June 24, 1930. E. F. ROBERTS 1,766,839

GRINDING MACHINE

Filed April 15, 1925 2 Sheets-Sheet 1

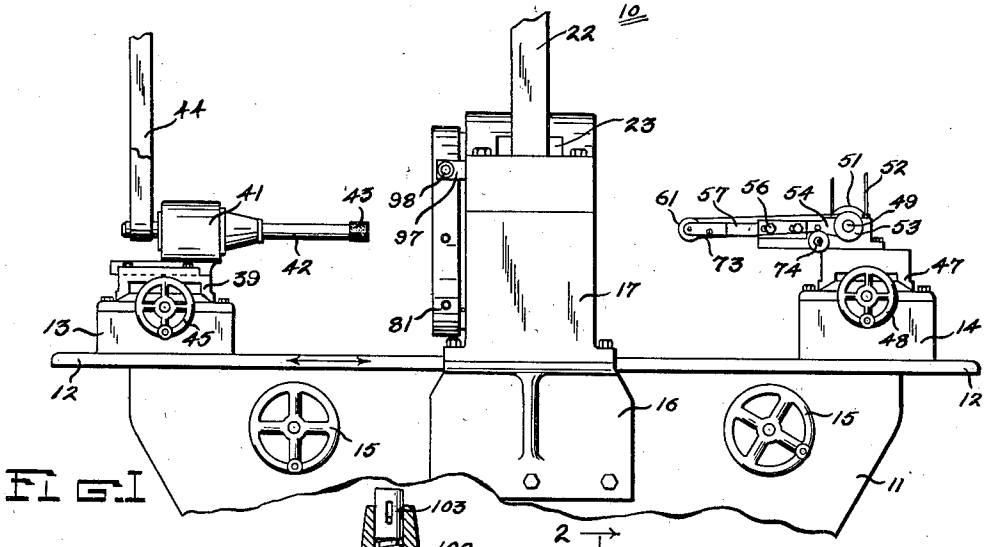


FIG. 1

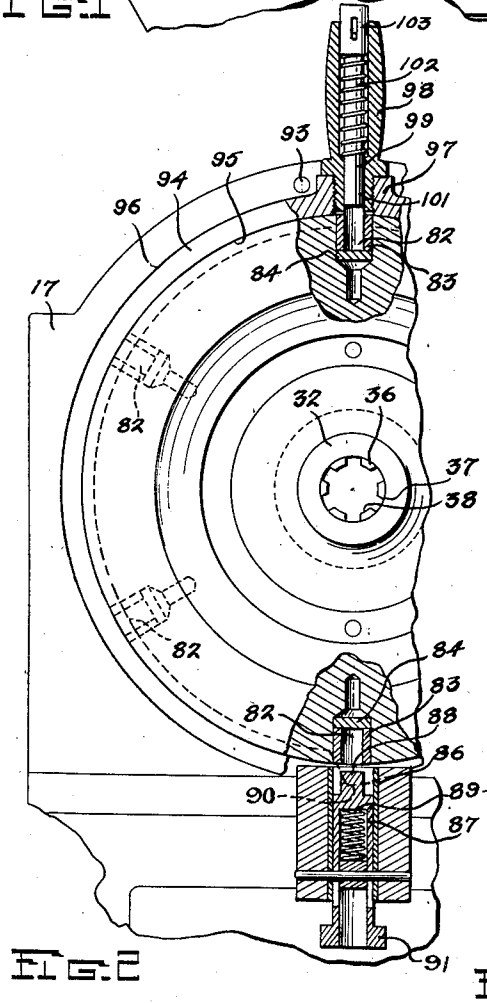


