section for the sake of illustration;

Figure 13 is a fragmentary view partly in elevation and partly in section, the section being taken in the plane of line 13—13 of Figure 4;

Figure 14 is a view partly in elevation and partly in section showing the lever and screw actuated shift forks for controlling the clutches of Figure 13;

Figure 15 is a view in section on line 15—15 of Figure 14;

Figure 16 is a view in elevation showing the lever operated shifting forks employed for the change speed gearing, parts being shown in section for the sake of illustration; and

Figure 17 is a view in section on line 17—17 of Figure 16, parts being shown in elevation for the sake of illustration.

General construction

Referring to the drawings and more particularly to Figure 1 it will be seen that the trencher comprises generally a suitable frame 1 supported at its forward end on steering wheels 2 and at its rearward end on traction devices 3 of the endless tread or self-laying track type. At a point well centered over the traction devices 3 a boom designated generally at 4 is supported, the boom 4 being pivoted to swing about the axis of a shaft 5 (see Fig. 11) suitably mounted in bearings provided therefor on the frame. Endless digging chains 6 are mounted on the usual sprockets (not shown) provided at the outer end of the boom and also on driving sprockets 7 keyed to the shaft 5. These digging chains 6 carry the digging buckets 6a.

For hoisting the boom and also for crowding the same during the digging a drum shaft 8 is rotatably mounted on the super-structure of the frame and carries drums for controlling a hoist line 9 and a crowding line 10. The arrangement of these drums and the reeving and organization of the crowding and hoisting lines with the boom and with the machine is fully set forth in my co-pending application for trench digging machines filed April 9, 1926, Serial No. 100,783, to which application reference is made for a full disclosure of these features. Of course, it is to be understood that the particular hoisting and crowding action may be varied without departing from the spirit and scope of the present invention.

A lateral spoil conveyor, designated generally at 11, is provided and extends transversely of the machine, this spoil conveyor receiving the dirt or spoil from the buckets and carrying it off to one side of the machine. The conveyor illustrated is identical with that forming the subject matter of my co-pending application for conveyors, filed December 29, 1926, Serial No. 157,646, now patent No. 1,743,878 to which application reference is made for a full disclosure of the conveyor construction and mounting. While the conveyor may be constructed as disclosed in the application referred to, it is to be under-

stood that various conveyor constructions and mountings may be employed.

At the forward end of the machine a power plant designated generally at 12 is provided and this power plant is usually an internal combustion engine. Interposed between this power plant and the shaft 5 of the digging means, the drum shaft 8 of the hoist and crowding boom, the conveyor drives and controls, and the traction devices 3, and organized with these several instrumentalities, is a mechanism embodying the present invention which, in Figure 1, is designated generally at M.

High or road traction

Referring now to Figure 4 it will be seen that the power plant is connected through a clutch 15 and flexible coupling 16 with a main shaft 17 journaled in bearings provided therefor in a single piece lower housing section or casing 18. This main drive shaft 17 constitutes the drive shaft of a selective change speed gear set G of the sliding gear type and has splined thereon a low speed pinion 19 and a pair of pinions designated at 20 and 21, the pinion 21 being mounted on an extension of the hub of the pinion 20 so that these two gears 20 and 21 are shifted and rotate as a unit. The slidable gear 19 is adapted to be brought into mesh with a low speed and reverse gear 22 fixed on a driven shaft 23 also rotatably mounted in bearings provided therefor in the main or lower section 18 of the casing. Similarly, the pinions 20 and 21 are adapted to be selectively meshed with driven gears 24 and 25, respectively, the gears 24 and 25 also being fixed on the driven shaft 23. When the gear 20 meshes with the gear 24 a high speed is obtained, whereas when the pinion 21 is meshed with the gear 25 a second or intermediate speed is had. To provide for reverse a countershaft 26 is journaled in bearings provided therefor in the section 18 as shown in Figure 7 and on the countershaft 26 a sleeve 27 is rotatably mounted and is provided with a pinion 28 constantly meshing with the low speed and reverse gear 22 and also has a gear 29 with which the low speed and reverse pinion 19 may be brought into mesh. The pinion 28 and gear 29 may be integral with the sleeve 27 or otherwise rigidly secured thereto.

