Nov. 1, 1932. C. H. LOTTE 1,886,032

EXCAVATING MACHINE

Filed April 11, 1931 7 Sheets-Sheet 1

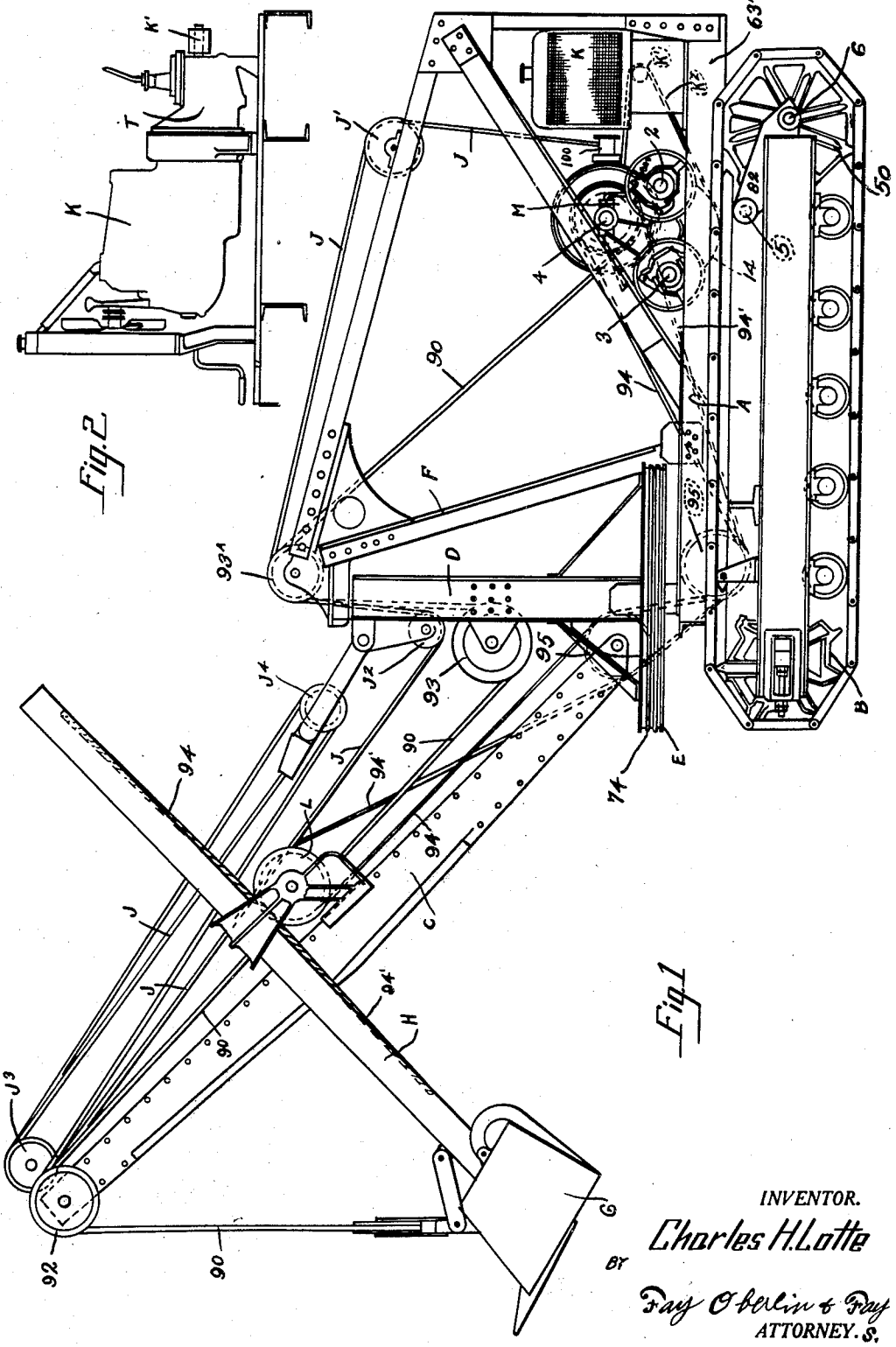


Fig. 2

Fig. 1

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Nov. 1, 1932. C. H. LOTTE 1,886,032

EXCAVATING MACHINE

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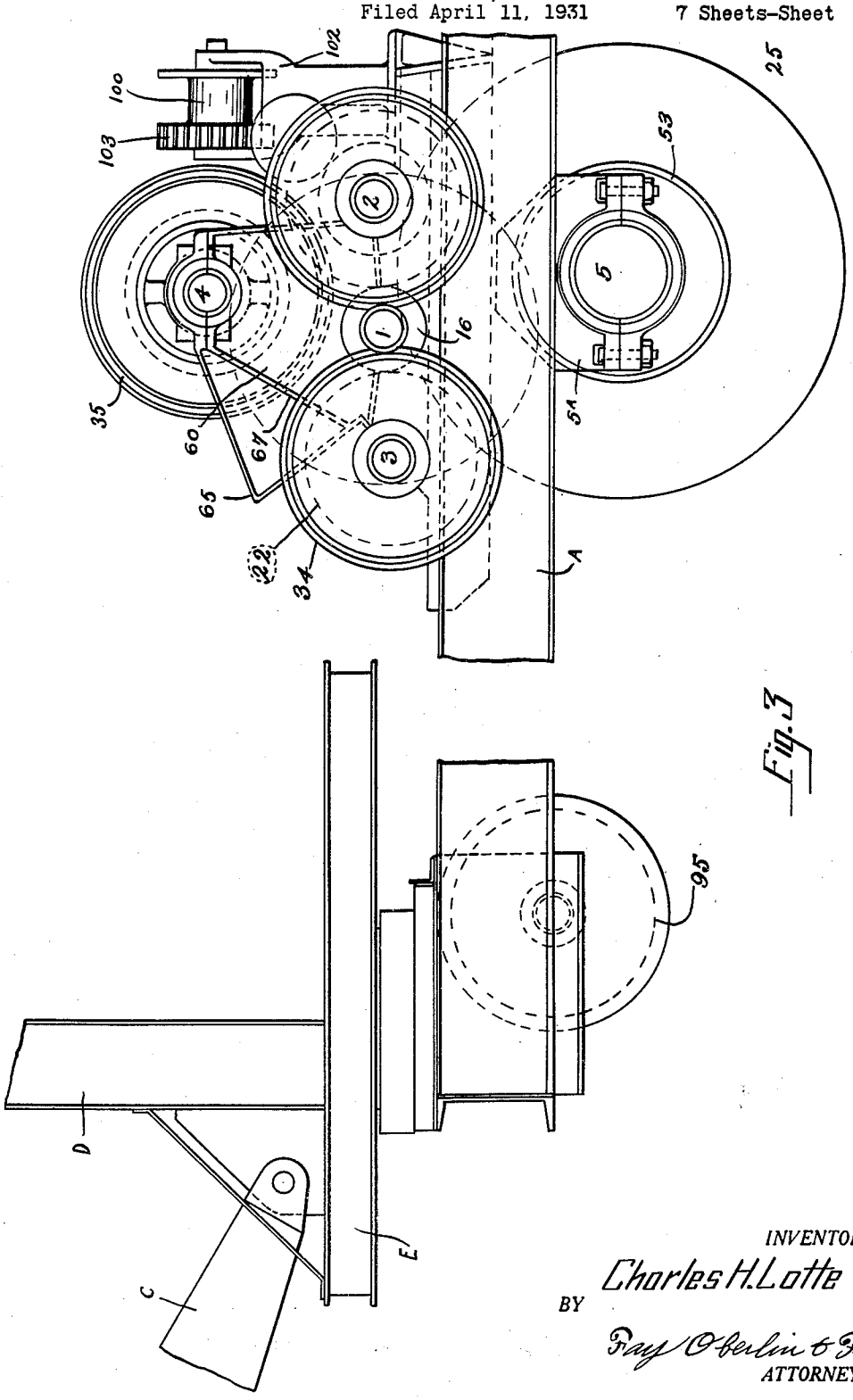