FIG. 2

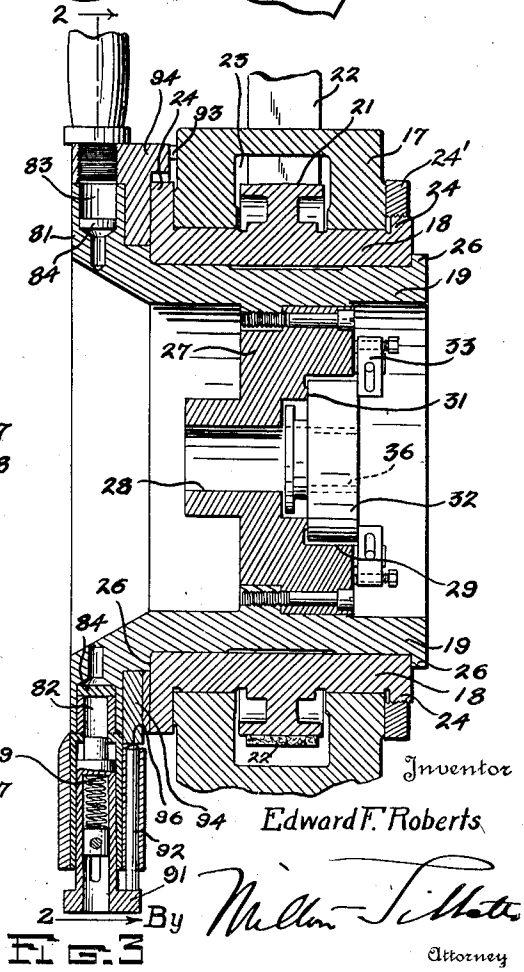


FIG. 3

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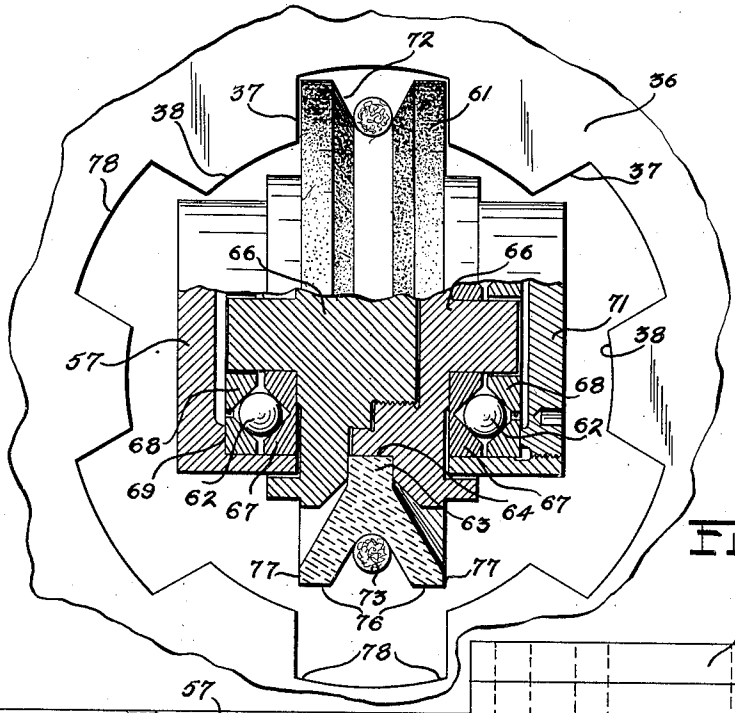