The pinions 19, 20 and 21 are shifted from a gear shift lever 30 (see Figs. 2, 16 and 17) having a universal mounting indicated at 31 in the removable top plate 32 of a cover section 33. The portion of the lever adjacent its upper end coacts with and H-slot 34 provided in a bracket 35 fixed to the removable top plate 32. The lower end of the lever 30 is flattened and enlarged transversely and is laterally shiftable to selectively coact with sets of lugs 36^a and 37^a formed on shifters, the shifters being designated respectively by the numerals 36 and 37. The shifters are of similar construction and each includes a sleeve-like body portion 38 slidably mounted on a fixed supporting shaft 39 and having a spring projected ball or detent 40 selectively engageable with spaced recesses 41 on the supporting shaft 39 for holding the shifter in any one of its adjusted positions. The shifters have shifting forks 42 integral with their sleeve-like bearing portions 38 and these shifting forks coact respectively with the annular grooves of the hubs of the slidable pinions with which they are associated.

Beveled pinion 45 is fixed to the rearward end of the shaft 23 and constantly meshes with a beveled gear 46 fixed on an intermediate transversely extending shaft 47 journaled in suitable bearings provided therefor on the main section 18 of the casing. A shiftable pinion 48 is splined on the intermediate portion of the shaft 47 and has a grooved hub extension 48^a adapted to coact with a shifter fork as will be hereinafter more fully described. This pinion 48 in one of its positions overlies and meshes with the master gear 49 of a differential designated generally at 50 and mounted in a lower section of the casing below and just rearwardly of the transverse shaft 47 (see Figs. 3 and 8). In another position of the pinion 48, that is, in the position shown in dotted lines in Figure 4, it is disengaged from the master gear of the differential. The master gear 49 of the differential is rotatably mounted on an inner solid shaft 51 journaled in a suitable bearing provided therefor on the lower section 18 of the casing and rotatably fitted in an appropriately bushed sleeve shaft 52 which is also rotatably mounted in a bearing provided for the same on the casing. Differential pinions 53 are rotatably mounted on radial studs 54 carried by the master gear 49 and these differential pinions mesh with confronting beveled gears 55 and 56 fixed respectively to the solid shaft 51 and to the outer sleeve shaft 52. The sleeve shaft 52 projects to one side of the casing 18 and the projecting portion has a sprocket wheel 57 integrally formed therewith or otherwise suitably connected thereto. The solid shaft 51 projects beyond the opposite side of the casing and has a sprocket wheel 58 fixed thereto.

The solid shaft 51 extends through the sleeve shaft 52 for the full length thereof and the ends of the shafts 51 and 52 located adjacent the sprocket wheel 57 have diametrical slots 51^a and 52^a, the slots 51^a and 52^a are adapted to receive a suitable key (not shown) when these slots are alined, and when the key is fitted and secured in the slots 51^a and 52^a then the shafts 51 and 52 are locked together and the differential is locked or rendered inoperative. This is an extremely desirable feature under some conditions.

As shown in Figure 8, the sprocket wheels

57 and 58 are in fore and aft alinement with the sprocket wheels 60 of the traction devices 3 and these sprocket wheels 57 and 58 are operatively connected with the sprocket wheels 60 by means of sprocket chains 61. As the traction devices 3 are of identical construction a single description will serve for both. Each sprocket wheel 60 is fixed to the inner end of a rotatable shaft 62. The shaft 62 of each traction device is rotatably supported in a fixed sleeve 63. The sleeve 63 is mounted in a member 64 of the frame of the trencher and projects laterally beyond the same and through a bearing 65 provided on the frame member 66 of the associate traction device. The ends of the frame 66 are provided with yokes 67 in which supporting shafts 68 are adjustably mounted, one shaft 68 supporting idler sprockets 69 and the other shaft 68 having fixed thereto drive sprockets 70, both sets of sprockets 69 and 70 being operatively engaged with the endless tread member 71. The drive is transmitted to the shaft 68 carrying the drive sprocket 70 through a sprocket wheel 72 fixed on the outer end of the shaft 62, a sprocket chain 73 and a sprocket wheel 74 fixed on the outer end of the shaft 68 on which the drive sprockets 70 are mounted. By transmitting the drive to the endless tread members through the axis about which they tilt, that is, through the center support thereof, the traction device is free to adjust itself to all slopes of grounds. Each traction device also has a number of rollers 75 for the endless tread member thereof.

