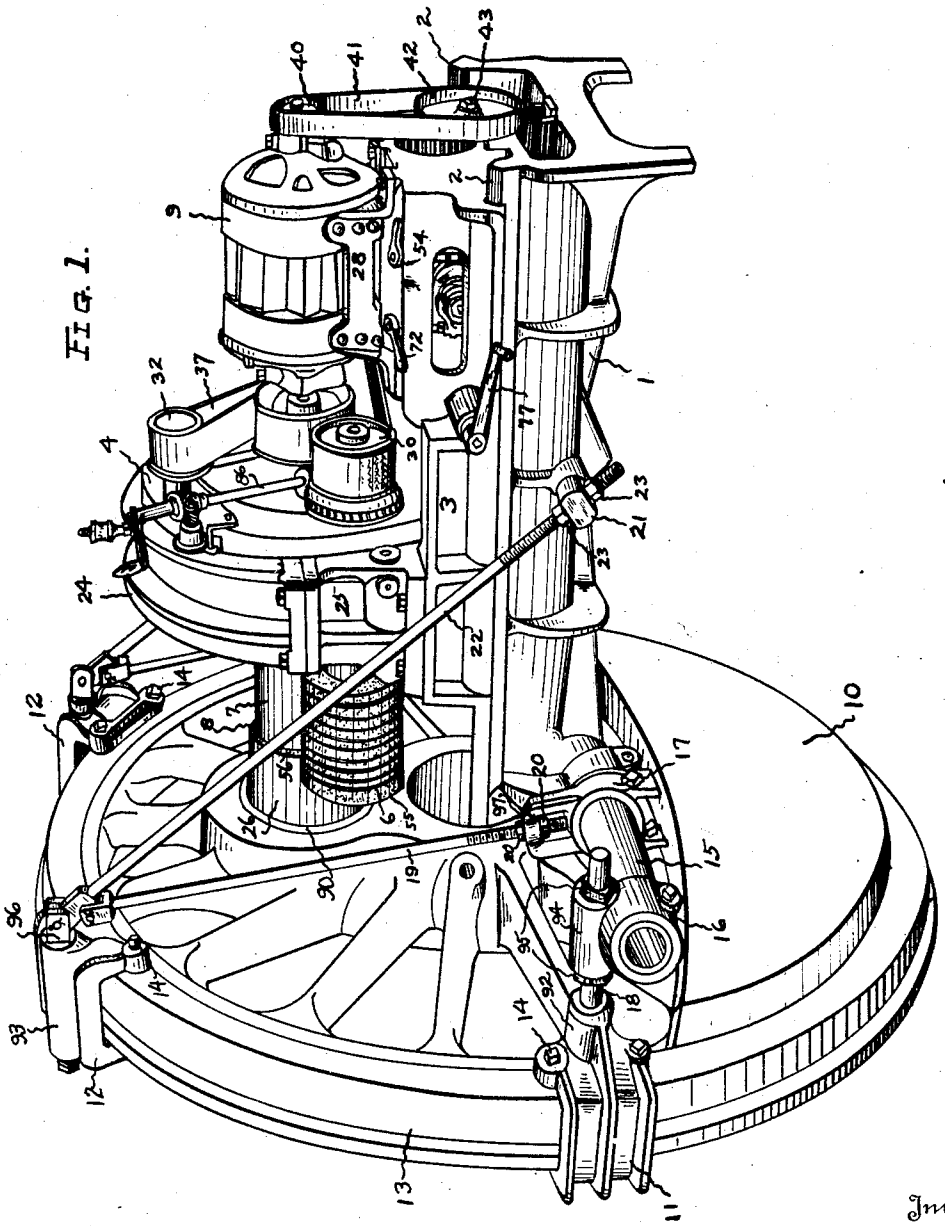
Nov. 4, 1930. H. H. YERK ET AL 1,780,288

GRINDING MACHINE

Filed Aug. 23, 1926 6 Sheets-Sheet 1

Fig. 1.



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GRINDING MACHINE

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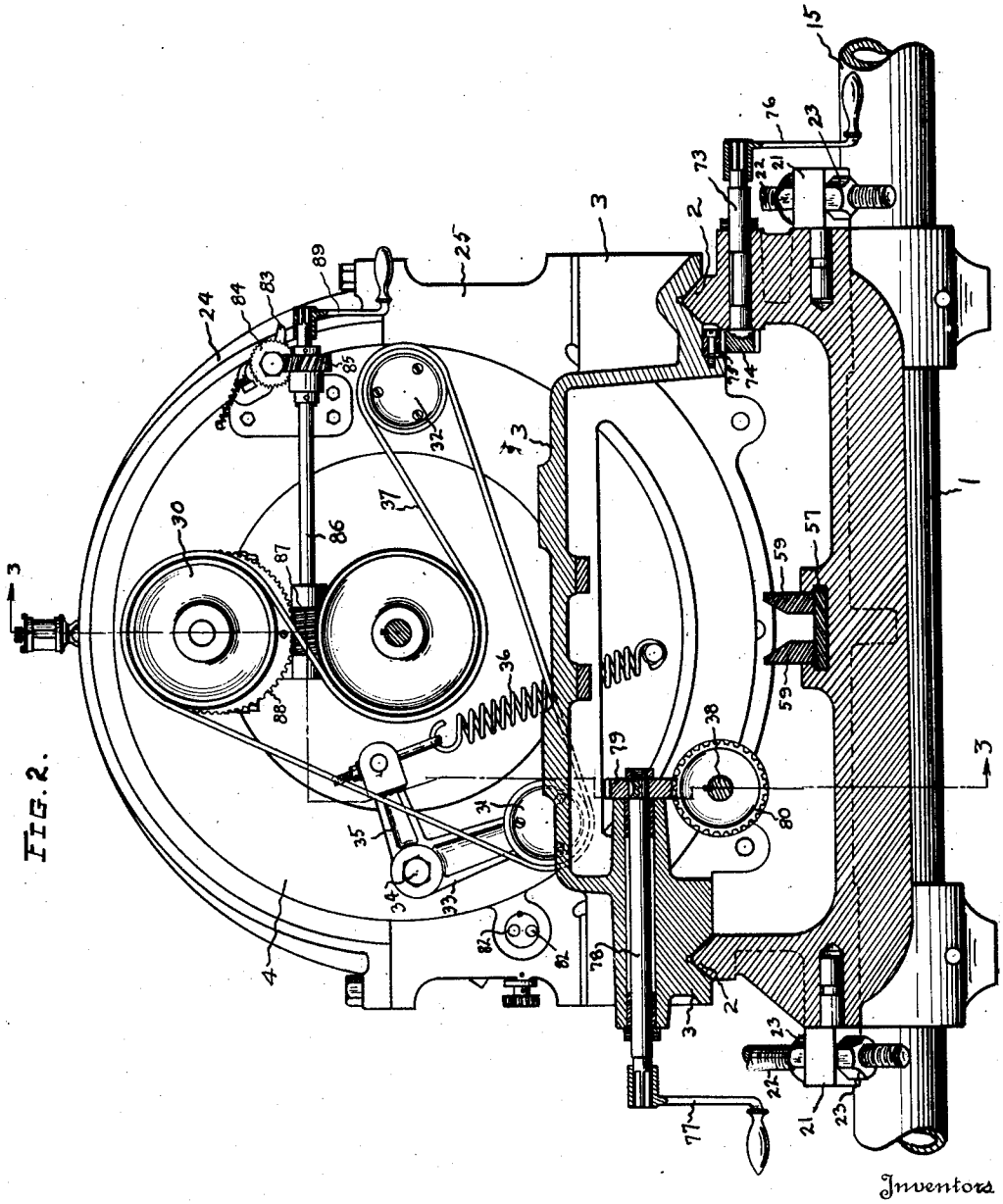