FIG. 4

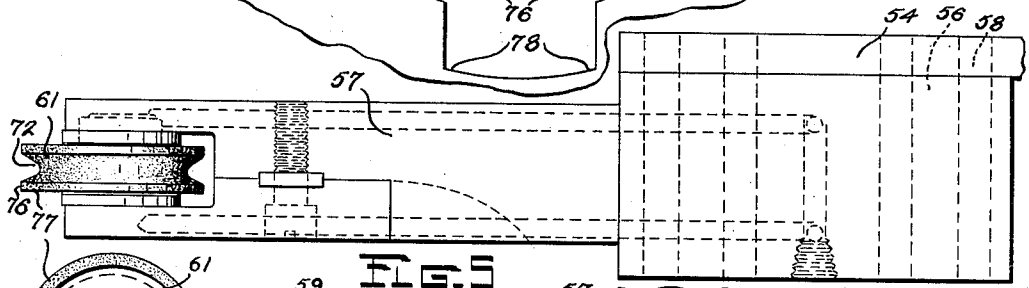


FIG. 5

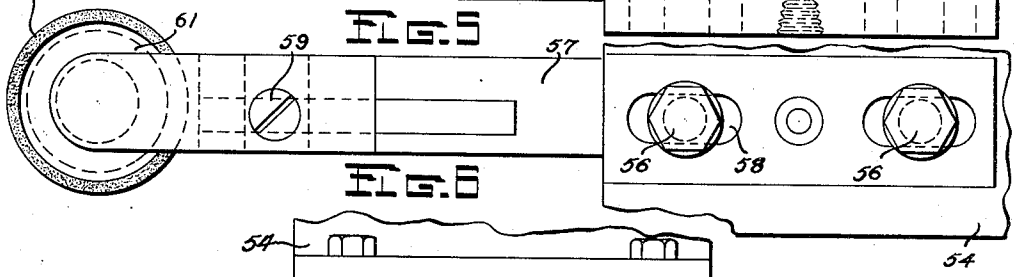


FIG. 6

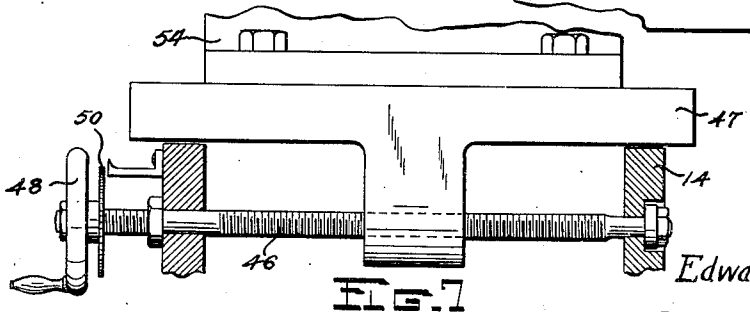


FIG. 7

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UNITED STATES PATENT OFFICE

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GRINDING MACHINE

Application filed April 15, 1925. Serial No. 23,229.

This invention relates to grinding machines, particularly to such machines for grinding splines or key ways on machine parts and it is especially adapted for grinding internal splines.

An object of the invention is to provide a device by which the tops and the sides of internal splines may be ground with a single setting of the work and with a high degree of accuracy.

Another object of the invention is to provide a device by which the sides of internal splines may be ground to close limits and maintained parallel.

A further object is to provide work supporting means for a grinding machine in which the work may be revolved on its axis during one operation of the grinding and rotated on its axis into a succession of predetermined positions during another operation thereof.

Other objects of the invention will appear from the following description taken in connection with the drawings, which form a part of this specification, and in which:

Fig. 1 is a view in side elevation of a grinding machine constructed in accordance with this invention;

Fig. 2 is a view, partially in end elevation and partially in section taken substantially on the line 2—2 of Fig. 3, of a portion of the machine shown in Fig. 1;

Fig. 3 is a vertical sectional view through the work holding head of the machine shown in Fig. 1;

Fig. 4 is a view partially in end elevation and partially in section through the grinding disk, the disk being shown in position in an internally splined member;

Figs. 5 and 6 are detail views of the disk supporting arm; and

Fig. 7 is a detail view showing adjusting mechanism for the disk supporting slide.

Referring to the drawings, at 10 is shown a grinding machine having a base 11 on which a table 12 is slidably mounted in a horizontal plane. The table 12 is preferably power driven to reciprocate with respect to the base 11, by suitable mechanism of the well known type (not shown). At the ends of the table 12 are pedestals 13 and 14 which constitute tool supports on which grinding devices are mounted. Control of the reciprocating mechanism and also manual adjustment of the table 12 is secured in the usual way, hand wheels 15 being provided for this purpose.

Intermediate the ends of the base 11 is mounted a stationary bridge or saddle 16 extending over the table 12, and to this saddle is rigidly secured a pedestal 17, in which is mounted the work supporting head of the machine. The work supporting head consists of a pair of concentric sleeves 18 and 19, mounted in the pedestal 17 for rotation about their common axis. The outer sleeve 18, which is preferably of bronze or similar bearing material, is provided with a belt engaging surface 21, adapted to be rotated by means of a belt 22 from a pulley on suitable power shafting (not shown), the pedestal 17 being formed with slots 23 for passage of the belt. Axial movement of the sleeve 18 in the pedestal 17 is prevented by suitable flanges 24 and an adjustable member 24′, by means of which the sleeve 18 is positioned. The pedestal 17 is preferably split to permit ready removal and insertion of the sleeves. The inner sleeve 19 rotates with the bronze sleeve 18, and is retained in position by suitable flanges 26.

