July 19, 1938. E. H. STEIN 2,124,319

MINING MACHINE

Filed Dec. 11, 1935 3 Sheets-Sheet 1

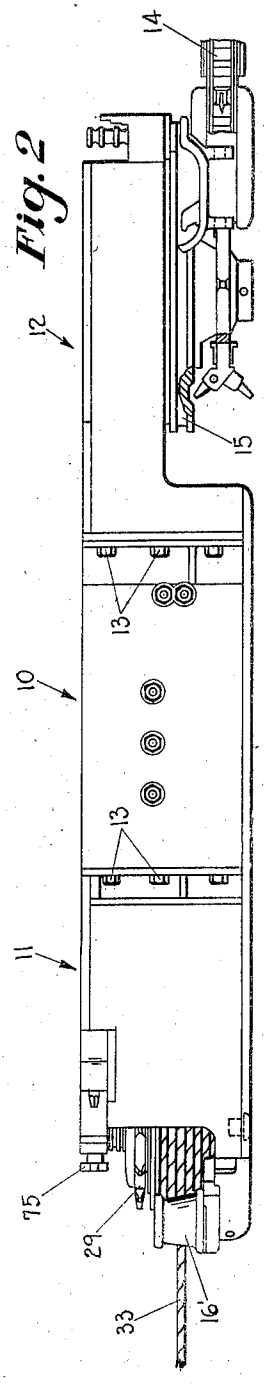


Fig. 2