FIG. 2.

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GRINDING MACHINE

Filed Aug. 23, 1926 6 Sheets-Sheet 3

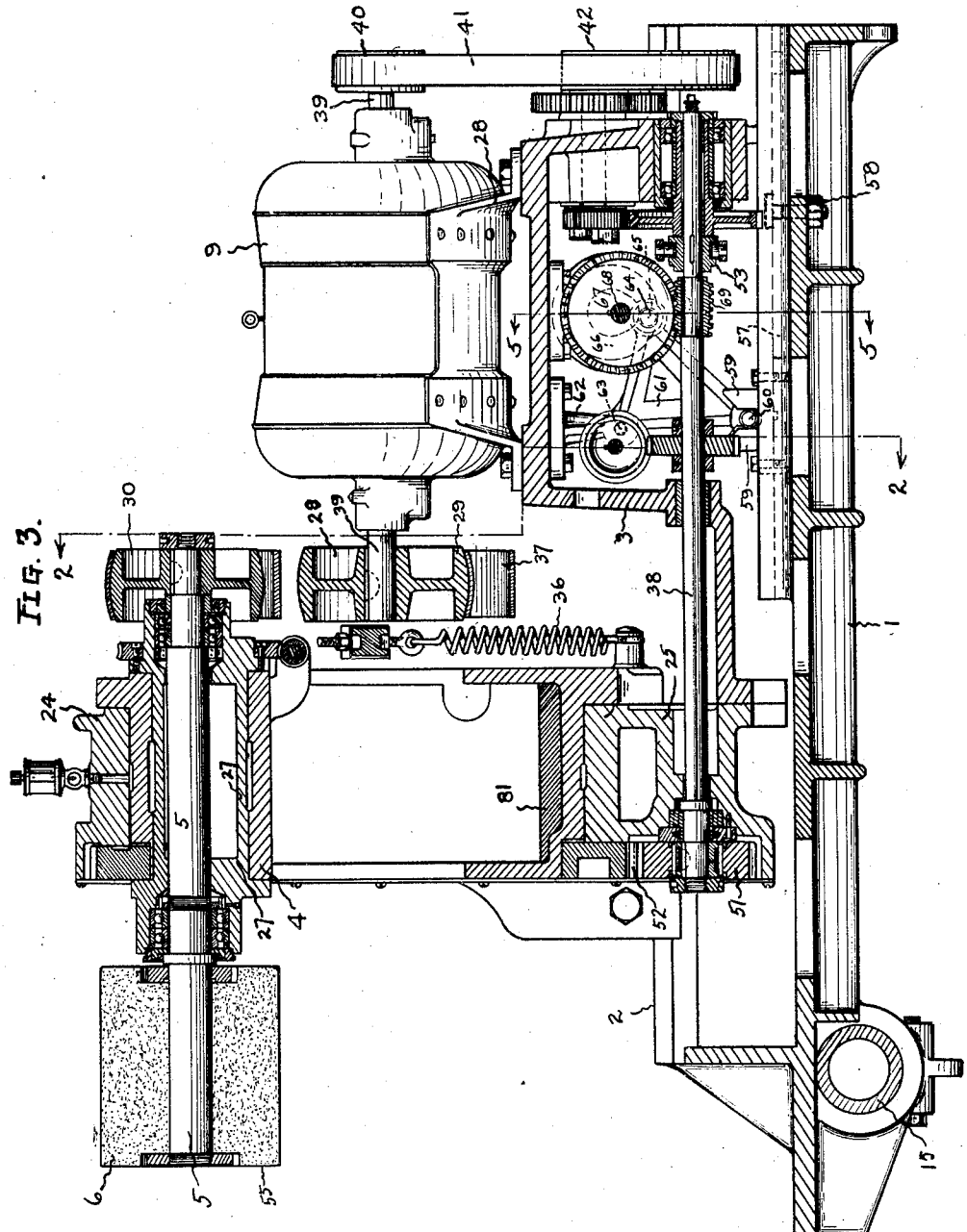


FIG. 3.