Fig. 3

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EXCAVATING MACHINE

Filed April 11, 1931 7 Sheets-Sheet 3

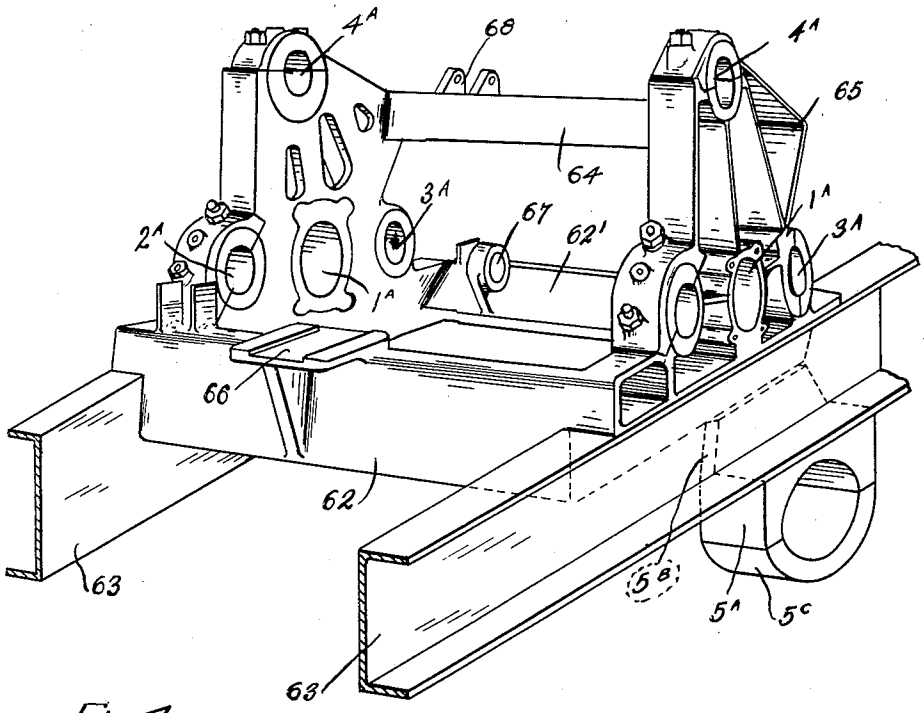


Fig. 4

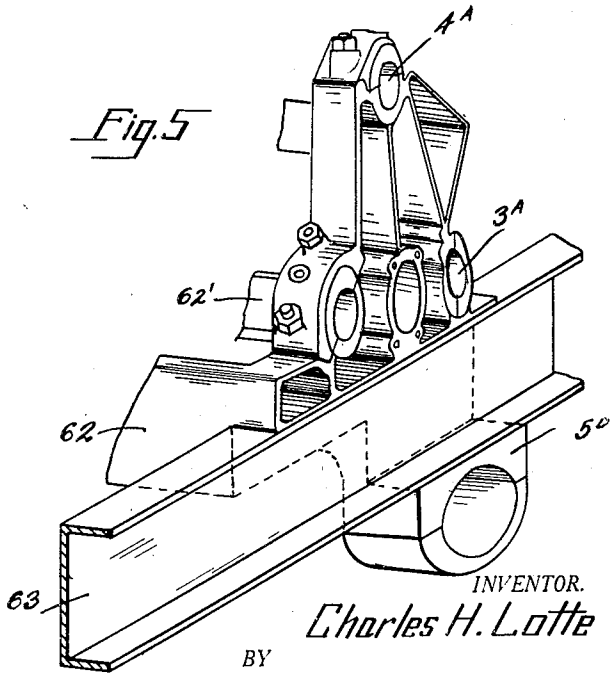


Fig. 5

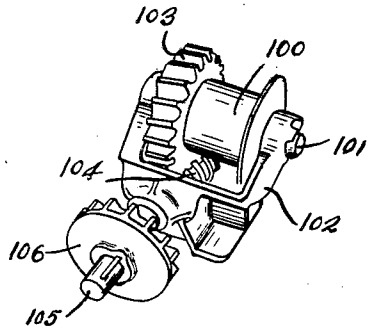