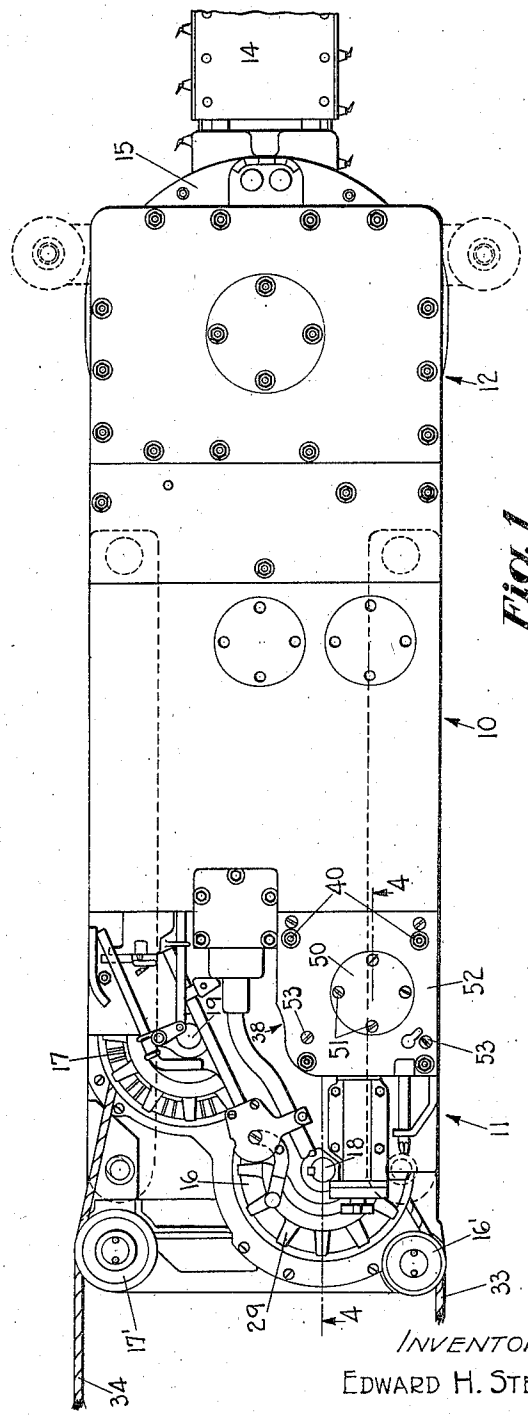


Fig. 1

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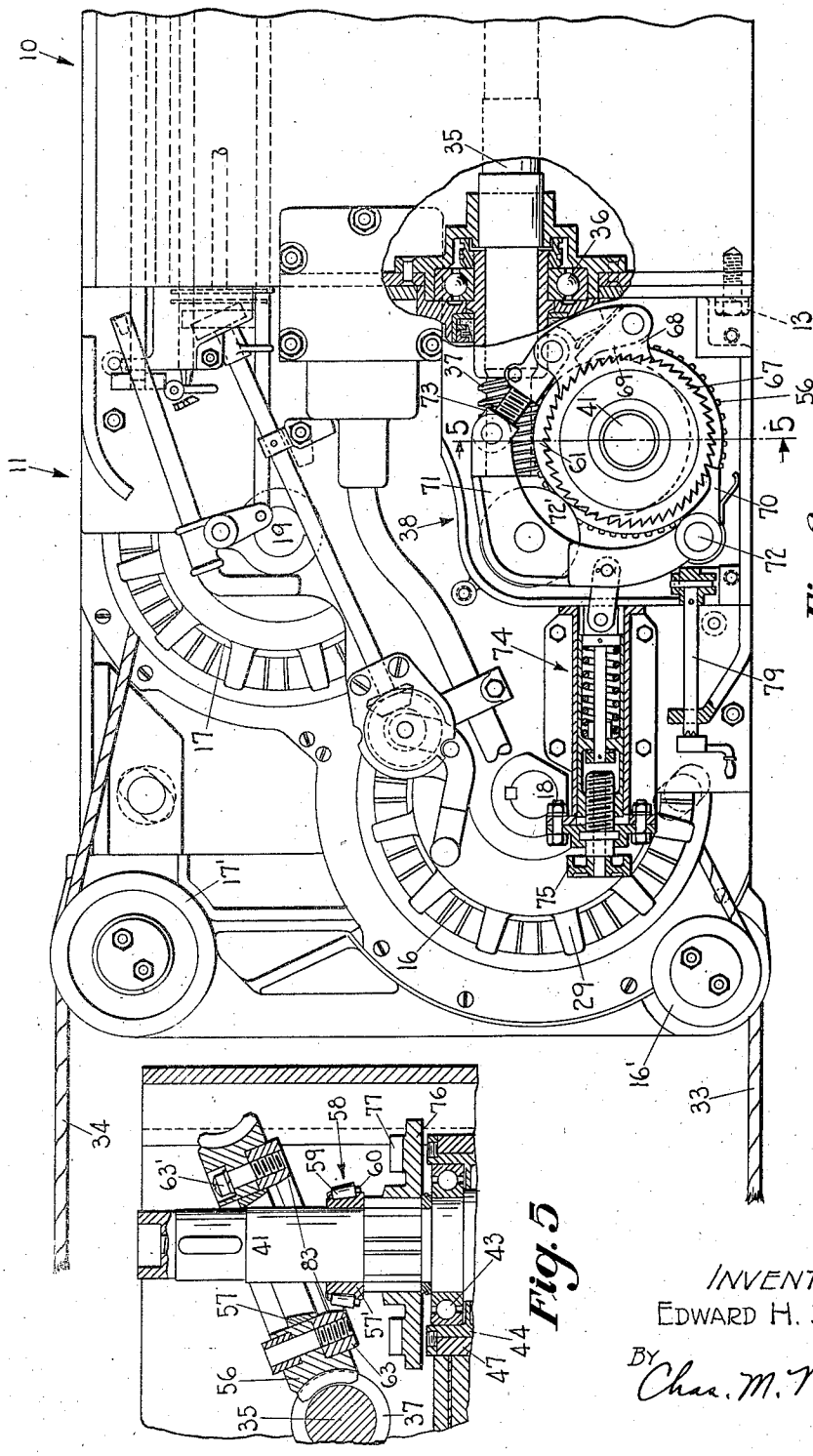