It will be understood that the parts hereinafter described and shown in Figure 8 constitute one form of traction device which is selectively actuated from either of the gear sets G and G′ as will hereinafter more clearly appear.

From the foregoing it will be understood that when the pinion 48 is engaged with the master gear 49 of the differential 50 high or road traction is had and by manipulating the gear shift lever 30 and the clutch 15 the advantage of three forward speeds and a reverse are available. Thus, in high traction there is provided a low speed for steep hills and hard pulls, and high speed for easy travel.

Feed or low traction

For imparting a slow forward feeding movement to the trencher when digging, provision is made for imparting a feed or low traction movement to the traction devices 3 and with the present invention this feed traction is had through a variable speed gear set G′ of the selective type and is had independently of the actuation or drive of the digging means as will hereinafter more clearly appear. In carrying out these purposes a sleeve 80 is rotatably mounted on the forward end of the main drive shaft 17 just outside of the main section 18 of the casing. At its forward end the sleeve 80 is provided with a flange 81 on which a driven friction disc 82 of a clutch designated generally at 83 is carried. The clutch 83 also includes a sleeve 84 keyed to the drive shaft 17 and having an integral flange 85 at its inner end. This flange 85 has a friction ring 86 interposed between it and one face of the driven friction disc 82. A similar friction ring 87 is engageable with the opposite face of the driven friction disc 82 and the engagement of these parts is controlled by a pressure ring 88 mounted on the sleeve 84 and controlled by camming lever arms 89 to which a shiftable collar 90 imparts operative movements. The collar 90 is controlled by clutch levers 91 duplicated to facilitate operation of the clutch 83 from either side of the machine (see Fig. 2) and having the usual shifting fork engaging in an annular groove in the collar. The sleeve 80 has a pinion 92 at its rearward end, this pinion 92 constantly meshing with a gear wheel 93 fixed to the forward end of the driving shaft 94 of a change speed gear set G′ of the selective type. A cover is provided for these gears 93 and 94 but is removed for the sake of illustration. Preferably this gear set G′ is of the type wherein sliding gears are provided to obtain the desired forward speed or reverse and in fact this gear set G′ is the same as the gear set G employed with the high traction arrangement hereinabove described except for variations in the gear ratios as will be understood from the drawings.

As shown in Figures 4 and 6 a low speed and reverse pinion 95 is splined on the drive shaft 94 and is engageable with a low speed driven gear 96, when shifted forwardly. When shifted rearwardly this pinion 95 is engageable with a gear 97 of the reversing arrangement substantially the same as that shown in Figure 7 and embodying a sleeve 98 rotatably mounted on a countershaft 99 and having a second integral pinion 100 constantly meshing with the driven gear 96. A second or intermediate speed gear 101 and a high speed gear 102 are also splined on the shaft 94 and are selectively engageable with driven gears 103 and 104, respectively, the driven gears being fixed on the driven shaft 105 to which the driven gear 96 is also fixed.

Figure 6 illustrates in detail just how the intermediate and high speed driving gears of both gear sets G and G′ are mounted on the driving shaft.

The forward end of the driven shaft 105 projects through the forward end of the section 18 of the casing and the projecting portion of this driven shaft 105 has a sprocket wheel 106 fastened thereto. The sprocket wheel 106 is connected to a sprocket wheel 107 by means of a sprocket chain 108ª (see

Fig. 5). As illustrated in Figure 8, the sprocket wheel 107 is fastened to the forward end of the worm shaft 108, the worm shaft 108 extending rearwardly into a lower section of the casing and being rotatably mounted in bearings provided therein. Within the casing this shaft 108 carries a worm 109 which meshes with a worm wheel 110 fixed to a transverse shaft 111 journaled in the casing section 18 above the worm shaft 108. A pinion 112 is splined on the shaft 111 and may be positioned to mesh with the master gear 49 of the differential and also may be positioned to be disengaged from this master gear.

When the pinion 112 is engaged with the master gear of the differential, feeding movement may be imparted to the traction devices by manipulating the clutch 83 and by shifting the gear shift lever 113. This gear shift lever 113 controls the action of the gear set G′ of the feed traction drive through a shifting fork arrangement identical with that shown in Figures 16 and 17, and hereinabove described.