Fig. 6

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EXCAVATING MACHINE

Filed April 11, 1931 7 Sheets-Sheet 4

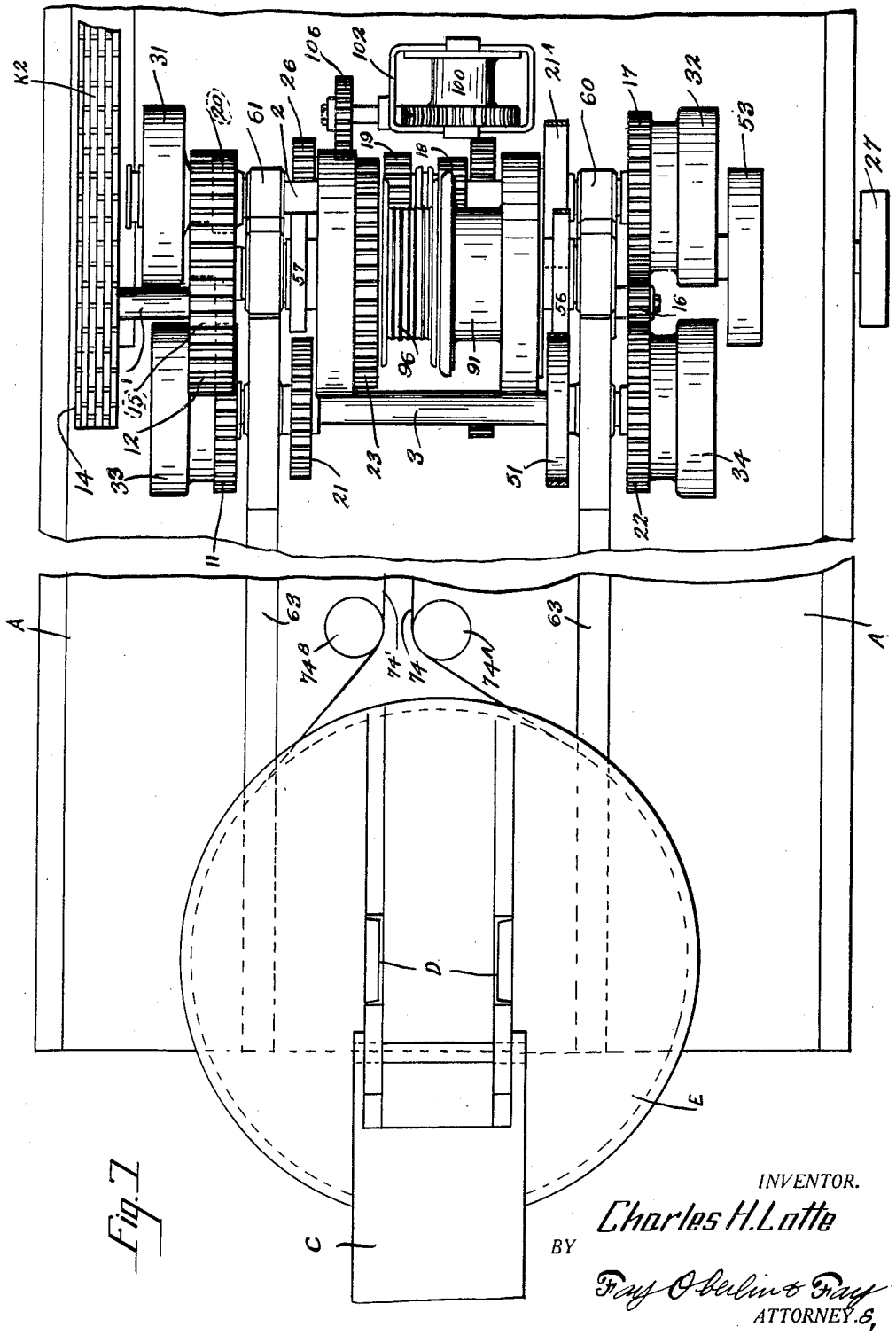


Fig. 7

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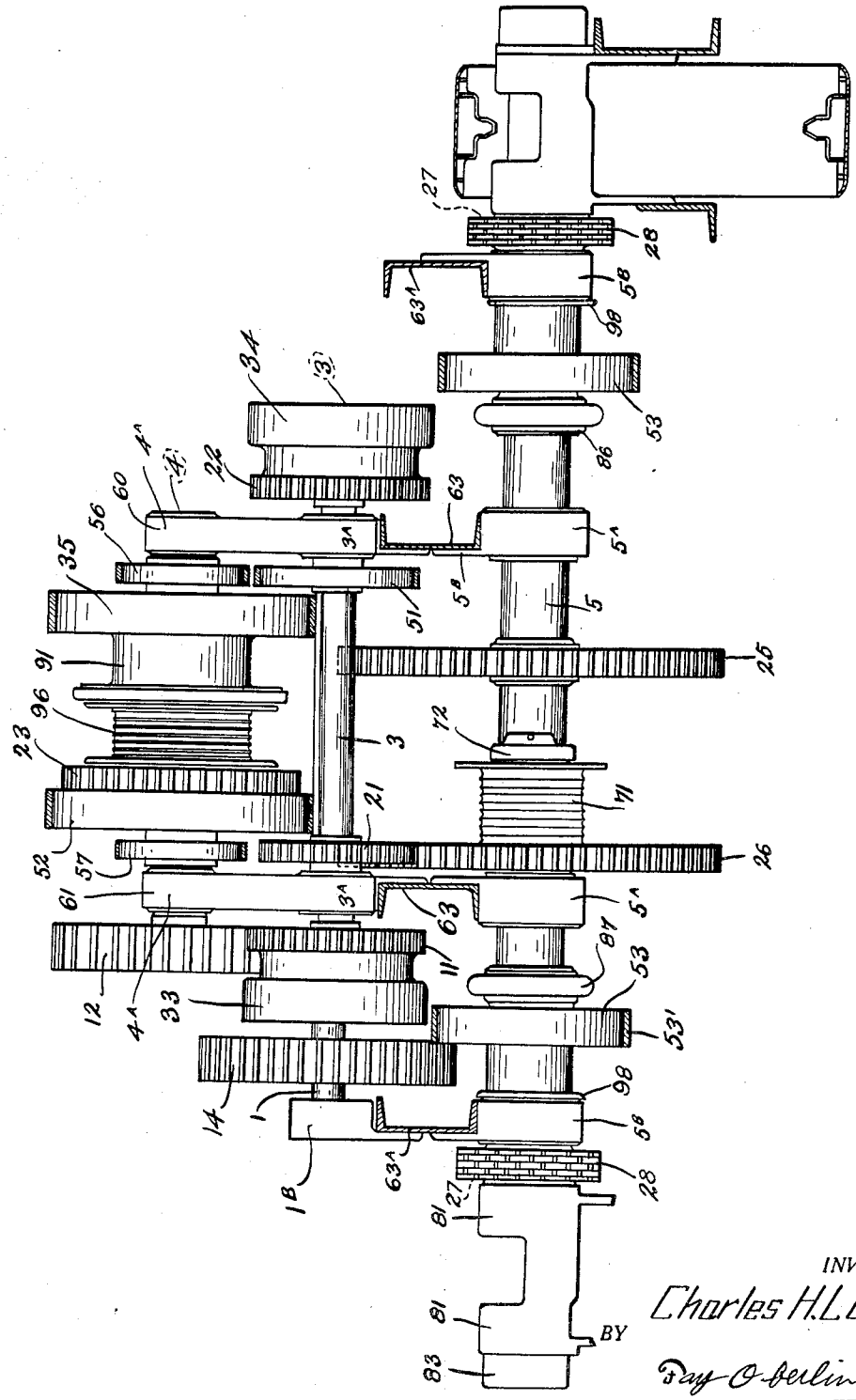