Fig. 3

Fig. 5

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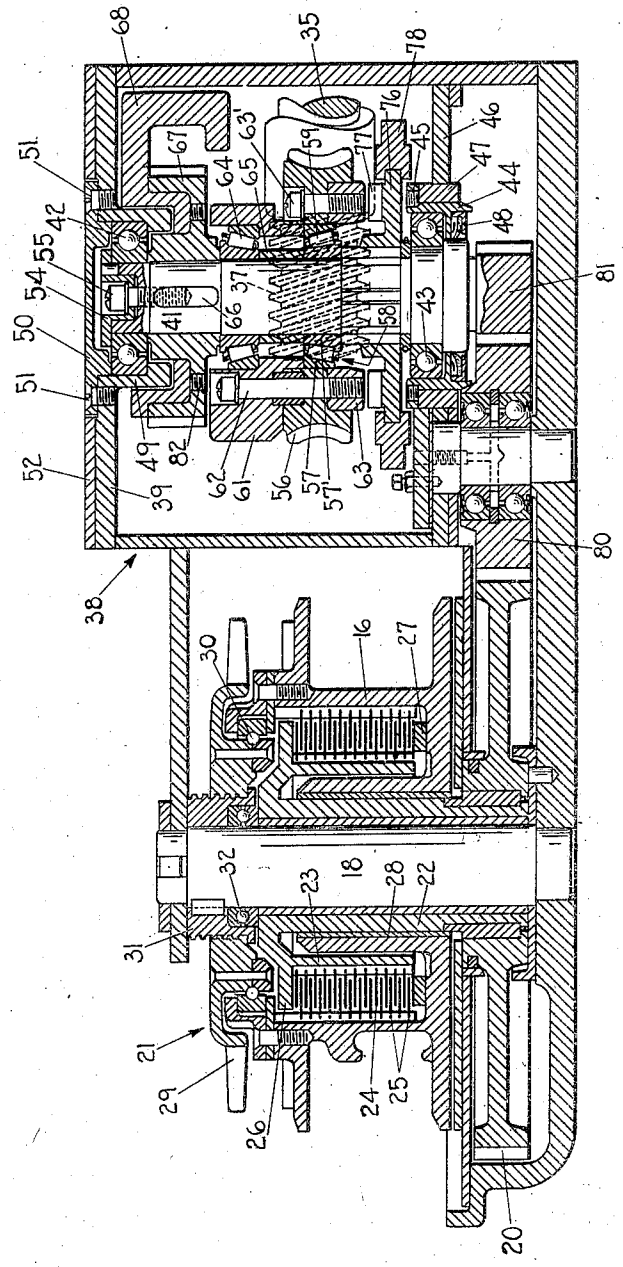


Fig. 4

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UNITED STATES PATENT OFFICE

2,124,319

MINING MACHINE

Edward H. Stein, Columbus, Ohio, assignor to The Jeffrey Manufacturing Company, a corporation of Ohio

Application December 11, 1935, Serial No. 53,951

19 Claims. (Cl. 74—425)

My invention relates to an improved mining machine, and more particularly to a novel gear train including a worm gear and driving worm.

An object of the invention is to provide a gear train including a worm and worm gear in which means are provided to permit ready disengagement of the worm and worm gear without moving the shaft on which either is mounted.

A more specific object of the invention is to provide a novel gear train between a motor and a drum, in a mining machine, which gear train includes a worm and worm gear and some type of clutch mechanism, in which means, including a tapered roller bearing, is provided for mounting the worm gear loosely on a driven shaft and which provides for ready removal of the worm gear without disturbing the worm or the driven shaft.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Fig. 1 represents a plan view of the mining machine embodying my improvement;

Fig. 2 is an elevational view of the mining machine shown in Fig. 1;

Fig. 3 is an enlarged plan view with certain parts removed and others shown in section of the haulage or front end of the machine shown at the left-hand end of Fig. 1;

Fig. 4 is a sectional elevational view taken on the line 4—4 of Fig. 1, looking in the direction of the arrows; and

Fig. 5 is a sectional elevational view taken on the line 5—5 of Fig. 3, looking in the direction of the arrows, with certain parts removed and with the worm gear in position to be readily removed.

This invention relates to improvements in the mining machine disclosed in the application of Robert K. Jeffrey and Lewis E. Mitchell, Serial No. 716,160 filed March 17, 1934, and in the application of Lewis E. Mitchell, Serial No. 716,660, filed March 21, 1934.

Referring particularly to Figs. 1 and 2, it will be seen that the supporting frame of the mining machine comprises an intermediate motor section 10, a front feeding and hauling section 11, and a rear cutting section 12. These sections are detachably-connected together by means of machine screws 13, 13, as best seen in Figs. 2 and 3. The detailed construction of the mining machine is disclosed more fully in each of the above-mentioned applications and reference is made thereto for those structural elements not described in detail in this application and which are not particularly concerned with the invention here involved.