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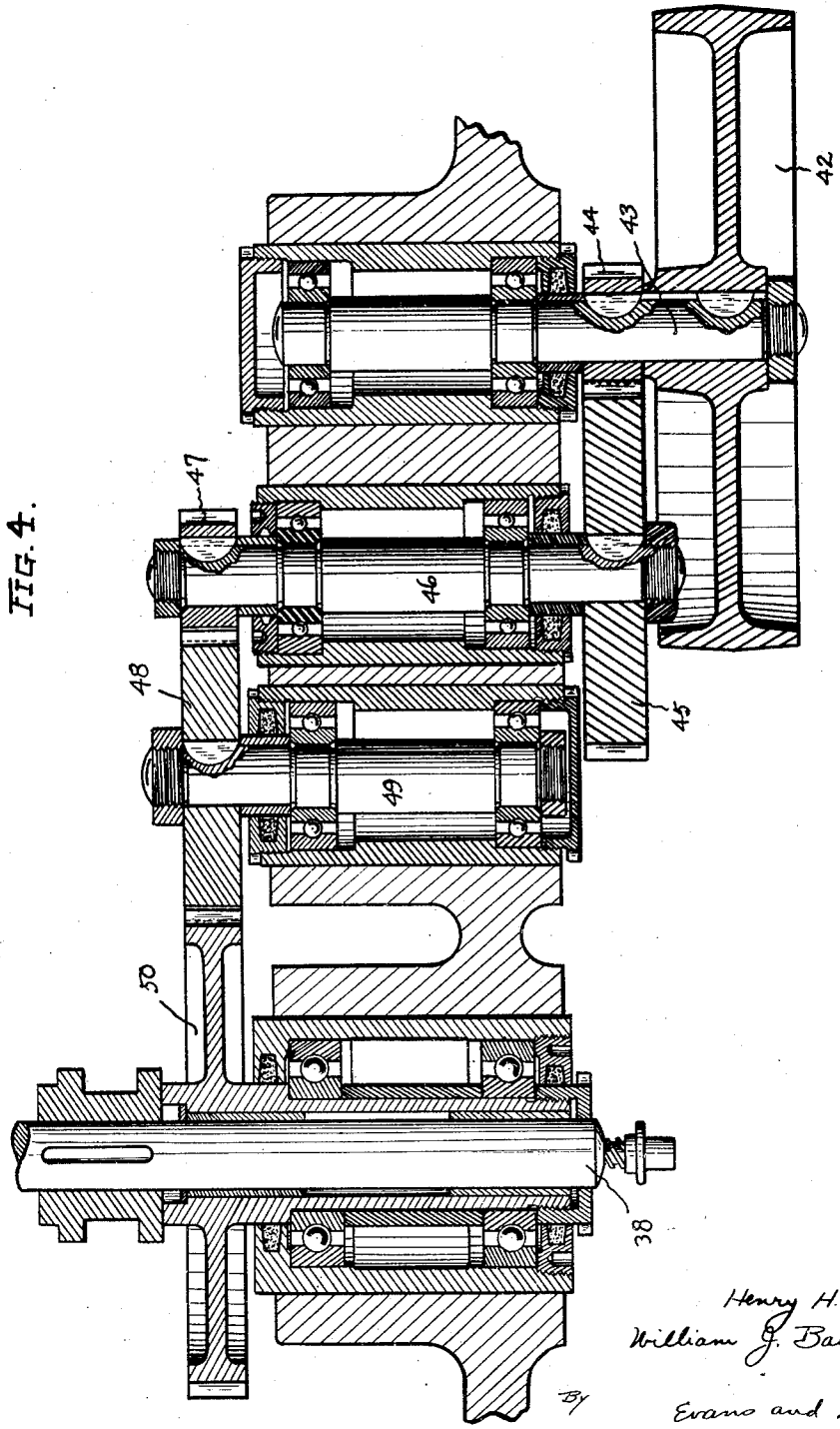
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GRINDING MACHINE

Filed Aug. 23, 1926 6 Sheets-Sheet 4

FIG. 4.



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Nov. 4, 1930. H. H. YERK ET AL 1,780,288

GRINDING MACHINE

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FIG. 5.

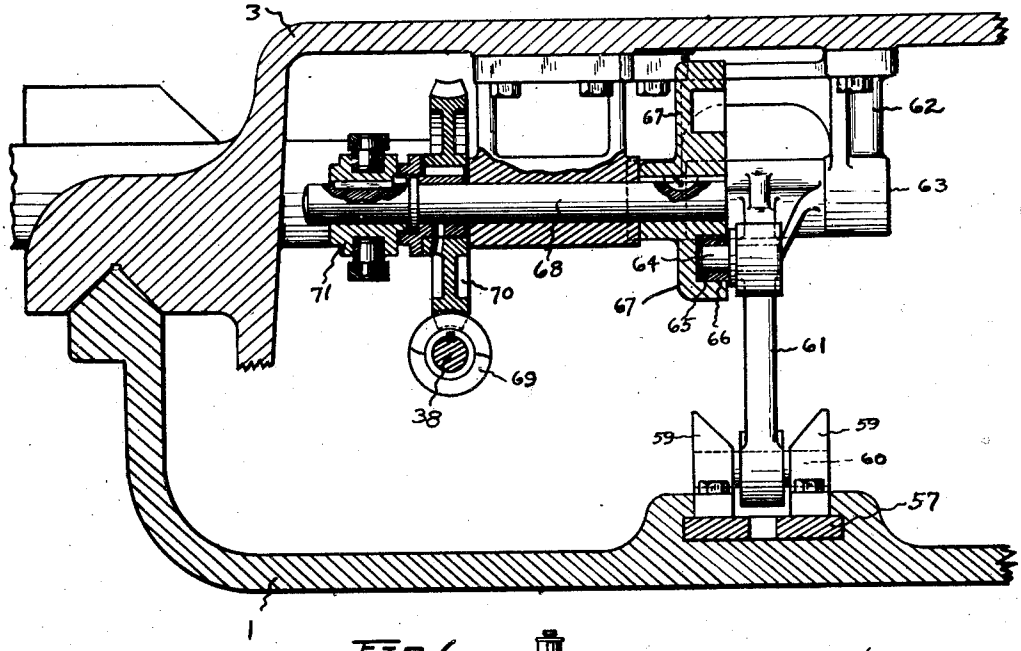
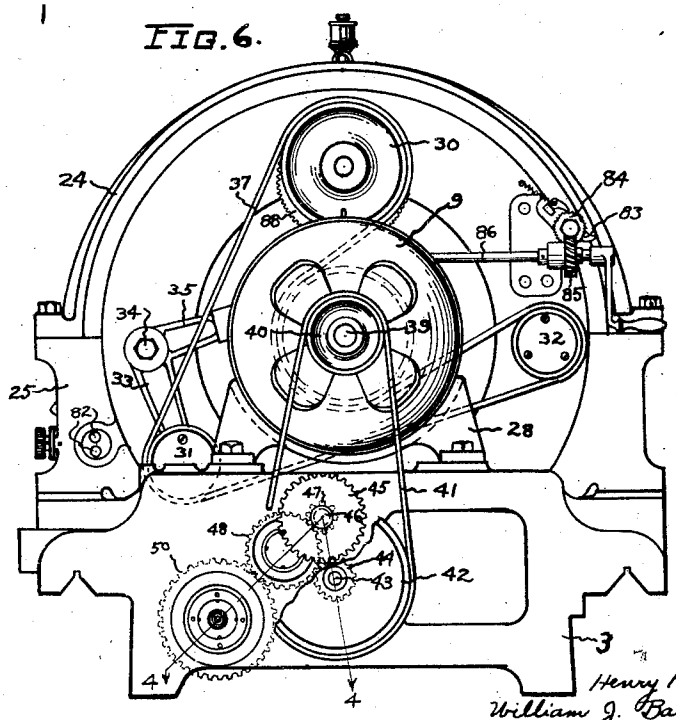