Fig. 8

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EXCAVATING MACHINE

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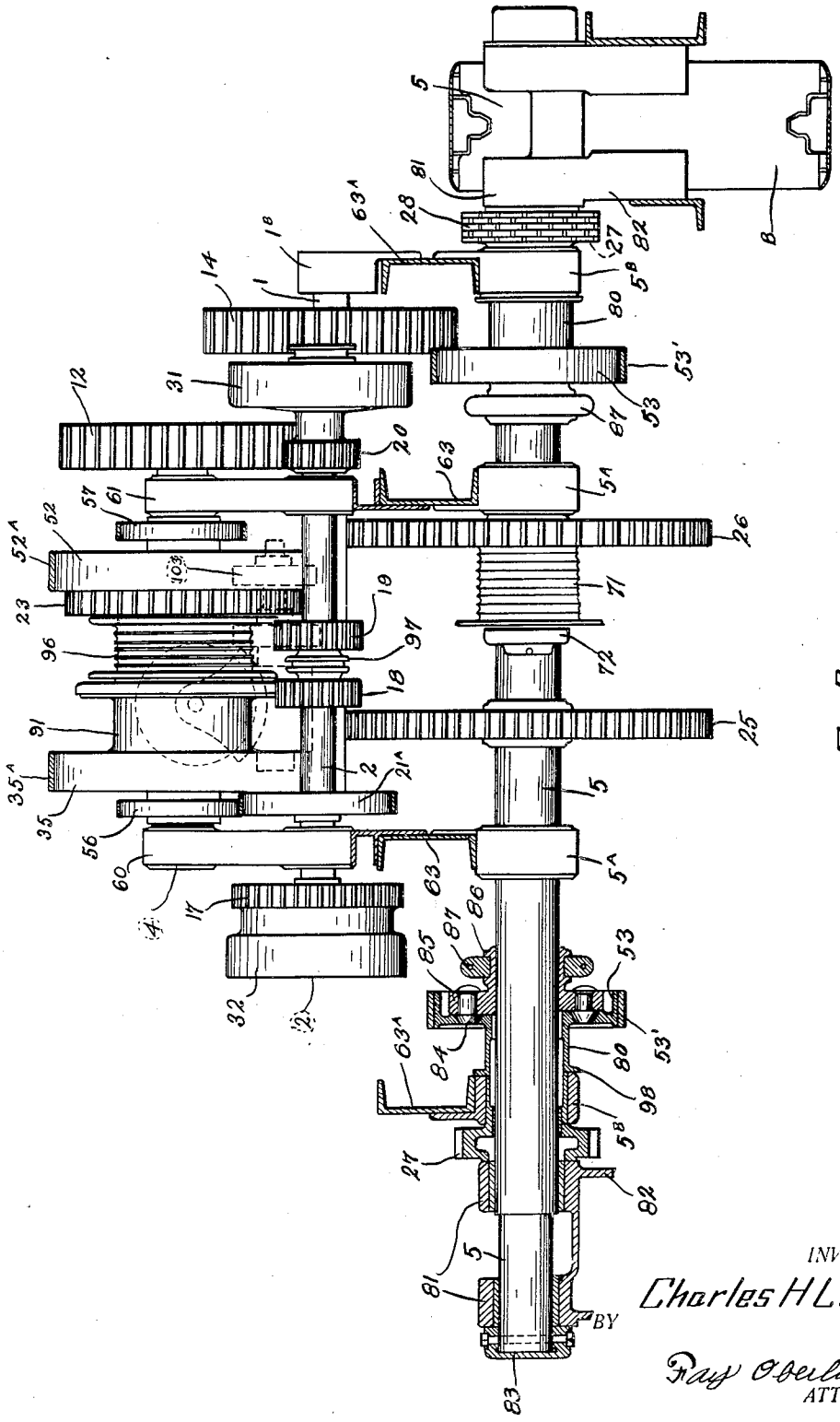


Fig. 9

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Filed April 11, 1931 7 Sheets-Sheet 7

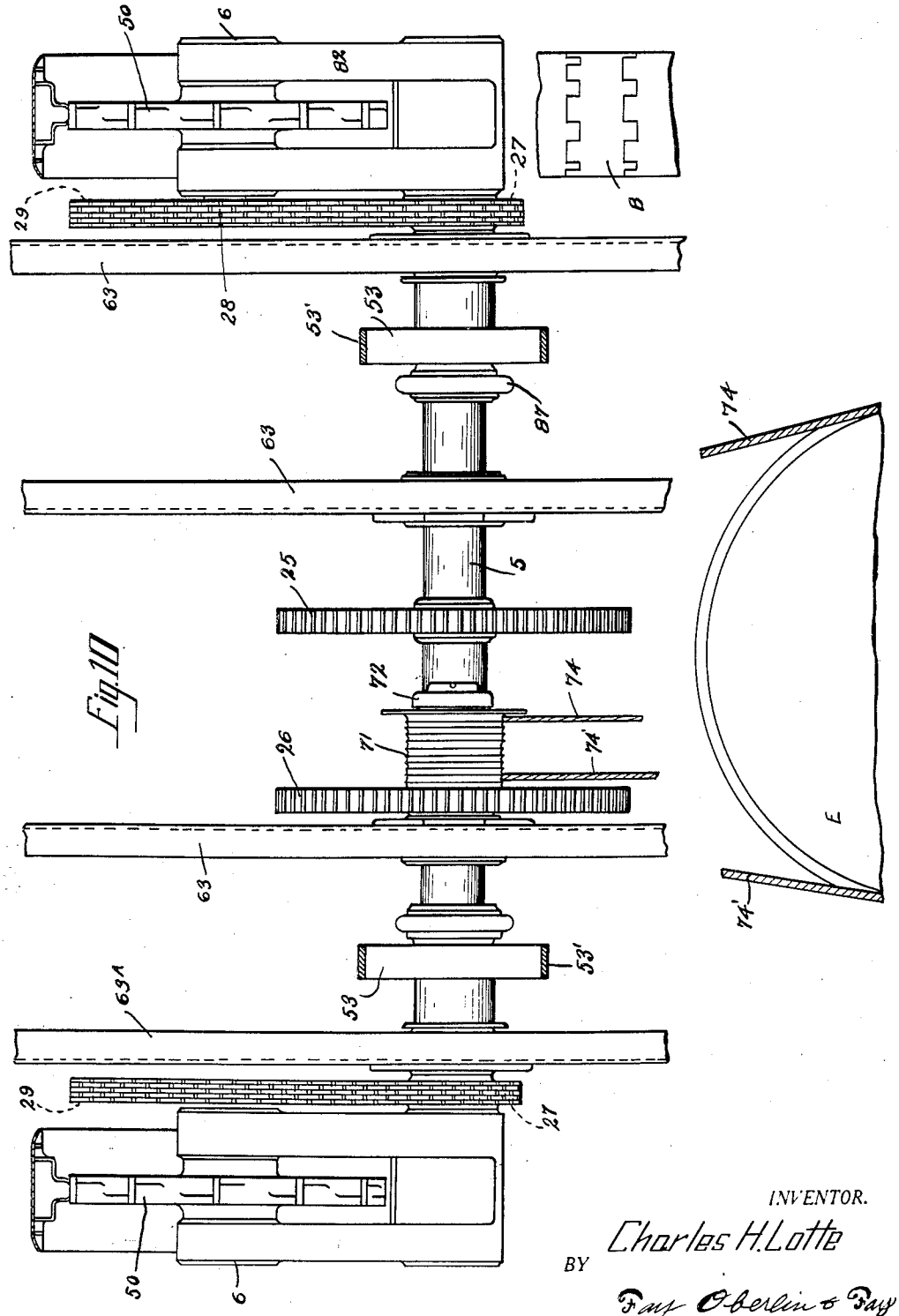


Fig 10

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Patented Nov. 1, 1932 1,886,032

UNITED STATES PATENT OFFICE

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EXCAVATING MACHINE

Application filed April 11, 1931. Serial No. 529,443.