It may be stated, however, that the machine carries a kerf-cutting mechanism 14 which is attached to a rotatable head 15 carried by the rear cutting section 12 thereof for pivotal movement about a vertical axis. It is thus possible to employ the machine to perform either a long-wall or a "Shortwall" cutting operation.

The feeding or hauling section 11 is provided with a pair of winding drums 16 and 17 which are preferably geared together to rotate in reverse directions. The winding drum 17 is so geared to the winding drum 16 that it tends to rotate at a slightly higher speed and is employed in many operations as a safety drum. The two drums 16 and 17 are mounted respectively on vertical shafts 18 and 19 and are adapted to be driven by a pair of large intermeshing gears one of which is seen at 20 in Fig. 4. A pair of friction clutches are also provided for effecting a driving connection between said large gears and the respective drums 16 and 17. These clutches are substantially of the same construction and one of them is seen at 21 in Fig. 4.

Briefly described, this clutch 21 comprises a quill 22 which is keyed to the hub of the gear 20 to rotate therewith. The quill 22 carries a cylindrical drum 23 which in turn carries a plurality of clutch discs 24 adapted to rotate therewith. The drum 16 also carries a plurality of clutch discs 25 adapted to interweave with the clutch discs 24. Appropriate bearing plates 26 and 27 are carried by the quill 22 and the drum 16, respectively, whereby upon movement of the two bearing plates 26, 27 toward each other, the clutch discs 24, 25 will be brought into friction engagement and transfer rotary movement of the quill 22 to the drum 16.

It is to be noted that the drum 16 is mounted for vertical sliding movement on an appropriate journal bearing 28 which surrounds the quill 22, and a stationary handwheel 29 is adapted to be rotated to lift the drum 16 to effect the aforementioned engagement. An anti-friction bearing 30 is provided between the handwheel 29 and the drum 16 thereby permitting the handwheel to remain stationary while the drum rotates, yet being operative to effect a vertical movement of the drum 16 upon vertical movement of the handwheel 29. Vertical movement of the handwheel 29 is provided by virtue of the threaded engagement between the hub thereof and the threaded collar 31 which is keyed to the stationary shaft 18.

It will be evident that by rotation of the hand-

wheel 29, an upward or downward movement of the drum 16 would be effected thereby, to effect an engagement or disengagement of the clutch and provide an engagement or disengagement between the gear 20 and the drum 16. An appropriate anti-friction bearing 32 is provided to maintain the quill 22 against upward movement.

The drums 16 and 17 are provided with cables 33 and 34, respectively, adapted to be reeved about pulleys 16' and 17' and to extend from the mining machine to perform any one of numerous mining operations, examples of which are disclosed more in detail in each of the above mentioned applications.

Power is supplied to the drums 16 and 17 from the motor carried by the motor section 10 through a gear train which will now be described in detail and which gear train includes the features of novelty comprising my invention.

As best seen in Figs. 3, 4 and 5, a motor armature shaft 35 extends rearwardly from the motor section 10 into the feeding or hauling section 11 and is mounted upon an appropriate anti-friction bearing 36 as it emerges from said motor section 10. Said armature shaft 35 comprises the driving shaft for the gear train and carries at its free end a worm 37. Said worm 37 extends into a totally enclosed housing 38 forming a part of the feeding or hauling section 11, which housing is provided with a removable top 39 (see Fig. 4) removably attached thereto by screws 40 (Fig. 1). Within the housing 38 there is provided a vertical shaft 41 which is mounted in said housing 38 for free rotation by the spaced anti-friction bearings 42 and 43. Anti-friction bearing 43 is carried in a removable cup 44 provided with threaded apertures 45 adapted to facilitate removal thereof, and carried on a plate 46 forming a false bottom for the housing 38, which plate 46 is provided with a bearing ring 47 to support said cup 44. A grease seal 48 is also provided adjacent the bottom of the cup 44 to prevent a loss of grease from the bearing 43.

The bearing 42 is carried within a cup 49 rigidly attached to the top 39 of the housing 38. A removable cap and grease seal 50 is provided for the bearing 42, which cap may be readily removed by the removal of retaining screws 51. A false cover plate 52 may also be provided over the top 39 and there retained by screws 53 (Fig. 1) to provide a substantially flush top for the housing 38.