FIG. 6.



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GRINDING MACHINE

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Fig. 8.

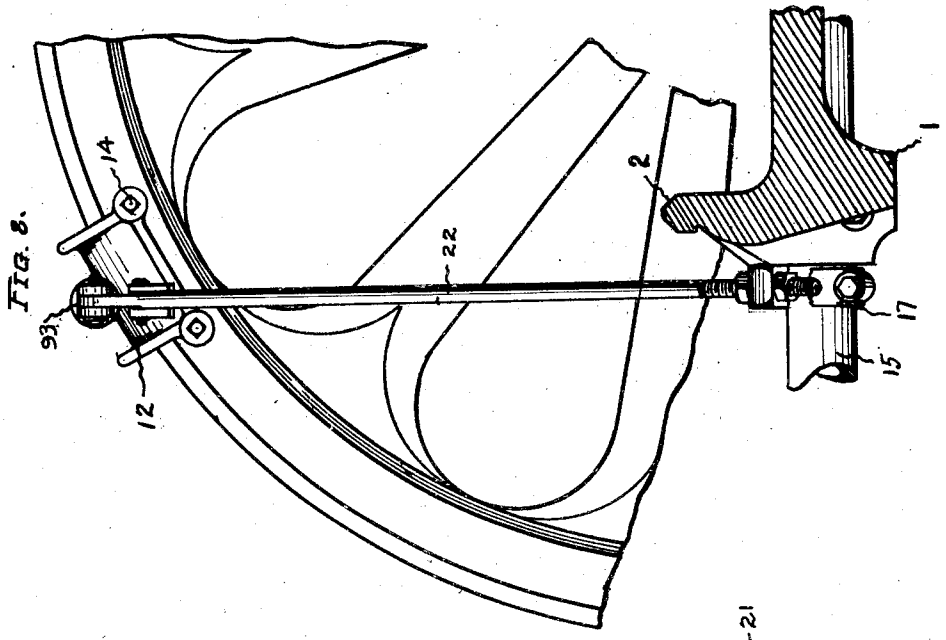
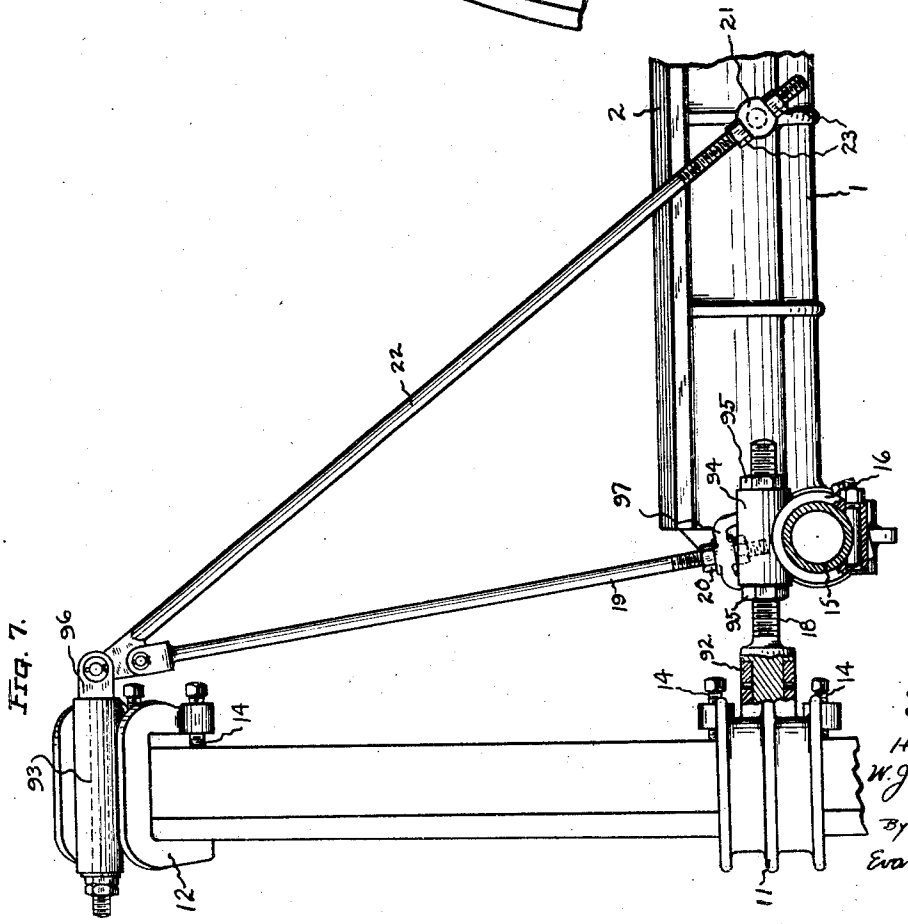


Fig. 7.



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UNITED STATES PATENT OFFICE

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GRINDING MACHINE

Application filed August 23, 1926. Serial No. 130,886.

This invention relates to grinding machines and more particularly to machines for grinding the external surfaces of relatively large cylindrical objects such as crank pins.

Hitherto the crank pins of locomotive wheels have been refinished by cutting tools to obtain the desired size of crank pin for cooperation with a locomotive driving link. By this means of finishing to size, however, the accuracy obtained in finishing has not been very great as a result of which a maximum efficiency of operation of the crank pin connections has not been obtainable.