This invention relates to excavating and other material handling machines, such as power operated shovels, either outstroke or instroke, buckets, skimmers, draglines and cranes, and is directed more particularly to assemblies for the operating mechanism of such machines and methods of mounting the same. Among the aims are to provide a machine having a gear and shafting organization of sturdy, compact, and simple construction, particularly designed for small size power shovels or other small sized machines of the types enumerated. One particular object of the invention is the provision of a mounting for the actuating or power transmitting elements of such machinery which will not be subject to the misalignment, distortions and strains which occur in the general machine frame under working and traveling conditions met with in practical use.

Another aim of the invention is the provision of an operating assembly or transmission assembly which maintains in constant readiness means for transmitting power from a common source to several selective points of application in such a manner that its application at those points can be varied in direction and in power-speed ratios at the will of the operator to cover a wide range of uses without the necessity of dismantling any portions of the machine, taking out or putting in different elements of the assembly, or of doing anything beyond the range of ordinary lever control.

A problem met with in machines of this type is that in going over uneven ground, or in working in such ground, the machinery platform and the general framework of the machine is forced more or less out of alignment. The result is that large elements such as power shafts, trains of gears, and the like, constituting what is referred to herein as the transmission assembly, which must be kept in accurate mutual relationship, cannot function efficiently if the elements are separately attached to the general framework or to the machinery platform. The reason for this condition is that as to elements of this character, such misalignment, although it does not prevent operation of the entire machine, causes binding of bearings, high friction losses, excessive wear, incorrect meshing of gears, occasional breakage, and similar difficulties. Therefore, an important object of the present invention is the mounting of such power transmitting elements, and particularly the driving gearing, in such a manner that strains on the platform and general framing do not affect the mutual relations of the several elements of the transmission assembly.

Further objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principles of the invention may be used.

In the specification the word "shovel" is used as a general designation for this type of machine, although it is to be understood that the purposes of the apparatus are not limited to shovel work and that unless the immediate context gives the word "shovel" a specific restricted meaning, any of the operations included in the foregoing list, and described hereafter, or others for which the machine is suitable, are included. The designations "right", "left", "front", "rear", etc., are used with reference to the normal direction of travel of the machine with the boom at the front end. Elements are described as rotating clockwise or counterclockwise from the standpoint of Fig. 1.

In said annexed drawings:

Fig. 1 is a side elevation showing the invention as applied to an outstroke dipper shovel; Fig. 2 is a rear elevation of the power plant; Fig. 3 is an enlarged elevation of the left side of the transmission assembly and also of certain other features; Fig. 4 is a perspective view of the transmission frame from the rear and right; Fig. 5 is a view similar to Fig. 4, showing a modified form of transmission frame; Fig. 6 is a perspective view of

the boom hoist; Fig. 7 is a plan view of the transmission assembly, also including certain general features of the machine; Figs. 8 and 9 are respectively front and rear views of the transmission assembly; and Fig. 10 is a plan view of the propelling mechanism.

The subject matter of this invention does not lend itself to use on machines of the full swing type, but is adapted, as shown, for power shovels where the machinery platform A occupies a fixed position with relation to the transporting means B, and the boom C is carried upon the foot of a mast D at the forward end of the machine, this mast being mounted upon a small turntable or bullwheel E and pivoted at its top to a stay truss F whereby strains on the top of the mast are passed to the machinery platform A. Such apparatus as a dipper G on a stick H, or other suitable material engaging means, is secured to the boom C. The actuating mechanism for the entire machine is collected in a transmission assembly M, the construction of which forms the principal subject of the present invention. In this assembly are found the various drums to which all the lines for bucket, boom and turntable are led; also the gears and clutches for applying power selectively to such drums and to the transporting mechanism. The boom is raised and lowered by the usual running rigging J from the top of the mast to the peak of the boom. The transporting means are herein shown as crawlers B, one beneath each side of the platform and mutually independent. Thus, it will be seen that the various elements of the entire shovel are attached above or below what is essentially a platform subjected to various distorting strains from above and below, and that these strains may differ at each end and at each side.

The motive power both for handling material and for moving the machine from place to place is supplied by a prime mover, such as an internal combustion engine K, the preferred form of which, here shown, is fitted with a three-speed single direction transmission T from which power is taken from a pinion K′ by flexible means such as a silent chain K² which drives a larger pinion 14 keyed to a jackshaft 1. In order to provide for the selective transmission of power from the jackshaft 1 with further variations of speed and varying degrees of mechanical advantage, and in either direction to the several elements of the material handling means and of the transporting means, a somewhat elaborate system of shafts, gears, clutches and drums is provided, all this transmission assembly being of course driven from the prime mover. The engine K and the transmission assembly M, in the preferred embodiment shown, are mounted at the rear end of the machinery platform A, counterweighting the boom and its load.

Such features are common in a general way throughout the power shovel and allied arts. The transmission assembly M, as already pointed out, must be of sturdy and heavy construction and must be compact and as simple as possible. It is necessary to have some gears and some clutch elements which are not constantly engaged, but which nevertheless can be brought into accurate registry at any time and under any conditions of distortion which may exist in the platform A. It is also most important to have those gears which are in constant mesh always correctly aligned and to this end their shaft bearings must also be correctly aligned, since misalignment causes undue friction losses both in bearings and gears, low efficiency, and at times stoppage of machinery or breakage of parts.

To avoid these troubles I have provided the transmission assembly M, the construction and operation of which will be described in detail below, all of the controlling points of bearing and contact of this assembly being mounted on the transmission frame shown in Figs. 4 and 5. Although it would be most desirable in theory to have this frame of absolutely unitary construction, made of a single casting as shown in Fig. 5, the practical question of assembly time and costs causes the preferred form for practical use to be that shown in Fig. 4. Even in the form of Fig. 4, although the frame is more than a single casting, it will be unitary in effect with respect to the internal relations of the elements mounted thereon, its effect being that of a cage or cell of great rigidity and strength, mounted within the limits of the more flexible and weaker platform A. In whatever way the transmission frame may be made, it is a feature of the present invention that it be of such relative size and strength as to be practically inflexible by the strains on the machinery deck A or general machine framework.

The form of frame shown in Fig. 4, comprises, as its top portion, a unitary casting particularly characterized by elements of large size relative to their length, having deep webs, whereby great rigidity is obtained. This frame consists preferably of an integral casting including two vertical sides 60 and 61, each of trapezium outline, two deep channel cross connecting members 62 and 62′ at rear and front, respectively, of the side members, at the platform level, and a third cross bar 64 between the forward upper corners. The forward bar 64 is carried on the projections 65 to clear certain of the gear wheels of the transmission assembly, as will appear below. The bottom outer edges of the frame are rabbeted to fit on top of and against the inner longitudinal sills 63 of the platform A, being bolted or otherwise firmly secured thereto. It will be noted that the vertical rabbet faces go down about half the depth of the sills 63.