A retaining washer 54 is attached to the upper end of the shaft 41 by a screw 55 to support said shaft 41 through the bearing 42. It will thus be seen that the shaft 41 is mounted for free rotation within the housing 38. As is best seen from Figs. 4 and 5 of the drawings, there is mounted upon the shaft 41 for free rotation with respect thereto, the worm gear 56 having the standard concave face which is adapted to mesh with the worm 37. In the claims a concave face worm gear includes this standard type as well as the hobbed straight face which has a concave tooth root. The internal diameter of the worm gear 56 is adapted to receive with a tight fit the outer cone 57 of a tapered roller bearing 58, the rollers 59 of which are adapted to be retained in a cage ring 60 which with the inner cone 57' of the roller bearing 58 are retained upon the shaft 41 when the worm gear 56 is removed. This is best illustrated in Fig. 5 of the drawings.

It is to be noted that the roller bearing 58 is so positioned with respect to the axis of rotation of the worm 53 that said roller bearing lies in a plane passing through said axis of rotation. This arrangement of parts is preferred for it provides a uniform transfer of the load from the worm 37 to the rollers 59. This positioning of the roller bearing also permits the ready removal of the worm gear 56 from the shaft 41 by permitting a disengagement of the teeth thereof with the teeth of the worm 37 without requiring a removal of the worm 37 or the shaft 41. This capability is of extreme practical importance for in the operation of mining machines it is often necessary to gain access to the lower portion of the housing 38 to remove any broken or worn parts or to renew the worm gear 56. In the absence of some ready means for removing the worm gear 56 without disturbing the shaft 41, it is an extremely difficult operation to gain access to the lower portion of said housing 38 and generally requires the disengagement of the two sections 10 and 11 of the machine, each of which often weighs near 2,000 pounds, which is an exceedingly difficult operation to perform particularly while the mining machine is adjacent the working face in a mine room.

By employing the tapering characteristic of a tapered roller bearing, I am able to employ this bearing not only for its usual function of providing an anti-friction bearing between the worm gear 56 and the shaft 41, but I also employ it as a means to permit the ready disengagement of the worm gear 56 and the worm 37. The particular method of this disengagement will be described more in detail hereinafter.

Reverting to a consideration of the elements of the gear train, as best seen in Figs. 4 and 5, there is provided a cam or eccentric 61 which is rigidly bolted to and above the worm gear 56 by three spaced bolts, one of which is seen at 62 in Fig. 4. The bolts 62 also engage a ring 63 which carries the jaws of a jaw clutch. In addition, the ring 63 is rigidly attached to the worm gear 56 by a plurality of bolts, one of which is seen at 63' in Figs. 4 and 5.

A second anti-friction tapered roller bearing 64 is provided between the cam 61 and the shaft 41. A spacer ring 65 is mounted very loosely on the shaft 41 and provides proper spacing means for the roller bearings 58 and 64. The cam 61 is also provided with a pair of diametrically disposed threaded holes similar to the threaded holes 45 in cup 44 which provide for a ready removal of the cam 61 after the bolts 62 are removed. It will be evident that removal of the cam 61 will also carry with it the roller bearing 64 including both the inner and outer races thereof. Positioned above the cam 61 and keyed rigid to the shaft 41 by key 66 is a ratchet wheel 67 which when rotated is adapted to impart rotary movement to the shaft 41. Rotary movement to said shaft 41 is imparted through the ratchet wheel 67 when a relatively slow speed for the drums 16 and 17 is desired, as for example, when performing a kerf-cutting operation.

A pawl carrier 68 is provided which carries a spring pressed pawl 69 (Fig. 3) adapted to cooperate with the teeth of the ratchet wheel 67. A retaining pawl 70 is provided to prevent reverse movement of the ratchet wheel 67. For oscillating the pawl carrier 68 there is provided a lever 71 pivoted at 72 to a stationary shaft. The lever 71 carries a roller 72' adapted to roll on the cam 61 and through said cam 61 to impart oscillatory movement to said lever 71 regardless of the di-

rection of rotation of the shaft 35. An adjustable linkage mechanism 73 is provided for connecting the lever 71 and the pawl carrier 68. An adjusting means 74 is provided for adjusting the extent of rotation of the shaft 41 under the influence of the ratchet wheel 67 upon each oscillation of the lever 71. By adjustment of the handle 75 of said adjusting mechanism 74, the ratchet wheel 67 may be adjusted to rotate through an angle corresponding to any desired number of teeth thereof from zero to the maximum limit provided by the lever 71, such as five teeth.