Interlocking control for high and feed traction

From the foregoing it will be understood that the selection of high or feed traction is determined by shifting the pinions 48 or 112 into engagement with the master gear 49 of the differential 50. It would be extremely undesirable and probably would result in serious damage to the machine if a careless operator engaged both of these pinions 48 and 112 with the master gear of the differential and attempted to bring into action the high and the low traction at the same time. To preclude any possibility of this an interlocking control is provided for the high and low traction whereby when the pinion 48 is engaged with the master gear 49 of the differential the pinion 112 is necessarily and automatically disengaged therefrom and vice versa.

Referring now to Figures 9 and 10 it will be seen that shifting forks 115 and 116 are provided for the pinions 48 and 112, respectively, the shifting forks 115 and 116 being respectively fixed on sliding shift rods 117 and 118 mounted for sliding movement in bearings 119 and 120 provided on the casing (see Fig. 3). The shift rod 117 is pivotally connected as at 120 to the upper end of an upwardly extending crank arm 122 fixed to one end of a rock shaft 123 journaled in bearing brackets 124 provided therefor and fixed to the casing section 18. The outer end of the shift rod 118 is pivotally connected as at 125 to the downwardly extending arm 126 of a double crank designated generally at 127 and loosely mounted on the rock shaft 123. This double crank 127 also has an upwardly extending crank arm 128. Opposite with respect to and confronting the arm 128 of the double crank is a third crank arm 129 which is keyed to the rock shaft 123. A control lever 130 is provided in between the arms 128 and 129 and has its lower end bifurcated and pivoted on trunnions 131 of a collar 132 loosely fitted on the rock shaft 123. With this mounting of the lever it may be shifted or swung in a substantially vertical plane and may be also adjusted angularly about the rock shaft. The lever 130 operates in a slotted bracket 133 (see Fig. 9a) fastened to the side of the casing and having its slot or opening divided for part of its length by a partition bar 134 constituting a guide for preventing lateral movement of the lever in certain phases of its movements. The bracket 133 also has spring projected balls or detents 135 and 136 engageable with recesses in the arms 128 and 129 to releasably hold these arms in their several adjustments. The upper ends of the arms 128 and 129 are of arcuate form and some portion of the upper ends of these arms underlies the spring projected detents in all adjustments of the arms. When the lever 130 is positioned outwardly beyond the partition or guide bar 134 it may be swung laterally in either direction. When swung laterally toward the arm 128 a laterally projecting lug 137 on the lever is engaged between a pair of similar lugs 138 provided on the arm 128 and when so engaged the lever may be swung angularly about the rock shaft 123 to rotate the double crank 127 and shift the pinion 112 into engagement with the master gear 49 of the differential. At this time the pinion 48 is necessarily disengaged from the master gear of the differential. To disengage the pinion 112 from the master gear of the differential the control lever 130 is swung outwardly to correspondingly adjust the double crank 127 and the shift rod. Not until the pinion 112 has been completely disengaged from the master gear 49 of the differential is the control lever 130 free to shift laterally, the dividing bar or guide bar 134 constraining against lateral shifting up to this time. However, when the complete disengagement of the pinion 112 has been effected then the lever 130 is positioned in the unobstructed portion of the slot of the bracket and may be shifted laterally away from the arm 128 and toward the arm 129 whereupon a lug 139 on the lever engages a similar pair of lugs 140 on the crank arm 129. With this lateral adjustment of the lever it may again be swung inwardly to rock the rock shaft through the crank arm 129 and to so slide the shift rod 117 from the crank arm 122 as to engage the pinion 48 with the master gear of the differential. In each instance it is impossible to engage either pinion 48 or 112 with the

master gear of the differential until the other has been completely disengaged therefrom.

Digging chain or bucket drive

The motion imparted to the digging chains 6 which carry the buckets 7 is taken from the shaft 47 which is driven through the gear set G at low, intermediate or high speeds or reverse.