Bearing openings are provided in the sides, as at 1^A, 2^A, 3^A and 4^A, with the usual fittings, such as liners and caps, to receive various shafts 1, 2, 3 and 4 respectively, all transverse, which are described hereafter. The sides are reinforced by connecting webs such as 67 at their edges and between the various bearings.

A bearing block 5^A, having an inside upstanding flange 5^B, is similarly rabbeted and secured to the bottom and inside of each sill 63. It will be seen by reference to Figs. 4 and 8 that the sills 63 are reinforced heavily by the frame M along the section where the bearings 5^A are attached, and only a very narrow unsupported strip of the sill web extends between the upper edge of the flange 5^B and the bottom of the frame. It has been found in practice that this construction is entirely effective and satisfactory in holding the axle 5, which is held in the bearing blocks 5^A by the caps 5^C, in its position as an element of the transmission assembly.

It is convenient to cast holding means for certain elements of the mechanism directly on the frame. For example, a pad 66 on the cross bar 62 is the seat for the boom hoist, Fig. 6; two ears 67, one inside each end of the bar 62′, hold bearings for a rod, not shown, to keep certain of the cables from dragging against the edge of the bar 62′; and two pairs of ears 68, only one pair being visible in Figs. 4 and 5, are anchorages for the hoist drum and crown drum brake bands 35^A and 52^A.

A completely unitary machinery frame is shown in Fig. 5, which is similar in all particulars to that of Fig. 4 except that the separate bearing blocks 5^A are replaced by bearing blocks 5^D, cast integral with the rest of the frame.

It will be seen by reference particularly to Figs. 8 and 9, that the only shafts which extend far enough beyond the sides 60 and 61 to require bearings external to the machinery frame, are the shafts 1 and 5. The external bearing 1^B carries the outer end of the shaft 1, while the bearings 5^B engage the shaft 5 somewhat within its ends. Suitable provision, not shown, but of any nature well understood in the art, is provided for allowing these bearings to float to a sufficient degree to prevent the transmission of any operative strains and displacements to their respective shafts.

The transverse shafts mounted on the transmission frame comprise a jackshaft 1, a crowd and propel shaft 2, a swing shaft 3, a hoist shaft 4, and a travel shaft 5. The jackshaft 1 is driven from the engine K as already described. The jackshaft 1 carries at its right end and outside the transmission frame, the large gear 14 on which the silent chain runs, and carries further in on the same end a small spur gear 15. On its left end is another small spur gear 16. In the operations hereafter described the jackshaft is assumed to turn clockwise. The crowd and propel shaft 2 is mounted in rear of the jackshaft and at about the same level, while the swing shaft 3 is similarly mounted in front of the jackshaft. The drum shaft 4 is mounted above the jackshaft and the drive shaft 5 below it. Upon these various shafts are mounted all of the gears, clutches and winding drums (with the exception of the boom hoist) used in the entire operation of the machine, either for material handling or for moving the machine.

The crowd and propelling shaft 2, carried in the transmission frame by the bearing 2^A, has at its left end a gear 17 rotatable upon the shaft, but fast to one element of a clutch 32. The gear 17 is in constant mesh with the jackshaft gear 16, and adapted to be clutched to the shaft by the clutch 32, thus rotating the shaft 2 counterclockwise. A small gear 20, also free on shaft 2, but adapted to be clutched thereto by clutch 31, is in constant mesh with a broad faced gear 12 fast upon shaft 4. Drive through the gear 20 turns the shaft 2 clockwise. A pair of small gears 18 and 19 on opposite ends of a short sleeve are keyed to the shaft 2 about the middle but are slidable therealong in either direction by means of any ordinary mechanism such as a collar 97. When these gears are centrally positioned as shown in Fig. 6 neither one is engaged, but when moved to the left, gear 18 engages with a large gear 25 on the propelling shaft 5, thus applying power to that shaft which may be used to move either or both of the crawlers according to the connection made on shaft 5, as will be described below. When moved to the right the gear 19 engages a gear 23, fast upon one end of a crowd drum 96 rotatable upon the hoist shaft 4, thus driving the crowd drum 96 in opposite direction to shaft 2, it being understood that the clutch 52 will be out of engagement at this time. The crowd drum will turn with the shaft 4 when the gears 19—23 are disengaged and the clutch 52 set.

The boom hoist, Fig. 6, mounted on the pad 66 of the frame M, is also driven from the shaft 2. This hoist comprises a small drum 100 fast to a short shaft 101 which is rotatably disposed longitudinally of the machine in a bracket 102. Integral with the rear end of the drum 100 there is a worm wheel 103, driven by a worm 104 fast to a short transverse shaft 105, also rotatably supported by the bracket 102. Slidably splined to the projecting end of this shaft 105 is a pinion 106, the sliding range of which is best seen in Fig. 9, in which the dotted showing of 106 illustrates its engagement with the pinion 19 and the solid showing illustrates the free position, clear of the pinion 19 even when 19 engages the gear 23.

The hoist shaft 4 is mounted in the bear-

ings 4A at the top of the transmission frame and carries fast to its right end a wide-faced gear 12. Engagement of this gear with the jackshaft gear 15 constantly turns the shaft 4 counterclockwise. By the use of a broad faced gear at 12 it is possible to transmit power from the gear 15 on the shaft 1 to the gear 11 on the shaft 3 by means of a single intermediate gear without having to either lengthen the transmission assembly or reduce the size of either 11 or 15 or provide an additional gear between 15 and 11 which would have no function in the assembly except that of an idler. It will be noted that all this difficulty is avoided by the fact that the face of the gear 12 is slightly broader than the combined breadth of the gears 11 and 15, so that these two gears 11 and 15 can overlap in parallel planes. The gear 12 also serves to transmit power from the gear 15 to the gear 20 and thus to the shaft 2, whereby the shafts 2 and 3 can both be rotated clockwise when desired.

The hoist drum 91, rotatably mounted on the shaft 4 beside the crowd drum 96, has one end formed by the outer element of a clutch 35. This clutch is of the booster type, the booster drum for its operation appearing at 56. The drum 91 is driven for hoisting by engaging the clutch 35, thus turning the hoist drum with the shaft 4. No means of applying power to unwind the line from the hoist drum is necessary inasmuch as such unwinding is accomplished by gravity. A brake 35A upon the outer face of the clutch element 35 provides a means for holding the hoist drum in any given position.

The crowd drum 96 is similar to the drum 91, although ordinarily having a grooved lagging surface. It has at its outer end a clutch 52, brake 52A and clutch booster drum 57, counterparts of the elements 35, 35A and 56, respectively. An additional feature is the gear 23 fast to the clutch element 52. By this gear the drum 96 can be driven from the pinion 19 on the shaft 2, the clutch 52 then being free. On the other hand, when the gear 19 and 23 are disengaged and the clutch 52 set, the drum 96 is of course rotated with the shaft 4.