It is evident that by virtue of the elements previously described, the shaft 41 may be driven at a relatively low speed in a step by step fashion from the driving shaft 35. In addition, means are provided whereby the shaft 41 may be driven at a much faster speed from the shaft 35 through the worm 37 and the worm gear 56, in which case the step by step mechanism is not effective. This means comprises a jaw clutch including a plate 76 splined to the lower portion of the shaft 41 to rotate therewith and carrying jaws 77 which are tapered on one side whereby upon engagement of the jaws carried by the ring 63 and said jaws 77, rotation of the worm gear 56 will be transferred directly to the shaft 41 if in the proper direction as permitted by the retaining pawl 70 of the pawl and ratchet mechanism. If an attempt is made to rotate the shaft 41 in a direction not permitted by the retaining pawl 70, the tapered faces of the jaws 77 will permit the worm gear 56 to rotate without imparting rotation of the plate 76, by the slipping of the jaws on ring 63.

Appropriate means including a split ring 78 which is operatively controlled from an operating handle 79 (Fig. 3) is provided for adjusting the position of the jaw clutch including the ring 63 and the plate 76.

The rotary movement of the shaft 41 either at high speed or at low speed will be transmitted to the gear 20 through the intermediary of an idler gear 80 which meshes with said gear 20 and with a pinion 81 which may be formed integral with the lower end of the shaft 41.

Attention is particularly directed to Figs. 4 and 5 and to the method of disassembling the parts whereby the worm gear 56 may be readily removed without the removal of the worm 37 or the shaft 41 and without requiring any disengagement of the two sections 10 and 11.

Assuming the parts to be first as in the position illustrated in Fig. 4, the method of disassembly will now be described. The screws 51 will first be removed and the cap 50 removed. Plate 52 will then be removed after which screws 40 (Fig. 1) are removed. Screw 55 may then be removed after which the washer 54 will be removed to permit free removal of the bearing 42 from the shaft 41. The top plate 39 will then be lifted upward and will carry with it the roller bearing 42 removing it from the shaft 41. The pawl carrier 68 may then be readily removed in obvious manner. The ratchet wheel 67 may then be removed from shaft 41 by the insertion of screws into threaded holes 82 to which screws may be attached a gear remover of a type well known in the art, which presses against the shaft 41 while pulling upwardly on the ratchet wheel 67. Similar gear removing means may then be employed to remove the cam 61 which also contains threaded apertures as aforementioned, after the bolts 62 have been removed. The removal of the cam 61 will carry with it the tapered roller bearing 64. The spacer ring 65 may then be readily removed by hand as it does not have a tight fit with the shaft 41.

After having removed all of the aforementioned parts, it is easy for an operator to stick his hands into the housing 38 and to grasp the worm wheel 56 on each side of the worm 37. The worm wheel 56 may thus be tilted about an axis passing through the axis of rotation of the worm 37 to the position illustrated in Fig. 5. When in this position it is evident that the worm gear 56 may move laterally of the shaft 41 or to the right of the position illustrated in Fig. 5. This is provided by virtue of the clearance between the rollers 59 and the ring 63, which clearance results by virtue of the tapered rollers 59 as well as by the tapered inner cone 57 and tapered surface 83 of the ring 63 which is substantially a continuation of the conical surface formed by the outer cone 57. This tapered surface 83 is preferably made by removing as much material as can be safely removed from the ring 63 to allow a maximum clearance in the position illustrated in Fig. 5. This lateral movement of the worm gear 56 will partially disengage the worm and worm gear and will permit additional tilting of the worm gear with consequent additional lateral movement thereof provided. By repeating this action, the worm gear 56 may be easily disengaged from the worm 37 and when once disengaged may, of course, be readily removed from the gear housing 38. Having removed the worm gear 56 it may be renewed, as it is of bronze and thus has a relatively short life as compared with the steel worm 37, or ready access to the lower portion of the housing 38 is provided whereby any parts therein may be easily removed or any foreign matter may be removed.