Within the inner sleeve 19 is mounted a work holding member 27 having an axial bore 28 and a counterbore 29 in one end thereof forming a circumferential ledge or shoulder 31 against which the work is adapted to bear. The work 32, which as illustrated is a partially completed sliding transmission gear having a splined bore, may be readily secured in the head by placing it on a suitable mandrel (not shown), the protruding end of which is then inserted in the bore 28. While thus centered with respect to the head the work 32 is clamped against the shoulder 31 by suitable clamp members 33, mounted in the face of the member 27, and the centering mandrel is then removed.

The gear 32 is formed with internal splines 36, having parallel plane sides 37 and

curved tops 38. To form these splines with the accuracy requisite to quiet and efficient operation of the gear, their dimensions must be held within close limits, a few ten-thousandths of an inch. The most rapid and accurate way to insure correct size in such members is to grind them, but such an operation on internal splines has not heretofore been practicable and therefore broaching, and other machine operations have been resorted to at the expense of the much desired accuracy. In the present invention apparatus is provided whereby the tops 38 of the splines are ground in one operation and the sides 37 are ground in a series of succeeding operations while the work 32 is clamped in position in the head.

The grinding of the tops 38 of the splines is accomplished by a device mounted on the pedestal 13. This pedestal is provided with a transverse slide 39, carrying a bearing 41 in which a high speed spindle 42 is journaled. The inner end of the spindle carries a suitable grinding wheel 43 having a diameter less than the diameter of the splined bore. The outer end of this spindle is driven by a belt 44, in the usual way. Transverse motion of the slide 39 and the bearing 41 is secured by a fine pitch feed screw (not shown) secured to the hand wheel 45. In this way the grinding wheel 43 may be fed toward the work in a direction normal to its axis while being rotated at a high speed by the belt 44. At the same time the spindle is carried in and out of the bore of the work 32 by reciprocation of the table 12 on which the device is mounted.

During the operation of wheel 43 the outer sleeve 18 is rotated in the pedestal 17 by the belt 22, carrying with it the inner sleeve 19 and the head member 27 secured in the sleeve 19. In this way the work 32 is rotated on its axis which is concentric with the axis of the sleeve 19, so that the tops 38 of the splines are brought successively into contact with the wheel 43. When grinding of the tops is complete, the table 12 is moved to retract the wheel 43 from the work, at the same time advancing the pedestal 14 toward the work on the opposite side of the work holding head for grinding the sides 37 of the splines, which is accomplished by the device mounted on the pedestal 14.

The pedestal 14 supports a transverse slide 47, similar to the slide 39, controlled by a feed screw 46 operable through a hand wheel 48. An indicating device 50 of any desired form may be secured to the screw shaft 46. Journaled in suitable bearings on the slide 47 is a transverse shaft 49 provided at one end with a pulley 51 which is driven by a belt 52 from suitable power shafting (not shown). The other end of the shaft 49 carries a pulley 53. The slide 47 also carries a suitable tool post 54 to which an arm 57 is removably secured, as by means of bolts 56, which pass through suitable slots 58 in the arm. The inner end of the arm 57 forms one branch of a fork, the other branch being removably secured thereto in any convenient manner as by means of a screw 59. A grinding disk 61 is journaled in suitable bearings 62 between the branches of this fork as best shown in Fig. 4.

The disk 61 is formed with a central web portion 63 having an axial hole 64, the web portion being clamped between trunnion members 66 which pass through the hole 64 and screwed together in the well known manner. Each of the trunnion members 66 carries a bearing race member 67 and each of the branches of the fork at the end of arm 57 carries a bearing race 68. That branch integral with the arm 57 is provided with a recess forming a shoulder 69 against which one of the outer races 68 is positioned. The other branch of the fork may be provided with a removable abutment 71, threaded or otherwise adjustably secured in the fork branch to position the corresponding race 68. The periphery of the disk 61 is grooved as shown at 72 for co-operation with a driving belt 73, which passes over and is driven by the pulley 53, thus providing a directly connected drive to the disk 61. An idler pulley 74 may be mounted on the slide 47 to regulate tension in the belt 73 if desired.