An object of this invention is to provide a grinding machine adapted to grind the external surfaces of large cylindrical metal objects.

A further object of the invention is to provide a portable grinding machine having a slidable carriage carrying a power unit for operating moving parts of the machine.

Another object of the invention is to provide a grinding machine having a rotatable headstock mounted on the carriage, said carriage having also mounted thereon a power shaft in longitudinal alignment with the axis of said headstock for rotating said headstock and simultaneously rotating a grinding wheel spindle carried by said headstock.

A further object of our invention is to provide a portable grinding machine adapted to be rigidly secured to a locomotive wheel for the grinding of the crank pin thereof.

Another object of this invention is to provide a portable grinding machine for grinding locomotive wheel crank pins, which machine may be readily attached to a locomotive wheel for grinding a crank pin thereof and which may be readily disassembled after grinding.

A further object of our invention is to provide a portable grinding machine which may be readily secured to a locomotive wheel for grinding the crank pin thereof and which may be readily adjusted to grind portions of different diameters on said crank pin.

Another object of the invention is to provide a grinding wheel of such construction to grind a crank pin or the like with the greatest speed and accuracy.

Other objects of the invention will be apparent to those skilled in the art from the accompanying description and appended claims.

In the drawings, Figure 1 is a perspective view showing a grinding machine contemplated by our invention rigidly secured to a locomotive wheel and in position for grinding the crank pin thereof;

Fig. 2 is an elevation partly in section on line 2—2 of Fig. 3;

Fig. 3 is a vertical section through the grinding machine taken on line 3—3 of Fig. 2;

Fig. 4 is a sectional view of driving gears taken on line 4—4 of Fig. 6;

Fig. 5 is a vertical section through the grinding machine taken on line 5—5 of Fig. 3;

Fig. 6 is a rear elevation of the grinding machine;

Fig. 7 is an elevation partly in section showing adjustable means for securing the grinding machine adjacent a locomotive wheel; and

Fig. 8 is an end elevation of the means shown in Fig. 7.

We have illustrated as one embodiment of our invention, a grinding machine comprising generally a bed 1 adapted to be secured rigidly to a locomotive wheel 10, adjacent which the machine is to be disposed. The bed 1 is provided with slideways 2 on which the carriage 3 is slidable. Carried by the carriage 3 is a rotatable headstock 4 which is preferably annular in shape. Rotatably mounted on the headstock 4 is a grinding wheel spindle 5 which in turn carries a grinding wheel 6 which, as will be later more fully described, is preferably relatively wide, and may be substantially as wide as the particular surface to be ground. The machine illustrated in Fig. 1 is disposed in position to grind the outer portion 7 of the crank pin 8. It will be noted that with an annular headstock as shown the crank pin 8 may extend into the annular space thereof. This feature is of particular advantage where the portion of the work to be ground is remote from the end of the work, such as in grinding the enlarged

portion 26 of the crank pin 8. The carriage 3 is moreover reciprocable longitudinally of the bed 1 and of the crank pin 8.

The power for operating the moving parts of our grinding machine is obtained from a power shaft, such as of the power unit 9 mounted on the carriage 3. The power unit 9 may comprise an electric motor, as shown. Suitable driving means to be later described are mounted on the carriage to rotate the headstock and grinding wheel from the power unit, and other means are cooperatively associated with the bed and with the carriage for reciprocating the carriage by power obtained from the motor 9. In operation, therefore, the grinding wheel rotates on its own axis, and is carried in an orbital path around the circumference of the surface to be ground by the rotating headstock 4. Simultaneously with the rotation of the grinding wheel and of the headstock, the carriage is moved longitudinally of the work to be ground whereby a smoother ground surface is obtained, and "patterns" in the said surface prevented.

The bed 1 as shown is of substantially U shaped structure, and is provided with a pair of spaced slideways 2. The said bed is adapted to be disposed adjacent a locomotive wheel 10 in such position that the slideways 2 will be parallel to, and the axis of the headstock 4 in longitudinal alignment with, the axis of the cylindrical surface to be ground on the crank pin 8.

This positioning of the bed 1 may be accomplished by the means illustrated in Figs. 1, 7 and 8. Thus, the C-clamps 11 and 12, which are provided with the apertured bosses 92 and 93 respectively, may be secured to the rim 13 by the bolts 14. Extending laterally from each side of the bed 1 are the tubular members 15 on which the collars 16 and 17 may be non-rotatively secured. The connecting rods 18 each have an enlarged head which may be secured within the apertured boss 92 and a threaded portion adapted to be disposed within the apertured boss 94 of the collar 16. The rods 18 may be adjustably secured to the bosses 24 by means of the nuts 95.

Adjustably disposed in each of the bosses 93 of the clamps 12 is a pin 96 threaded at one end, and bifurcated at its opposed end to cooperate pivotally with the upper flattened portion of the connecting rod 22. The lower portion of each rod 22 extends through an apertured boss 21 extending laterally from the bed 1 remote from the wheel 10. The bosses 21 are pivotally mounted with respect to the bed 1, and each rod 22 may be adjustably secured to a boss 21 by nuts 23.

Each rod 19 is bifurcated at its upper end and pivotally secured to the flattened portion of a rod 22. At their lower ends, each rod 19 is threaded and may be adjustably secured to the apertured boss 97 of a rod 19 by nuts 20.

By the above described means, a grinding machine contemplated by our invention may readily be adjustably secured in rigid position adjacent the work to be ground.

It will, moreover, be noted that our machine is readily adapted to grind a locomotive wheel crank pin so that the stroke, namely the radial distance between the axis of the wheel and the axis of the crank pin, is absolutely accurate and equal to the stroke of the other wheels of the same locomotive. By the adjustable supporting means which we have provided, one crank pin may readily be ground with its axis at exactly 90° to the axis of the crank pin on the same axle and mounted on the opposed locomotive wheel.

Slidably mounted on the slideways 2 of the bed 1 is the carriage 3 which carries moving parts of the grinding machine. It will be noted that the said carriage may be removed entirely from the bed by sliding said carriage longitudinally on the slideways. Thus, for ease in positioning the machine adjacent work to be ground, the bed 1 may be secured in position and the carriage thereafter assembled with the bed for the grinding operation.