As was above described, the roller bearing 58 is preferably so positioned as to lie approximately in a plane passing through the axis of rotation of the worm 37. In this position the load on the worm gear 56 is distributed evenly over the rollers 59 which insures a proper mesh between the worm 37 and worm gear 56. It will be evident that in proper mesh, the curvature of the teeth of worm gear 56 and worm 37 prevent their disengagement by a vertical movement of said worm gear 56. However, the construction of my invention permits their disengagement without moving the shaft 41 or the worm 37.

It is believed evident that due to the novel arrangement of the parts of the gear train and due to the novel mode of employing a tapered roller bearing, I have produced a new mounting which permits ready removal of a worm gear from a shaft and ready disengagement of a worm gear and worm wheel without requiring removal of the worm and without requiring removal of the shaft which supports the worm gear. This is of extremely practical importance when it is necessary to repair any parts associated with the worm or worm gear not readily accessible without removal of the worm gear or to the renewal of the worm or worm gear.

The term "Shortwall" used herein is the trade-mark of The Jeffrey Manufacturing Company, a corporation of Ohio, the assignee of this application, said trade-mark having been registered October 31, 1911, in Class 23, Cutlery, machinery, and tools, and parts thereof, registration No. 84,006, and renewed June 9, 1931.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims

hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a mining machine, the combination with a motor having an armature shaft extending therefrom, of feeding mechanism comprising, a worm on said armature shaft, a worm gear meshing with said worm, a second shaft for supporting said worm gear, a tapered roller bearing positioned between said second shaft and said worm gear in a position where a plane passing through the rollers thereof will also pass through the axis of rotation of said worm, and means for effecting a driving connection between said worm gear and said second shaft.

2. In a mining machine, the combination with a motor having an armature shaft extending therefrom, of feeding mechanism comprising, a worm on said armature shaft, a worm gear meshing with said worm, a second shaft for supporting said worm gear, a tapered roller bearing positioned between said second shaft and said worm gear, and means for effecting a driving connection between said worm gear and said second shaft, said above described elements being so constructed and arranged as to provide for the removal of said worm gear while said worm and said shafts remain in place.

3. In a mining machine, the combination with a motor having a drive shaft connected thereto, of driving mechanism therefor, comprising a worm on said drive shaft, a worm gear meshing with said worm, a driven shaft for said worm gear, and means adapted to permit disengagement of said worm gear and said worm while both said worm and said driven shaft remain in their normal operating positions, said means comprising a tapered bearing positioned between said worm gear and said driven shaft and lying in a plane passing through the axis of rotation of said worm.

4. In a mining machine, the combination with a motor having a drive shaft connected thereto, of a gear train therefor, comprising a worm on said drive shaft, a worm gear meshing with said worm, a driven shaft for said worm gear, and means adapted to permit disengagement of said worm gear and said worm while said worm driving shaft and driven shaft remain in their normal operating positions, said means comprising a tapered roller bearing positioned between said worm gear and said driven shaft.

5. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear while said worm driving shaft and driven shaft remain in their normal operating positions, said means comprising a tapered roller bearing positioned between said worm gear and said driven shaft and lying in a plane passing through the axis of rotation of said worm.

6. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear while both said driving shaft and said driven shaft remain in their normal operating positions, said means comprising a tapered roller bearing positioned between said worm gear and said driven shaft.

7. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear while both said driving shaft and said driven shaft remain in their normal operating positions, said means comprising a pair of spaced roller bearings for mounting said worm gear on said driven shaft, at least one of which has tapered rollers, and a spacer between said bearings easily removable from said driven shaft said tapered roller bearing lying in a plane passing through the axis of rotation of said worm.

8. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear while said worm driving shaft and driven shaft remain in their normal operating positions, said means comprising a pair of spaced roller bearings for mounting said worm gear on said driven shaft, at least one of which has tapered rollers, and a spacer between said bearings easily removable from said driven shaft.

9. In a mining machine, the combination with a motor, of a driving shaft driven by said motor, a driven shaft, means for effecting a driving connection between said driving shaft and said driven shaft comprising a worm on said driving shaft, a worm gear mounted for free rotation on said driven shaft, clutch means attached to said worm gear, a clutch plate carrying co-operating means and splined on said driven shaft, means for engaging and disengaging said means to effect a driving connection between said worm gear and said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear, while said worm driving shaft and driven shaft remain in their normal operating positions, said means comprising a tapered roller bearing positioned between said worm gear and said driven shaft, and lying in a plane passing through the axis of rotation of said worm.