As shown in Figure 4 one end of the shaft 47 projects through the main section 18 of the casing and has a sprocket wheel 145 loosely mounted thereon. The hub of the sprocket wheel 145 is provided with a clutch member 146 cooperable with a clutch member 147 splined on the shaft 47 and controlled as to its engagement with the clutch member 146 by means of a lever 148 (see Fig. 1). A chain 149 is trained over the sprocket wheel 145 and also over a large sprocket wheel 150 loosely mounted on the drive shaft 5 which carries the drive sprocket 7 for the digging chains. The sprocket 150 is connected with the shaft 5 by a slip connection which normally constrains the shaft 5 to rotate with the sprocket 150 but it yields or slips when the strain exceeds a predetermined amount. This slip connection includes an arm 151 keyed to the shaft 5 and carrying a friction band 152 having an adjustable spring tensioning device associated therewith, the friction band embracing and clamping a drum 153 integral with the sprocket 150. With this arrangement, when any impossible obstruction is encountered the friction band will slip, relieving the digging chain of any excessive strain and preventing breakage. Moreover, no jerks or sudden shocks are transmitted to the main machinery. This slip connection is a positive safety device protecting the whole mechanism from sudden shocks.

Boom hoist and crowd

The motion for rotating the drum shaft 8 in the proper direction for hoisting or crowding the boom is also taken from the shaft 47 and for this purpose the shaft 47 is provided at its inner end with a beveled pinion 155 which constantly meshes with a pair of oppositely disposed beveled gears designated at 156 and 157 (see Figs. 4 and 13). The beveled gears 156 and 157 are loosely mounted on a shaft 158 journaled in bearings provided therefor in the main section 18 of the casing and these beveled gears have mounted thereon and fixed thereto conical clutch members 159 and 160. Coacting clutch members 161 and 162 are splined on the shaft 158 and coact with the clutch members 159 and 160, respectively. These clutch members are alternately engaged, that is, the clutch members 159 and 161 are engaged in one adjustment and the clutch members 160 and 162 are engaged in the other adjustment, and vice versa.

The operating mechanism for the clutch members 159 and 161, 160 and 162 is shown in Figures 14 and 15 and comprise a shifting fork 163 cooperable with the trunnions of a loose band 164 mounted in an annular groove in the hub of the clutch member 161 and a similar shifting fork 165 similarly associated with the clutch member 162. A rod 166 is provided and has its ends pivotally connected to the shifting forks as at 167. Turn buckles 168 are incorporated in the rod to provide for adjustment of the shifting forks. The central portion of the rod 166 is formed with a screw 169 threadedly engaged with a nut 170 having cylindrical extensions 171 adjustably mounted in bearings 172 provided therefor on the casing. A hand lever 173 is fixed to the nut in between the bearing brackets 172. The nut is shouldered as at 174 and these shoulders engage the bearing brackets 172 to prevent axial movement of the nut while leaving it free to rotate. Spring projected balls or detents 175 are provided on the bearing brackets 172 and engage spaced recesses on the extensions 171 of the nut to releasably hold the nut in neutral position. A guide stud 176 is threaded through the rod 166 and has its lower smoothed end slidably fitted in a guide slot 177 whereby the rod 166 is constrained to rectilinear movement. With this arrangement when the hand lever 173 is swung in one direction the clutch members 159 and 161 are engaged and the clutch members 160 and 162 are disengaged. A reverse movement of the rod 173 reversely actuates the clutches. The control lever 173 is connected by a cross bar 178 with a duplicate control lever 173a provided on the opposite side of the machine to afford convenient control of these clutches from either side.

The rearward end of the shaft 158 is coupled as at 179 with a worm shaft 180 having a worm 181 rigid therewith and meshing with and underlying a worm wheel 182 fixed to a transversely extending shaft 183 journaled in suitable bearing brackets 184 mounted on the casing. A sprocket wheel 185 is fixed to the shaft 183 and has a sprocket chain 186 trained thereover, the sprocket chain also being trained over a sprocket wheel 187 fixed on the drum shaft 8. With this arrangement the drum shaft 8 may be reversely rotated by manipulating the control lever 173 or 173a and shifting the cone clutch assembly shown in detail in Figure 13.