The disk 61 has peripheral grinding surfaces 76 and radial grinding surfaces 77, adapted to engage the bottoms 78 and the sides 37 respectively, of the splines 36. With the work supporting head locked in a predetermined position, the disk 61 is rapidly rotated by the belt 73 and is at the same time moved in and out of the bore of the work 32 by reciprocation of the table 12. By laterally adjusting the slide 47 the whole arm 57 is moved bringing the grinding face 77 into engagement with one of the side faces 37 of one of the splines, which is thus ground to size. The work head 17 is then moved through a predetermined angle to bring the adjacent spline 36 into proper position for grinding by the disk 61.

The indexing mechanism by means of which the work supporting head is moved into predetermined position and locked is best shown in Figs. 2 and 3. The inner sleeve 19 is provided at one end with a radially disposed flange 81 in which is formed a number of dowel holes 82 which correspond in number and location to the positions in which it is desired to lock the work supporting head for subsequent grinding of the sides of the splines. In the present instance the work 32 is provided with six splines 36 and there are accordingly six of the equi-spaced dowel holes 82 in the flange 81. These holes may be provided with

suitable bushings 83 and suitable end blocks 84 if desired. Fixed to the pedestal 17 at any convenient point in the plane of the flange 81 is a bushed recess 86 in which is mounted a sliding plunger 87 having an end of reduced section 88 forming a pin adapted to enter and co-operate with the dowel holes 82. The plunger 87 is urged into locking position by a spring 89 suitably mounted therein and it carries a head 91 adapted for cooperation with a sliding pin 92, by means of which it may be moved against the tension of the spring 89 into unlocked position.

Mounted to rotate through a predetermined arc between stops 93 on the pedestal 17, only one of the stops being shown, is a sleeve 94, the inner surface 95 of which is concentric with the axis of the sleeve 19 and its outer surface 96 has an eccentric portion forming a cam 90. The sleeve member 94 is provided with a lug 97 in which is screwed a hollow handle 98, and within the handle 98 is mounted a bolt or plunger 99 having an extremity 101 forming a pin adapted to enter the dowel holes 82. The plunger 99 is urged outwardly into disengaged position by a suitable spring 102 mounted within the handle 98, and the upper end of this plunger is provided with a suitable thumb button 103 by means of which the spring may be manually compressed to force the pin 101 to engage the dowel hole 82.

In the operation of this device, when it is desired to rotate the sleeve 19, and with it the work 32 through the angle between two adjacent dowel holes 82, the operator moves the member 94 by means of the handle 98 around the periphery of the flange 81 until it engages the upper stop 93. During this movement the cam 90 on the member 94 bears upon and depresses the pin 92, thereby moving the head 91 of the locking plunger 87 and withdrawing the locking pin 88 from the lower dowel hole 82. The operator then depresses the thumb button 103 thus moving the pin 101 into engagement with the upper or diametrically opposite dowel hole 82, locking the handle 98 to the inner sleeve member 19. By means of the handle the sleeve member 19 is swung through an angle until the cam 90 releases the spring pressed locking pin 88 to enter the next dowel hole 82, thus preventing further rotation of the sleeve 19. This swinging motion takes place relatively to the outer sleeve 18 which is held stationary by the resistance to motion of the belt 22.

The predetermined motion of the sleeve 19 and the head member 27 brings the next succeeding spline 36 into correct position to engage the disk 61, in which position one of its side faces 37 is ground in the manner described. After homologous sides of the several splines have been ground, the work 32 will have been rotated through one complete revolution. A second revolution by similar steps is then performed, during which the other sides of each of the splines is ground in the manner described.

It will be evident that this invention provides means by which both the curved and the plane surfaces of splines may be readily ground with a single setting of the work, and that this grinding may be quickly and accurately done within exceptionally close limits. It will be understood that various forms of the invention other than those described above may be used without departing from the spirit or scope of the invention.

What is claimed is:

1. In a machine of the character described, a grinding disk having a grooved driving circumference and parallel grinding faces on either side of said driving circumference.

2. In a machine of the character described, an arm, means for reciprocating the arm, means for adjusting the arm normal to its line of reciprocation, a grinding disk journaled for rotation in one end the arm, and means engaging the periphery of the disk to rotate the disk.