The swing shaft 3 is best seen in Figs. 7 and 8. It is mounted in bearings 3A in the transmission frame, and carries clutches 33 and 34 at its respective ends, outside the transmission frame. The outer elements of these clutches have gears 11 and 22, respectively, fast thereto, the result being that the shaft can be driven by either gear by throwing the appropriate clutches in and out. Near the right end (which appears at the left side of Fig. 8 because this figure is from the point of view of an observer facing the machine) inside the transmission frame, a gear 21 is fast on the shaft 3, this gear being in constant engagement with a larger gear 26 which will be described below. A brake disk 51 is similarly fast at a corresponding position near the left end of the shaft 3 (shown at the right side of the drawing, Fig. 8). By means of the two clutches and the brake, the shaft 3 can be driven in either direction or held. The gear 22 is in constant mesh with the gear 16 on the jackshaft 1 and is therefore always running counterclockwise when the engine runs. The gear 11 is likewise constantly turning clockwise by reason of being in mesh with the gear 12 on the shaft 4, which gear 12 meshes with the jackshaft gear 15.

The large gear 26 and a drum 71 fast thereto are freely rotatable on the shaft 5. A collar 72 secured to the shaft 5, but with respect to which the drum is rotatable, prevents endwise movement of the drum and gear assembly inwardly while the hub of the gear 26 backs against one of the bearings 5A to prevent movement in the other direction. A cable 74 is wound around this drum 71 and is led over sheaves 74A and 74B to and around the turntable E, so that clockwise rotation of the gear 26 swings the boom C to the left, and vice versa, whereas the brake 51 is available to prevent swinging. For convenience in reading the drawings, the right side run of the cable 74 is designated 74′ in Figs. 7 and 10.

As best seen in Figs. 1, 8 and 9, the shaft 5, carried by the bearings 5A in the lower part of the transmission frame, extends beyond the outer longitudinal sills 63A of the machine platform, carrying rotatably near each outer end a sleeve 80 with clutch and gear elements described hereafter, and supporting on each extreme outer end the forward end of an arm 82 (Figs. 1 and 9) pivoted on the shaft 5 by a double bearing 81. The other end of the arm 82 receives the stub shaft 6 on its respective side of the machine. The sleeve 80 and its associated parts, shown in section at the left end of Fig. 9, constitute means whereby the crawlers B can be driven in various combinations from the shaft 5. These means are found on each end of the shaft 5, but are independent on each end. By these means sprockets 27 which drive the crawlers B through chains 28 to sprockets 29 on the inner ends of stub shafts 6 and sprockets 50 on the outer ends of the same shafts, may be independently actuated, whereby either crawler can be driven independently of the other.

Referring now to the sectional view at the left end of Fig. 9, it will be seen that each bearing 81 is held on the shaft 5 between a cap 83 and the outer side of the gear 27. The sleeve 80 is formed at its outer end with a functionally integral enlargement consisting of the gear 27 and at its inner end with a functionally integral enlargement consisting of a clutch element 53, the circumference of the outer member of the clutch also serving

as a brake drum, with a brake band 53'. Axial movement of the sleeve 80 is prevented by the inner face of the sprocket 27 and by a flange 98, on opposite ends of the bearing 5B. While the clutch may be of any desired type, I prefer a positive type in which the web of the member 53 is apertured at intervals to receive the coned ends 84 of teeth which are set in the inner clutch member 85. The inner clutch member is slidably keyed to the shaft 5 and movable axially therealong by means of a collar 86 and yoke 87 moved by suitable actuating element, not shown. The preferred arrangement is to have the two clutches 53 automatically maintained in engaged position, but separately movable to disengage by action of the operator. The sleeve 80 bears upon the shaft 5 by means of packing rings in each end leaving an oil space therebetween.

A gear 25 is fast upon the shaft 5 near the middle, and power is applied thereto by means of the gear 18, which may be brought into engagement with the gear 25 as already described. The swing drum 71 and its gear 26, although mounted upon the shaft 5, have nothing to do with the propelling function of the shaft. The mounting of these two elements on the shaft, however, makes a much more compact arrangement than would otherwise be possible, by reason of the fact that otherwise the large gear 26 would have to be disposed in a manner that would manifestly increase the size of the transmission assembly.

Operation of the machine and the various connections necessary thereto will now be briefly reviewed.

To drive the machine forward the gear 18 is shifted to the left, as shown in Fig. 9, to engage with the gear 25, the clutches 53 both being automatically kept constantly engaged, and being disengageable only by the action of the operator. Thus the shaft 5 is driven from the shaft 2 but in the opposite direction. As viewed in Fig. 1, wherein the outline of the end of shaft 5 is shown, and in Fig. 3, the shaft 5 will be running counterclockwise taking its power from shaft 2 which will be running clockwise by reason of having the clutch 31, carrying the gear 20, connected and the clutch 32 free, so that the power comes from the counterclockwise gear 12, which in turn is driven by the clockwise jackshaft pinion 15. The gear train used gives a high mechanical advantage, due to the relative sizes of the various gears. To drive backward the connections between the shafts 5 and 2 remain the same, but the clutch 31 is freed and the clutch 32 engaged, whereby the shaft 2 is driven counterclockwise by the gear 17 which is driven from the gear 16 on the clockwise jackshaft 1.

To steer the machine to the right on a large circle the right side clutch 53 is thrown out, while the left side clutch 53 automatically remains in, so that the right hand crawler runs idle while the left hand crawler is driven. The opposite arrangement of course steers the machine to the left. To turn on a shorter circle the brake is set on the edge face of the disengaged clutch 53 or 54, as the case may be.

In Fig. 1 the reeving of the lines for an outstroke shovel is shown as an aid to understanding the operation of the transmission assembly, but it will be understood that by the practices usual in the operation of this class of machinery other attachments may be employed, as already mentioned. In Fig. 1 certain of the sheaves conceal others, and it will therefore be understood that a reference to a sheave hereafter is to be taken as meaning the appropriate one of two or more, designated by a common reference character, only the left end sheave of which series is visible. No novelty is claimed in the reeving arrangements.

To hoist the dipper G, the line 90 is wound on the drum section 91, by engaging the clutch 35, using the booster band 56 for that purpose, thus rotating the drum with the shaft 4. This shaft takes a counterclockwise motion from engagement of the larger gear 12 with the small clockwise gear 15 on the jackshaft 1, sacrificing speed to power. The drum 96 is normally not used during shovel operations. During such operations the gears 19 and 23 are engaged, the clutches 31 and 32 released, and the crowd brake 21B set, thus holding the shaft 2, and so the drum 96, stationary. The hoist line 90 is led to the drum 91 over suitable sheaves such as 92 at the peak of the boom C and 93 and 93A on the mast D as may be necessary, and this line is formed with as many parts as are called for to give the requisite mechanical advantage. The present invention is not concerned with such details. When the machine, instead of being set up with a dipper as shown in Fig. 1, is used with a clam shell bucket, an orange peel bucket, or simply as a crane to hoist a load, the drum 91 is preferably used for a hoist line and the drum 96 for a holding line.