Conveyor drive, shift and hoist

The motion for driving, shifting and hoisting the conveyor is also taken from the shaft 47 and for this purpose a gear wheel 190 is fixed to the shaft 47 and constantly meshes with a gear wheel 191 fixed to a shaft 192 extending parallel to the shaft 47 and jour-

naled in suitable bearings provided in the main section 18 of the casing. Oppositely disposed beveled gear wheels 193 and 194 are loosely mounted on the shaft 192 and have clutch members 195 and 196 formed on their hubs and adapted to cooperate with a slidable double clutch member 197 splined on the shaft 192 and selectively engageable with either the clutch member 195 or the clutch member 196. A clutch control lever 198 (see Fig. 2) is provided for shifting the sliding double clutch member 197, this lever 198 controlling a shifting fork (not shown) which engages in the annular groove of the sliding double clutch member. The beveled gears 193 and 194 constantly mesh with a beveled gear 199 fixed to the forward end of a shaft 200, rotatably mounted in suitable bearings provided therefor on the casing section 18. On the shaft 200 sprocket wheels 201 and 202 are loosely fitted and may be selectively clutched to the shaft 200 by means of a sliding double clutch member 203 which coacts with clutch members 204 and 205 provided on the hubs of the sprocket wheels 201 and 202, respectively. The sprocket wheel 201 meshes with the conveyor drive chain (not shown). For a full disclosure an explanation of just how the sprocket wheel 201 effects the drive of the conveyor in all of its adjustment, reference is made to the conveyor application of Robert L. Brown, filed December 29, 1926, Serial No. 157,646.

A sprocket chain 206 is trained over the sprocket wheel 202 and an underlying and vertical alined sprocket wheel 207 (see Figs. 3 and 12) fixed on a shaft 208 journaled in suitable bearings provided therefor in a lower part of the rearward end of the casing. On this shaft 208 worms 209 and 210 are loosely mounted and constantly mesh with worm wheels 211 and 212 fixed on short shafts 213 and 214 rotatably supported on the casing. The shaft 213 has a hoist drum 215 fixed thereto, this hoisting drum 215 serving to control the winding of the hoist line 216 which extends upwardly over suitable guide pulleys provided on the super-structure of the frame and then downwardly to the outer end of the conveyor to which it is suitably attached. The hoist line may be attached to either end of the conveyor, the guide pulleys being such as to permit proper reeving of the hoist line in both instances. The short shaft 214 has a beveled gear wheel 217 fixed thereto, the beveled gear wheel 217 meshing with the beveled gear wheel 218 fixed on a shaft 219 extending fore and aft of the machine and having a pinion 220 fixed thereto and operatively connected with the means for shifting the conveyor as more fully set out in the conveyor application Serial No. 100,783, hereinabove referred to. In order to provide for the selective actuation of the shift or hoist a sliding double clutch member 221 is splined on the shaft 208 and alternately or selectively coacts with the clutch members 222 and 223 provided on the worms 209 and 210. The sliding clutch member 197 and also the sliding clutch member 203 are both suitably operated or manipulated by any suitable means such as the usual hand levers and shifting fork arrangement.

From the foregoing it will be understood that the conveyor may be reversely driven by suitably manipulating the clutch member 197 and engaging the clutch members 203 and 204. If either the hoisting drum 215 or the conveyor shift pinion 220 are to be actuated then the clutch member 203 is engaged with the clutch member 205 to make possible actuation of either the drum 215 or the pinion 220. Selection as between the drum 215 and the pinion 220 is accomplished by appropriately manipulating the clutching member 221. Whether the conveyor is to be driven or shifted or hoisted the clutch 197 controls the direction of movement.

Operation

The lowering of the boom for digging is under the control of the hoisting drums on the drum shaft 8 and the movements of this drum shaft 8 is controlled from the lever 173 which manipulates the clutches 159 and 161, and 160 and 162, to rotate the drum shaft in either direction. In between this clutch assembly and the drum shaft is the self-locking worm and worm wheel arrangement 181 and 182 so that the boom is held in any position by this self-locking worm and worm wheel. By properly manipulating the lever 173 a positive crowding action may be exerted on the boom.

As above pointed out one of the important features of the invention resides in the arrangement whereby the digging chains and buckets may be driven at variable speed and power ratios or may be reversed, this advantage resulting from the organization whereby the gear set G is also interposed between the power plant and the digging means.

While the digging is progressing feed traction is had through the gear set G′ which is independent of the gear set G driving the digging chains and buckets. This is a feature which makes it entirely practical to vary the speed and power ratio as may be warranted by the load on the digging chains and buckets and this variation is had while permitting an independent or a parallel variation in the speed of feed. The speed at which the conveyor is driven automatically varies with the speed of the digging chains and buckets and along with this advantage there is a further advantage of having a power hoist and shift for the conveyor.

When traveling from place to place high speed traction is available through the gear set G and yet the high traction means are

practically the only parts set in motion at this time.