On the carriage 3 is mounted a rotatable annular headstock 4 which is secured in position during rotation by the bearing portions 24 and 25. The headstock 4, as previously mentioned, is preferably of annular shape to lighten the weight of the machine and so that the crank pin 8 may extend into the annular space thereof, as when the inner enlarged portion 26 of the crank pin 8 is being ground.

In the headstock 4 is rotatably mounted a hollow cylindrical spindle housing 27, the purpose of which is to permit adjustment of the grinding wheel for grinding various diameters of crank pins, for example, and for feeding the grinding wheel to the work to be ground, as will be later more fully described. In the spindle housing 27 is eccentrically mounted in suitable bearings the grinding wheel spindle 5, at the forward end of which is mounted the grinding wheel 6. The inner portion of the headstock 4 substantially opposite to the spindle 5 is counterweighted as at 81, to counterbalance the weight of the spindle 5 and the grinding wheel 6, and thus obtain smoother operation of the machine.

The grinding wheel 6 is preferably relatively wide, as shown, and may be of substantially the same width as the surface to be ground whereby relatively large amounts of stock may be removed in a short time. In operation, the said grinding wheel is preferably reciprocated to a small degree longitudinally of the surface to be ground

during the grinding in order to produce a smoother ground surface, and to keep the outer surface of the wheel true so that stock may be removed substantially uniformly by the wheel. To provide a plurality of spaced, axially aligned grinding wheel surfaces, a grinding wheel 6 may be advantageously provided with a plurality of spaced annular grooves such as illustrated in Fig. 1, or, if desired, the grinding wheel 6 may comprise a plurality of spaced, relatively narrow wheels to accomplish this same purpose.

To provide the power to rotate the headstock 4, the grinding wheel 6, and to reciprocate the carriage 3 longitudinally of the bed 1, a power shaft 39 is mounted on the carriage 3 and movable therewith. This power shaft may be driven by any suitable means, and may form part of a power unit disposed on the carriage. Thus, there is shown mounted on the carriage 3 rearwardly of the headstock 4, a power unit comprising an electric motor 9 secured to the carriage 3 by suitable securing means 28.

Means is provided for driving the grinding wheel spindle 5 directly from the power shaft 39 of the motor 9. Thus, the forward end of the motor drive shaft is provided with a pulley 29. A similar pulley 30 is mounted on the inner end of the grinding wheel spindle 5. Also mounted rearwardly of, and carried by, the headstock 4 are the idler pulleys 31 and 32. A driving belt engages the above mentioned four pulleys as is clearly shown in Figs. 2 and 6. The idler pulley 32 is rotatably mounted on the headstock 4 while the idler pulley 31 is mounted on the arm 33 of a bell crank pivotally mounted on the headstock at 34. To the bell crank arm 35 is attached a tension spring 36 whereby the belt 37 may always be maintained under a suitable constant tension to provide smooth even rotation of the grinding wheel spindle 5.

The headstock is rotated by power transmitted from the motor 9 through suitable reducing gears to the shaft 38 running longitudinally of the carriage 3. Thus, at the rearward end of the motor shaft 39 is a drive pulley 40 which transmits power by means of the belt 41 to the large pulley 42 mounted on the shaft 43 at the rearward end of the carriage. As is clearly indicated, particularly in Figs. 4 and 6, the power is transmitted from the small gear 44 mounted on the shaft 43 to the large gear 45 mounted on the shaft 46. The power is in turn transmitted from the small gear 47 mounted on the shaft 46 to the gear 48 mounted on the shaft 49 and in turn to the larger gear 50 mounted on the longitudinally extending shaft 38. At the forward end of the longitudinal shaft 38 is a small gear 51 which meshes with the gear teeth 52 associated with the headstock 4 to thereby rotate the headstock and move the grinding wheel in a circular orbital path about the surface to be ground. By means of the clutch mechanism 53 operated by a handle 54, as shown in Figs. 1 and 3, rotation of the headstock may be stopped without stopping the motor 9.

Means are also provided to obtain an intermittent reciprocating motion of the carriage. Thus, the carriage may be brought to a forward position so that the outer forward edge 55 of the grinding wheel may cooperate with the shoulder 56 of the crank pin as indicated in Fig. 1. In this position the carriage may be maintained stationary while the headstock makes an uneven number of revolutions, such as one and a fraction revolutions. The object of the uneven number of revolutions is to prevent the formation of scallops or patterns on the finished ground surface and to insure uniform even grinding of the surface of the pin adjacent the shoulder 56. The carriage is then moved to its rearward position, forwardly again, and the carriage then permitted to remain stationary for a predetermined time in said forward position, after which the reciprocating motion is repeated.

The mechanism for accomplishing this reciprocating motion comprises an adjustable slide 57 disposed in a lower portion of the carriage as shown in the Figs. 2, 3 and 5, the said slide being adjustable longitudinally of the carriage. The slide 57 may be fixed in a desired position, depending on the limits of longitudinal travel desired, by suitable means such as the nut and bolt shown at 58. Reciprocating motion is transmitted to the carriage by a quadrant 61 pivotally associated with the bed 1 and carriage 3. Thus, carried by the slide 57 are the upstanding lugs 59 which support the fixed pivot pin 60 of the quadrant 61. Carried by a bracket 62 secured to the under side of the carriage 3 is the pivot pin 63 of the quadrant 61. A third pivot pin 64 of the quadrant carries a roller 65 movable in the cam groove 66 of the cam 67 which is mounted on the transverse shaft 68. The cam groove 66 is so shaped to cause the pivot pin 64 to move vertically at intermittent periods, and thereby cause the intermittent motion previously described.

Power is supplied for the reciprocating motion as follows: On the longitudinally extending shaft 38 is mounted a worm 69 rotated by said shaft 38. The worm meshes with a worm wheel 70 mounted on the transverse shaft 68 which transmits power to the clutch 71 operable by the handle 72, and thence to the transverse shaft 68 and the cam 67 which is keyed to said transverse shaft. Rotation of the cam 67 causes the quadrant pivot pin 64 to move vertically at intermittent periods. Since the lower pivot pin 60 is fixed against movement longitudinally of the

carriage, and since the quadrant is rigid, the pivot pin 63 is caused to move forwardly and rearwardly with an arcuate movement, thereby reciprocating the carriage 3 longitudinally of the slideways 2 in the manner previously described.