To lower the dipper G or other corresponding load, the clutch 35 is thrown out and the load goes down by its own weight, its speed being controlled by the brake on the clutch rim 35.

To crowd the dipper into the work the mechanism which includes the crowding wheels L is actuated by a cable 94 guided by suitable sheaves such as 95 on the mast D to the crowd drum 96 rotatably mounted on the shaft 4 and driven clockwise for shovel work from shaft 2 by gears 19 and 23. To crowd the dipper into the work or to retract it two cables 94 and 94' are used which pass respectively under and over the crowd wheels L,

which wheels also serve as carriers and guides for the boom H, and are secured near the upper and lower ends respectively of the boom H so that hauling in on the cable 94 crowds the dipper while hauling in on the cable 94′ retracts the dipper. The leads of the cables 94 and 94′ are respectively over and under the parallel sheaves 95, under the parallel sheaves 95′ and so to the drum 96 whereby clockwise rotation of the drum 96 crowds the dipper G and counterclockwise rotation retracts it. For this operation power is taken from the shaft 2 by engaging the gears 19 and 23 and the proper direction is given to the shaft 2 by setting either the clutch 31 or 32 as the case may be and leaving the corresponding clutch disengaged. To hold the crowd drum the brake is set on the crowd drum 21^A, the gears 19 and 23 being left in engagement. The above operations of the crowd drum are the methods used with the shovel attachment of Fig. 1. For all other attachments the gears 19 and 23 are left out of engagement and the drum 96 is operated by the direct motion of the shaft 4. The connection between the drum and the shaft is made by the clutch 52, this clutch being equipped with a booster 57. When so used the drum 96 is held by its own direct brake band 52^A.

The boom C is swung to the right or left by means of a cable 74 around the turntable E and leading to the drum 71. This drum, it will be remembered, is freely rotatable upon and never partakes of the motion of shaft 5, but can be driven only by means of the gear 26 which is fast to the drum and in constant mesh with the gear 21 on the shaft 3. By releasing the clutches 33 and 34 at opposite ends of the shaft 3 and setting the brake 51, swinging of the boom is prevented. On the other hand the boom may be swung to the left by engaging the clutch 34, whereupon the shaft 3 rotates with the counterclockwise gear 22 which is in turn driven by the clockwise gear 16 on the jackshaft 1. To swing to the right the clutch 34 is released and the clutch 33 set, whereupon the shaft 3 takes a clockwise motion from the gear 11 which is in constant mesh with the gear 12 on the shaft 4, the gear 12 being driven by the jackshaft gear 15. Thus the gear ratio to swing the boom in either direction is not so great as is available to propel the machine, but the speed is greater. This arrangement is obviously correct, since more power is needed to move the entire machine than to swing the boom.

The boom hoist is actuated by moving the gear 106 into engagement with the gear 19 on the shaft 2, thereby driving the drum 100 through the worm gear 103 and worm 104, thus hauling in or paying out the line J as may be required. The line J is led as shown over sheaves J′, 93^A, J^2, J^3 and J^4. To multiply the power, the line J is carried in several parts between the block at the peak of the boom which includes the sheaves J^3 and a block which is pivoted near the top of the mast and includes the sheaves J^4. The worm drive being irreversible, no other holding means are necessary to maintain the boom in any desired position.

It will be seen from the foregoing that I have devised a gear assembly characterized by unusual strength and stiffness of the elements which hold the gears in alignment without having to resort to an unduly heavy general structure for the entire machine, thus making an apparatus more economical to manufacture and operate than would be the case if it were necessary to have the entire assembly as strong as the machinery frame. A further advantage which I have attained is the saving of space and the shortening of the various gear trains by utilizing certain shafts both for power transmitting purposes and as mountings for gears, some of which are never, and others of which are only selectively, rotated with such shafts. In like manner the number of elements is reduced and the space occupied by those retained is economized by clutch and brake mechanisms advantageously mounted in relation to the various shafts, drums and gears.

Although I have above shown and described a preferred embodiment of the invention, it will be understood that this description is illustrative and does not constitute a limitation upon the principles or scope of the invention, these last being set forth in the claims.

What I claim is:

1. In a transmission assembly for a material handling machine, a jackshaft, a hoist shaft, a swing shaft, gears on each of said shafts, a gear fast on said jackshaft, a gear fast on said hoist shaft double the width of the other gears, a gear rotatable upon said swing shaft, a clutch adapted to connect between the swing shaft and its gear, said jackshaft gear and said swing shaft gear overlapping one another and both engaging said hoist shaft gear, but in different planes.

2. In a transmission assembly for material handling apparatus, a jackshaft having gears thereon, an idler gear in mesh with one of said jackshaft gears, a crowd-propel shaft, an independent clutch on each end of said crowd-propel shaft, each clutch including a gear fast to a clutch element, one of said clutch gears meshing with a jackshaft gear. the other meshing with said idler, a travel shaft, a gear fast thereon, and a gear rotatably fast but axially slidable upon said crowd-propel shaft into and out of engagement with said travel shaft gear.

3. In a transmission assembly for material handling apparatus, a jackshaft having gears thereon, an idler gear in mesh with one of said jackshaft gears, a crowd-propel shaft,

two independent clutches on said crowd-propel shaft, each clutch including a gear fast to a clutch element, one of said clutch gears meshing with a jackshaft gear, the other meshing with said idler, a travel shaft, a gear fast thereon, and a gear rotatably fast but axially slidable upon said crowd-propel shaft into and out of engagement with said travel shaft gear, a second sliding gear on said crowd-propel shaft and rotatable therewith, a crowd drum mounted adjacent said crowd-propel shaft, a gear fast on said crowd drum, said second sliding gear being engageable with said crowd-drum gear.

4. A transmission assembly for a material handling machine comprising in combination a jackshaft, a hoist shaft, a crowd-propel shaft and a swing shaft, gears on each of said shafts, gears adjacent each end of said jackshaft and fast thereto, a gear fast on said hoist shaft, a hoist drum and a crowd drum on said hoist shaft, said drums being rotatable selectively on or with said hoist shaft, gears on each end of said crowd-propel shaft rotatable selectively thereon or therewith, gears on each end of said swing shaft rotatable selectively thereon or therewith, a gear on said crowd drum, a gear on said crowd-propel shaft selectively engageable with said drum gear, one of said jackshaft gears and one of said swing shaft gears overlapping one another and both engaging said hoist shaft gear, but in different planes, one of said crowd-propel shaft gears engaging said hoist shaft gear, said other jackshaft gear engaging both said other gears on said crowd-propel shaft and on said swing shaft, said gears being of different ratios in each mutually engaging pair, whereby a constant speed and direction of said jackshaft may be used to impart selectively varying speeds and opposite direction to said crowd-propel shaft, to said swing shaft, and to said hoist drum.

Signed by me this 31 day of March, 1931.

CHARLES H. LOTTE.