Many other important objects and advantages have been stressed with particularity in the foregoing description but in this connection it is to be understood that various changes in the size, arrangement and construction of the parts is contemplated within the spirit of the invention and the scope of the subjoined claims.

The invention claimed is:

1. A trencher comprising a frame, traction means therefor, digging means carried by the frame, a traction drive operatively connected with the traction means, a power plant, two change speed gear sets operatively connected to the power plant, mechanisms for selectively actuating the traction drive from the gear sets for imparting high and low traction movements thereto with variable speed and power ratios available in the gear sets in either selection, an interlocking control for the mechanisms insuring the disconnection of one when the other is operatively positioned, and means operated from one of the gear sets for actuating the digging means.

2. A trencher comprising a frame, traction means therefor, digging means carried by the frame, a traction drive operatively connected with the traction means, and including a differential having a master gear, a power plant, two change speed gear sets operatively connected to the power plant, two sets of mechanisms for selectively actuating the traction drive from the gear sets for imparting high and low traction movements thereto with variable speed and power ratios available in the gear sets in either selection, each set of mechanism including a shiftable pinion engageable with and disengageable from the master gear of the differential, an interlocking control for the shiftable pinions whereby one pinion is disengaged from the master gear when the other is engaged therewith, and means operated from one of the gear sets for actuating the digging means.

3. A trencher comprising a frame, traction means therefor, digging means carried by the frame, a traction drive operatively connected with the traction means, and including a differential having a master gear, a power plant, two change speed gear sets operatively connected to the power plant, two sets of mechanisms for selectively actuating the traction drive from the gear sets for imparting high and low traction movements thereto with variable speed and power ratios available in the gear sets in either selection, each set of mechanism including a shiftable pinion engageable with and disengageable from the master gear of the differential, and means operated from one of the gear sets for actuating the digging means.

4. A ladder type trencher comprising a frame, traction means for the frame, a traction drive operatively connected to the traction means, a boom pivotally supported on the frame, endless digging chains mounted on the boom, digging buckets carried by the digging chains, hoisting and crowding means for the boom, a spoil conveyor receiving the discharge from the buckets, a power plant, two change speed gear sets operatively connected to the power plant, an intermediate shaft driven from one of said gear sets, mechanisms for selectively actuating the traction drive from one of the gear sets through its associated intermediate shaft and from the other gear set, motion transmission means between the intermediate shaft and the digging chains, motion transmission means between the intermediate shaft and the hoisting and crowding means for the boom and motion transmission means between the intermediate shaft and the conveyor.

5. A ladder type trencher comprising a frame, traction means for the frame, a boom pivotally supported on the frame, digging means on the boom including endless digging chains, hoisting and crowding means for the boom, a spoil conveyor receiving the discharge from the digging means and adapted to be reversely driven, to be reversely shifted and to be hoisted and lowered, a power plant, a change speed gear set of the selective type operatively connected to the power plant, means operated from the gear set for driving the digging chains, means operated from the gear set for reversely actuating the hoisting and crowding means, means operated from the gear set for selectively actuating the conveyor in any of its operative movements, and means for actuating the traction means.

6. A ladder type trencher comprising a frame, traction means for the frame, a traction drive operatively connected with the traction means, a boom pivotally supported on the frame, digging means on the boom including endless digging chains, hoisting means for the boom, a spoil conveyor receiving the discharge from the digging means, a power plant, two change speed gear sets of the selective type operatively connected to the power plant, mechanisms for selectively actuating the traction drive from the gear sets for imparting high and low traction movements thereto with variable speed and power ratios available in either gear set in either selection, means operated from one of the gear sets for driving the digging chains, means operated from the same gear set for actuating the hoisting means, and means operated from the same gear set for actuating the conveyor.

7. A trencher of the character described including a conveyor adapted to be reversely driven, reversely shifted, hoisted and lowered, a power driven gear set, a reversing clutch arrangement operatively connected to the gear set, a conveyor driving member, a

conveyor shifting member, a conveyor hoisting member, said conveyor hoisting member also controlling the lowering of the conveyor, a common actuating member for the conveyor shifting member and the conveyor hoisting member, clutching means for selectively and operatively connecting the conveyor driving member and the actuating member with the reversing clutch arrangement, and motion transmission means between the actuating member, the hoisting member and the shifting member and including a clutching arrangement for selectively driving the hoisting member and the shifting member from the common actuating member.