The carriage 3 may be manually reciprocated by releasing the clutch 71 shown in Fig. 5 and turning the transverse shaft 73 shown in Fig. 2. The shaft 73 carries a pinion 74 which meshes with a rack 75, and may be turned by a suitable handle 76.

The headstock 4 may be manually rotated by releasing the clutch 53 shown in Figs. 1 and 3 and by manually rotating the handle 77 shown in Figs. 1 and 2 attached to the transverse shaft 78. A gear 79 is attached to the inner end of the shaft 78 and meshes with the gear 80 keyed to the longitudinal shaft 38, as shown in Figs. 2 and 3.

The grinding wheel may be adjusted for grinding a desired diameter of crank pin, and the wheel may be fed to such pin by automatic or manual means associated with the spindle housing 27. The grinding wheel is adjusted for a given diameter of work and is fed toward such work by rotating the spindle housing 27 and thereby changing the diameter of the orbital path of the grinding wheel. Such automatic means for gradually feeding the grinding wheel to the work are shown in Figs. 1, 2 and 6. Thus, on every revolution of the headstock 4 one of the stops 82 on the headstock may trip the arm 83 to thereby rotate to a desired degree the ratchet 84 and hence the gear 85 and the transverse shaft 86, which said shaft carries a worm 87 to transmit shaft rotation to the worm wheel 88 associated with the spindle housing 27. In this manner the spindle housing is rotated to the desired degree. The housing 27 may be rotated manually by releasing the arm 83 and rotating the shaft 86 by means of a suitable handle 89.

In operation the bed 1 is suitably secured to the locomotive wheel 10 or other equivalent member so that the slideways 2 are parallel to, and the axis of the headstock 4 in longitudinal alignment with, the axis of the cylindrical surfaces to be ground on the crank pin 8 or other member to be ground. The spindle housing 27 is then rotated to such a position as will give the desired diameter of orbital movement of the grinding wheel. The automatic means including the members 82, 83 and 84, may then be adjusted to automatically feed the grinding wheel at a desired rate to the work. The slide 57 and the cam 67 are then adjusted so that when the carriage is in its extreme forward position the outer forward edge of the grinding wheel just contacts with, for example, the shoulder 56 of the crank pin portion 70. Where the enlarged crank pin portion 26 is to be ground the slide 57 and the cam 67 are so arranged that the extreme forward position of the carriage during the reciprocating movement will just bring the outer forward edge of the grinding wheel 6 to the shoulder 90. Thus, the reciprocating motion of the carriage takes place away from, for example, the shoulder 90 or the shoulder 56.

It may be noted that the gear ratio of the gears rotating the headstock, and the mechanism reciprocating the headstock is so calculated preferably that the headstock makes one and a fraction revolutions for one complete reciprocation of the carriage. In this manner patterns or scallops in the ground surface are prevented and a smoother finish obtained.

It will thus be seen that we have provided an advantageous grinding machine for finishing large cylindrical surfaces such as crank pins on locomotive wheels and the like.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from our invention as defined in the appended claims.

What we claim is:

1. A grinding machine for grinding external cylindrical surfaces comprising, in combination, a bed, a carriage slidable on said bed, an annular headstock rotatably mounted on said carriage and arranged that portions of the work to be ground may extend into the annular space thereof, a rotatable grinding wheel spindle carried by said headstock, a power shaft on said carriage having its axis in longitudinal alignment with the axis of said headstock, means for rotating said headstock from said power shaft, and means for rotating said grinding wheel spindle on its own axis from said power shaft during the rotation of said headstock, whereby said grinding wheel spindle may be caused to rotate on its own axis and simultaneously in an orbital path about the surface to be ground.

2. A grinding machine for grinding external cylindrical surfaces comprising, in combination, a bed, a carriage slidable on said bed, a headstock rotatably mounted on said carriage, a rotatably adjustable spindle housing carried by said headstock, a rotatable grinding wheel spindle eccentrically mounted in said spindle housing, a motor carried by and movable with said carriage, said motor having a power shaft in longitudinal alignment with the axis of said headstock, a belt for rotating said grinding wheel spindle at a relatively high speed directly from said power shaft, means for rotating said headstock at a slower speed from said power shaft simultaneously with the rotation of said

spindle, and means for moving said carriage longitudinally of said bed from said motor.

3. A grinding machine for grinding external cylindrical surfaces comprising, in combination, a bed, a carriage slidable on said bed, a headstock rotatably mounted on said carriage, a rotatably adjustable spindle housing carried by said headstock, a rotatable grinding wheel spindle eccentrically mounted in said spindle housing, a motor carried by and movable with said carriage, said motor having a power shaft in longitudinal alignment with the axis of said headstock, a belt for rotating said grinding wheel spindle at a relatively high speed directly from said power shaft, means for rotating said headstock at a slower speed from said power shaft simultaneously with the rotation of said spindle, and means associated with said carriage and bed for reciprocating said carriage from said motor longitudinally of said bed, and for interrupting said reciprocative movement when said carriage is at one end of its longitudinal travel for a time sufficient to permit said headstock to complete at least one and a fraction revolutions.

4. A grinding machine for grinding external cylindrical surfaces comprising, in combination, a bed, a carriage slidable on said bed, a headstock rotatably mounted on said carriage, a rotatably adjustable spindle housing carried by said headstock, a rotatable grinding wheel spindle eccentrically mounted in said spindle housing, a motor carried by and movable with said carriage, said motor having a power shaft in longitudinal alignment with the axis of said headstock, a belt for rotating said grinding wheel spindle at a relatively high speed directly from said power shaft, means for rotating said headstock at a slower speed from said power shaft simultaneously with the rotation of said spindle, means for manually rotating said headstock, means for automatically imparting rotative movement to said spindle housing, means actuated by said motor for moving said carriage longitudinally of said base, and manual means for moving said carriage longitudinally of said base.