3. In a machine of the character described, a forked arm, bearing races in each branch of said arm, a grinding disk having a hub portion provided with trunnions, a bearing race on each trunnion, bearing members between the said arm and trunnion races, and means engaging the periphery of the disk driving the disk.

4. A grinding machine comprising a peripheral face grinding device, a radial face grinding device, a work holding head mounted for rotation when desired, a disengageable means operated at will to lock the head in a succession of predetermined positions and means for selectively moving the devices into and out of operative relation to the work.

5. A grinding machine comprising a peripheral face grinding device, a radial face grinding device, a work holding head mounted for rotation when desired, a disengageable means operated at will to lock the head in a succession of predetermined positions and means operated at will for reciprocating the grinding devices for alternate cooperation with the work holding head.

6. A grinding machine comprising a peripheral face grinding device, a radial face grinding device, a work holding head mounted for rotation when desired, a disengageable means operated at will to lock the head in a succession of predetermined positions, said work holding head being mounted intermediate the grinding devices and means operated at will for reciprocating the grinding devices to alternately cooperate with the work holding head.

7. A grinding machine comprising a peripheral face grinding device, a radial face

grinding device, a work holding head mounted intermediate the grinding devices adaptable for rotation during the grinding of the peripheral faces and means operated at will to lock the work holding head in a succession of predetermined positions during the grinding of the radial faces, the work holding head and the grinding devices being so spaced that when one grinding device is in engagement with the work the other must be out of engagement therewith..

8. A grinding machine comprising a fixed pedestal and a reciprocable table, peripheral and radial grinding devices mounted on the table in oppositely disposed relation and on opposite sides of the pedestal, inner and outer sleeve members mounted for rotation in the pedestal, a work holding member mounted in the inner sleeve, means operated at will for rotating the sleeves during the operation of the peripheral grinding device, means operated at will for indexing the sleeves in predetermined positions for the operation of the radial grinding device and means operated at will for selectively moving the grinding devices for cooperation with the work holding head.

9. A grinding machine comprising a peripheral grinding device, a radial grinding device, a hollow rotatable work supporting head mounted intermediate the grinding devices, means operated at will to lock the head in a succession of predetermined positions, the work holding head and the grinding devices being so spaced that when one grinding device is in engagement with the work, the other must be out of engagement therewith.

10. A grinding machine comprising a peripheral face grinding device, arranged in spaced relation thereto, a radial face grinding device, a work holding head intermediate the grinding devices, a work supporting member in said head, means operated at will for rotating the head for cooperation with the peripheral face grinding device, means operated at will for rotating the head in a succession of predetermined positions for cooperation with the radial face grinding device and means for selectively moving the grinding devices for cooperation with the work holding head.

11. In a grinding machine, the combination with a radial face grinding device, of an arm, a grinding disk journaled at one end of the arm, and a belt directly engaging and driving the disk.

12. In a grinding machine, the combination with a radial face grinding device, of an arm, a grinding disk journaled in one end of the arm, said disk having parallel work engaging faces and a peripheral groove a belt engaging the groove to a driving disk.

13. In a grinding machine, the combination with a work holding head, of a reciprocable support, an arm secured in said support adapted to enter the work holding head, a grinding disk on the arm having parallel work engaging faces and means upon the periphery of the disk for rotating the disk.

14. In a grinding machine, the combination with a work holding head adaptable for supporting internally splined members, of a reciprocable support, an arm secured to said support adapted to enter the head, a grinding disk on the arm, means for rotating the disk including a belt engaging the periphery of the disk and means for reciprocating the support to position the disk for work on said splined members.

15. In a grinding machine, the combination with a work holding head, of a support, an arm carried by said support, a grinding disk on said arm, means for reciprocating the support, means for moving the support transversely, and means for rotating the disk including a belt engaging the periphery thereof.

16. In a grinding machine, the combination with a work holding head, of a support, an arm on said support, a disk mounted on the free end of said arm adapted to enter said working head, and means for rotating said disk, including a belt engaging a groove in the periphery of the disk.

In testimony whereof I affix my signature.

EDWARD F. ROBERTS.