10. In a mining machine, the combination with a motor, of a driving shaft driven by said motor, a driven shaft, means for effecting a driving connection between said driving shaft and said driven shaft comprising a worm on said driving shaft, a worm gear mounted for free rotation on said driven shaft, clutch means attached to said worm gear, a clutch plate carrying co-operating means and splined on said driven shaft, means for engaging and disengaging said means to effect a driving connection between said worm gear and said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear, while both said worm and said driven shaft remain in their normal operating positions, said means comprising a tapered bearing positioned between said worm gear and said driven shaft.

11. In a mining machine, the combination with a motor, of a driving shaft driven by said motor, a driven shaft, means for effecting a driving connection between said driving shaft and said driven shaft comprising a worm on said driving shaft, a worm gear mounted for free rotation on said driven shaft, clutch means attached to said worm gear, a clutch plate carrying co-operating means and splined on said driven shaft, means for en-

gaging and disengaging said means to effect a driving connection between said worm gear and said driven shaft, and means adapted to permit disengagement of said worm and worm gear by removal of said worm gear, while said worm driving shaft and driven shaft remain in their normal operating positions.

12. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means comprising a tapered bearing positioned between said driven shaft and said worm gear and constructed and arranged to permit movement of said worm gear laterally of said worm thereby to provide for removal of said worm gear while both said worm and said driven shaft remain in their normal operating positions.

13. In a gear train, the combination with a driving shaft, of a driven shaft, a worm on said driving shaft, a worm gear on said driven shaft, and means comprising an antifriction bearing positioned between said driven shaft and said worm gear and constructed and arranged to provide for removal of said worm gear while both said worm and said driven shaft remain in their normal operating positions.

14. In a gear train, the combination with a worm, of a worm gear in mesh therewith, supporting means for said worm gear, a tapered roller bearing mounted on said supporting means, means supporting said worm for rotation, and means, including said tapered roller bearing, constructed and arranged to provide for the removal of said worm gear while said worm and said worm gear supporting means remain in their normal operating positions.

15. In a gear train, the combination with a rigid worm, of a rigid gear having a continuous rim carrying concave teeth meshing with said worm, supporting means for said worm gear, a tapered roller bearing mounted on said supporting means, means supporting said worm for rotation, and means including said tapered roller bearing, constructed and arranged to provide for the removal of said worm gear while said worm and said worm gear supporting means remain in their normal operating positions.

16. In a mining machine, the combination with a motor, of a drive shaft driven thereby, feeding mechanism including a gear train connected to said drive shaft, comprising a rigid worm on said drive shaft having teeth thereon, a rigid concave gear having a continuous rim and having teeth meshing with said worm teeth, a driven shaft connected to said worm gear, and mechanism constructed and arranged to permit disengagement of said worm gear and said worm while both said worm and said driven shaft remain in their normal operating positions.

17. In a gear train, the combination with a driving shaft, of a driven shaft, a rigid worm on said driving shaft having teeth thereon, a rigid concave worm gear on said driven shaft having a continuous rim and having teeth meshing with said worm teeth, and mechanism constructed and arranged to permit disengagement of said worm and worm gear by removal of said worm gear while both said worm and said driven shaft remain in their normal operating positions.

18. In a gear train, the combination with a driving shaft, of a driven shaft, a rigid worm on said driving shaft having teeth, a rigid worm gear on said driven shaft having a continuous rim and having teeth meshing with said worm teeth, and means constructed and arranged to permit movement of said worm gear laterally of said worm thereby to provide for removal of said worm gear while both said worm and said driven shaft remain in their normal operating positions.

19. In a gear train, the combination with a rigid worm having teeth, of a rigid concave worm gear having a continuous rim and having teeth meshing with said worm teeth, means for mounting said worm and worm gear for rotation with the teeth thereof in mesh, and mechanism having a tapered surface constructed and arranged to provide for lateral movement of said worm gear to disengage it from said worm while said worm and said mounting means remain in their normal operating positions.

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