5. A portable machine for grinding crank pins and the like, comprising, in combination, a bed arranged to be supported independently of the crank pin in desired position relative to the member carrying said crank pin, a carriage slidable on said bed toward and away from said crank pin, an annular headstock rotatably mounted on said carriage and arranged so that portions of a crank pin may extend into the annular space thereof, a rotatable grinding wheel spindle carried by said headstock, means for securing said machine adjacent said crank pin with the axis of said annular headstock in longitudinal alignment with the axis of the cylindrical surface to be ground on said crank pin, a power shaft on said carriage having its axis in longitudinal alignment with the axis of said headstock, means for rotating said headstock from said power shaft, means for rotating said grinding wheel spindle on its own axis from said power shaft during the rotation of said headstock, whereby said grinding wheel spindle may be caused to rotate on its own axis and simultaneously in an orbital path about the surface to be ground.

6. A portable machine for grinding the crank pins of locomotive wheels and the like comprising, in combination, a bed, slideways on said bed, a carriage slidable on said slideways, an annular headstock rotatably mounted on said carriage and arranged so that portions of a crank pin to be ground may extend into the annular space thereof, a rotatably adjustable spindle housing carried by said headstock, a rotatable grinding wheel spindle eccentrically mounted in said spindle housing, adjustable means for securing said bed to said locomotive wheel whereby the axis of said annular headstock will be in longitudinal alignment with the axis of the cylindrical surface to be formed on said crank pin, a power unit carried by and movable with said carriage, said power unit having a power shaft in longitudinal alignment with the axis of said headstock, a belt for rotating said grinding wheel spindle at a relatively high speed directly from said power shaft, means for rotating said headstock at a slower speed from said power shaft simultaneously with the rotation of said spindle, and means associated with said carriage and bed for moving said carriage from said power shaft longitudinally of said slideways simultaneously with the rotation of said grinding wheel spindle and headstock.

7. A portable machine for grinding the crank pins of locomotive wheels and the like comprising, in combination, a bed, a carriage slidable on said bed, an annular headstock rotatably mounted on said carriage and arranged so that portions of a crank pin to be ground may extend into the annular space thereof, a rotatable grinding wheel spindle carried by said headstock, adjustable means for securing said bed to said locomotive wheel whereby the axis of said annular headstock will be in longitudinal alignment with the axis of the cylindrical surface to be formed on said crank pin, a power shaft carried by and movable with said carriage, means for simultaneously rotating said headstock and said grinding wheel spindle from said power shaft, means for manually rotating said headstock, a quadrant carried by said carriage and having a pivot fixed against movement longitudinally of said bed, means for moving said quadrant from said power shaft to reciprocate said carriage longitudinally of said bed,

and means for manually moving said carriage longitudinally of said bed.

8. In a portable grinding machine having a bed, a carriage slidable on said bed, and a power shaft mounted on and movable with said carriage, means for reciprocating said carriage longitudinally of said bed comprising, in combination, a quadrant having pins pivotally associated with said carriage and bed respectively, a cam operable from said power shaft, and a third pin carried by said quadrant cooperating with said cam and movable vertically thereby whereby to reciprocate said carriage longitudinally of said bed.

9. In a portable grinding machine having a bed, a carriage slidable on said bed, and a power shaft mounted on and movable with said carriage, means for intermittently reciprocating said carriage longitudinally of said bed comprising, in combination, a quadrant having pins pivotally associated with said carriage and bed respectively, a cam member provided with a cam slot and operable from said power shaft, a third pin carried by said quadrant cooperating with said cam slot and movable vertically thereby, said cam slot being so shaped to cause said carriage to move to one end of its longitudinal travel, remain there stationary for a predetermined time, and then reciprocate longitudinally of the bed.

10. In a portable grinding machine for grinding locomotive wheel crank pins, in combination, a base, means for securing said base rigidly to a locomotive wheel in desired position relative to a crank pin thereof to be ground in such manner that the weight of said machine is not carried by said crank pin, a carriage reciprocable on said base, a cylinder housing carried by said carriage, a cylinder revoluble in said housing about the axis of the surface to be ground, a grinding wheel spindle carried by said cylinder, said spindle being revoluble about its own axis exteriorly of the work to grind an external cylindrical surface thereon, means for reciprocating said carriage, means for rotating said cylinder, and means for rotating said grinding wheel spindle during the rotation of said cylinder.

11. In a grinding machine for grinding external cylindrical surfaces, a base arranged to be rigidly disposed in desired position relative to a surface to be ground, a carriage mounted on said base for reciprocable movement thereon axially of said surface to be ground, a cylinder housing carried by said carriage and reciprocable therewith, a cylinder revoluble in said cylinder housing about the axis of the surface to be ground, said cylinder being of relatively large diameter with respect to the cross-sectional dimensions of the portions of the work to be ground, said cylinder being of annular form and having an axial opening into which the work may project, a grinding wheel spindle eccentrically journaled in said cylinder, said spindle being radially adjustable and revoluble about said work to grind a cylindrical surface thereon, carriage reciprocating mechanism and cylinder rotating mechanism carried by said carriage, means for rotating said grinding wheel spindle during the rotation of said cylinder, and means for actuating said carriage reciprocating mechanism and cylinder rotating mechanism.

12. A grinding machine for grinding external cylindrical surfaces comprising a bed, a work support, a carriage slidable on the bed toward and away from said work support, an annular headstock rotatably mounted on said carriage and having a central opening into which a portion of the work may extend during the grinding operation, a rotatable grinding wheel spindle carried by said headstock, means for rotating said headstock, and means for driving said grinding wheel spindle during rotation of said headstock, whereby said grinding wheel spindle may be caused to rotate on its own axis and simultaneously in an orbital path about the surface to be ground.

13. A grinding machine for grinding external cylindrical surfaces comprising a bed, a carriage slidable on said bed, a headstock rotatably mounted on said carriage, a rotatable grinding wheel spindle parallel with the axis of the headstock and eccentrically mounted therein, means for driving said grinding wheel spindle at a relatively high speed, means for rotating said headstock at a slower speed, simultaneously with the rotation of said spindle, means associated with said carriage and bed for reciprocating said carriage longitudinally of said bed and means for automatically interrupting said reciprocating movement of the carriage when the carriage is at one end of its longitudinal travel for a time sufficient to permit said headstock to complete at least one and a fraction revolutions.

In testimony whereof, we hereunto affix our signatures.

HENRY H. YERK.
WILLIAM J. BAUMBERGER.