8. A trencher of the character described including a conveyor adapted to be reversely driven, reversely shifted, hoisted and lowered, a power driven gear set, a reversing clutch arrangement operatively connected to the gear set, a conveyor driving member, a conveyor shifting member, a conveyor hoisting member, said conveyor hoisting member also controlling the lowering of the conveyor, and means for selectively driving the conveyor driving member, the conveyor shifting member and the hoisting member from the reversing clutch arrangement.

9. A trencher including a spoil conveyor adapted to be reversely driven and laterally shifted, a power plant, a change speed gear set of the selective type operatively connected to the power plant, a reversing clutch arrangement operatively connected to the change speed gear set, and selective means for reversely driving the conveyor and for reversely shifting the same from the reversing clutch arrangement.

10. A ladder type trencher comprising a frame, traction means for the frame, a boom pivotally supported on the frame, digging means on the boom, hoisting and crowding means for the boom, a power plant, a change speed gear set of the selective type operatively connected to the power plant, means operated from the gear set for driving the digging means, means operated from the gear set for reversely actuating the hoisting and crowding means, and means for actuating the traction means.

11. A trencher including the usual instrumentalities adapted to be driven during the operation of the trencher, and a main machinery unit containing the gearing and shafting through which the instrumentalities are driven and having a single piece casting adapted to provide the support and an element of the enclosure for the gearing and shafting whereby to maintain the same in proper alinement and to insure rigidity and the elimination of vibration.

12. A trencher comprising a frame, traction means for the frame, digging means carried by the frame, a power plant, a change speed gear set of the selective type actuated by the power plant, a releasable driving connection between said gear set and the digging means, a releasable driving connection between said gear set and said traction means whereby the one gear set is selectively operable to drive the traction means with variable speed and power ratios when traveling from place to place or to drive the digging means at variable speed and power ratios when digging and independent means for imparting feeding movement to said traction means when the digging means is operated.

13. A trencher comprising a frame, traction means for the frame, digging means carried by the frame, a power plant, a change speed gear set of the selective type actuated by the power plant, a clutch controlled driving connection between said gear set and the digging means, a releasable driving connection between said gear set and said traction means whereby said gear set is selectively operable to drive the traction means with a variable speed and power ratio when traveling from space to space or to drive the digging means at variable speed and power ratios when digging, a second change speed gear set of the selective type having a clutch controlled connection with the power plant independent of the first mentioned change speed gear set and a releasable driving connection between the second change speed gear set and the traction means and controllable at will to impart variable feeding movement to the traction means while digging.

14. A trencher comprising a frame, traction means for the frame, digging means carried by the frame, a power plant, a main machinery unit including a change speed gear set of the selective type operatively connected to the power plant and to the digging means for actuating the digging means at variable speed and power ratios, independent gearing for actuating the traction means from the power plant and a single piece casting adapted to provide the support and an element of the enclosure for said gear set and gearing.

15. A trencher of the character described comprising a frame, traction means for the frame, digging means carried by the frame, a power plant, a change speed gear set of the selective type having a main shaft, a clutch controlled connection between the main shaft and the power plant, an intermediate shaft driven from said change speed gear set and having a clutch controlled connection with the digging means, a traction drive connected to the traction means, and having a gear element adapted to receive the drive and cooperatively disposed with respect to the intermediate shaft, a shiftable pinion on said intermediate shaft engageable with said gear element, a second change speed gear set of the selective type having a clutch controlled connection with said main shaft, and

a driving connection between said second change speed gear set and the gear element of said traction drive, said driving connection including a shiftable pinion engageable with said gear element.

16. A trencher comprising a frame, traction means therefor, digging means carried by the frame, a power plant, high and low traction change speed gear sets of the selective type operatively connected to the power plant, releasable means for establishing a driving connection between said high traction gear set and said traction means or between said low traction gear set and said traction means whereby the traction means may be actuated with a variable speed and power ratios over a comparatively high speed range when traveling from place to place and may be actuated with variable speed and power ratios over a low speed range to impart feeding movement to the trencher during digging, and means operated from the high traction gear set and receiving a variable speed drive therefrom and connected to the digging means for actuating the same at variable speeds.

In witness whereof, I hereto affix my signature.

ROBERT L. BROWN.