April 19, 1938. W. E. SYKES 2,114,616

GEAR LAPPING MACHINE

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Fig. 1.

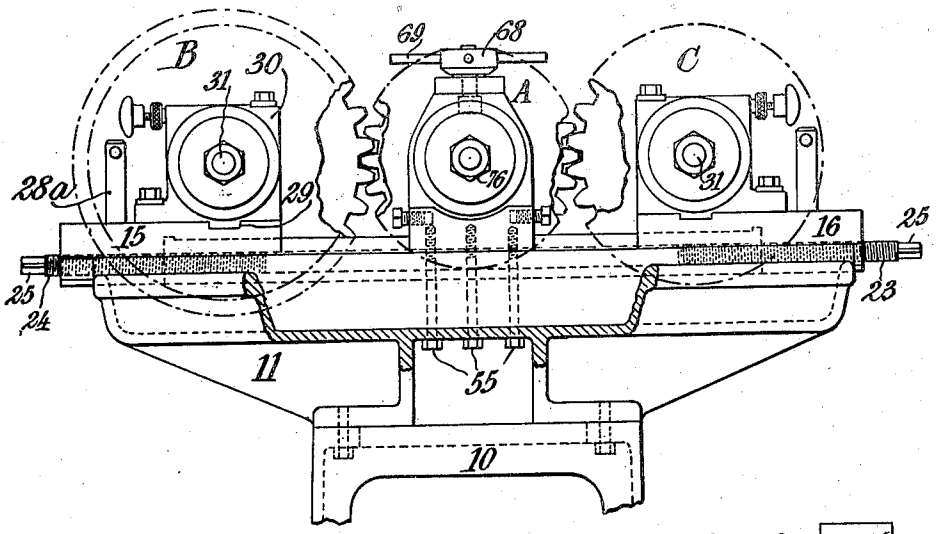


Fig. 2.

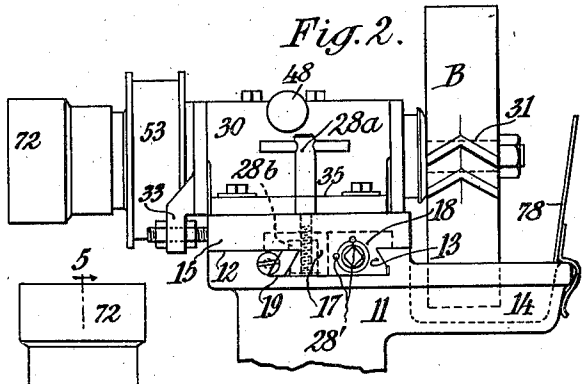
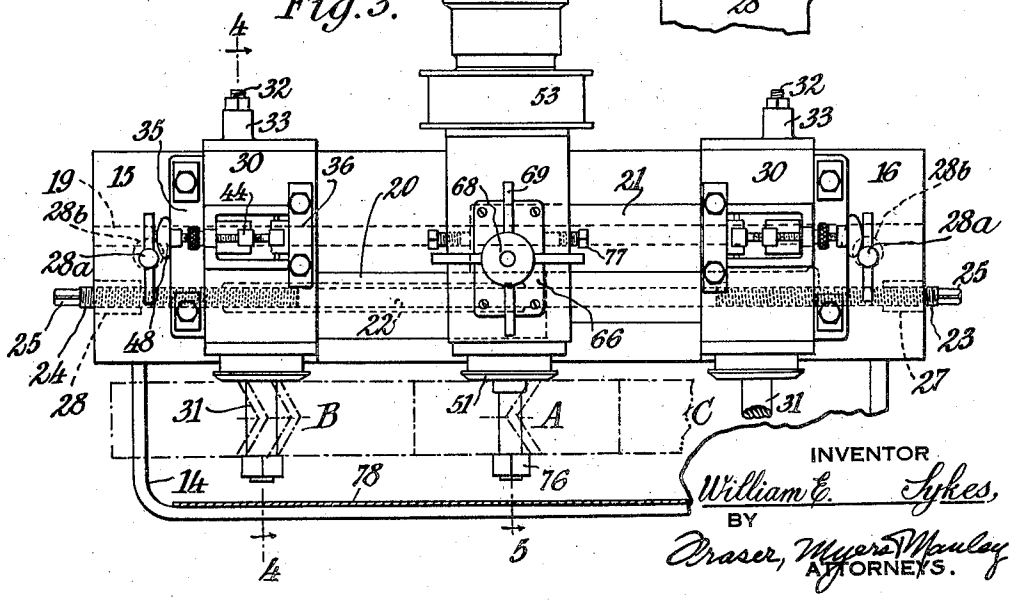


Fig. 3.



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Fig. 4.

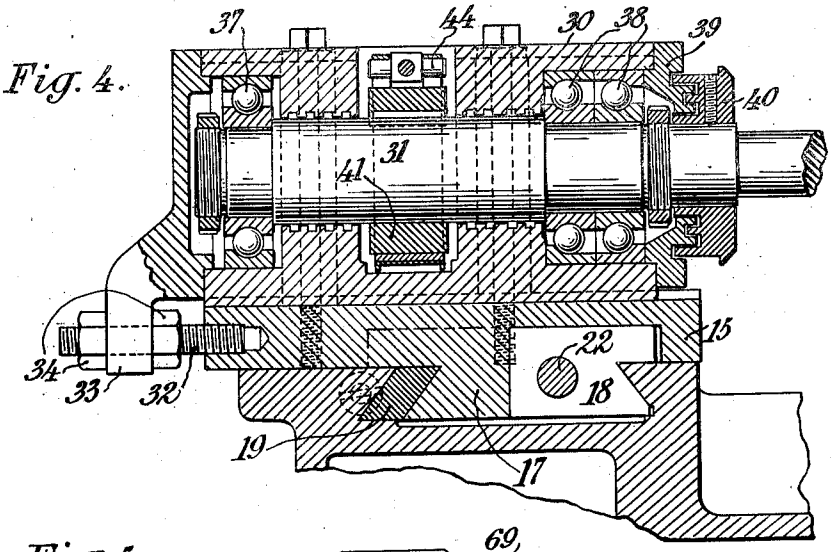


Fig. 5.

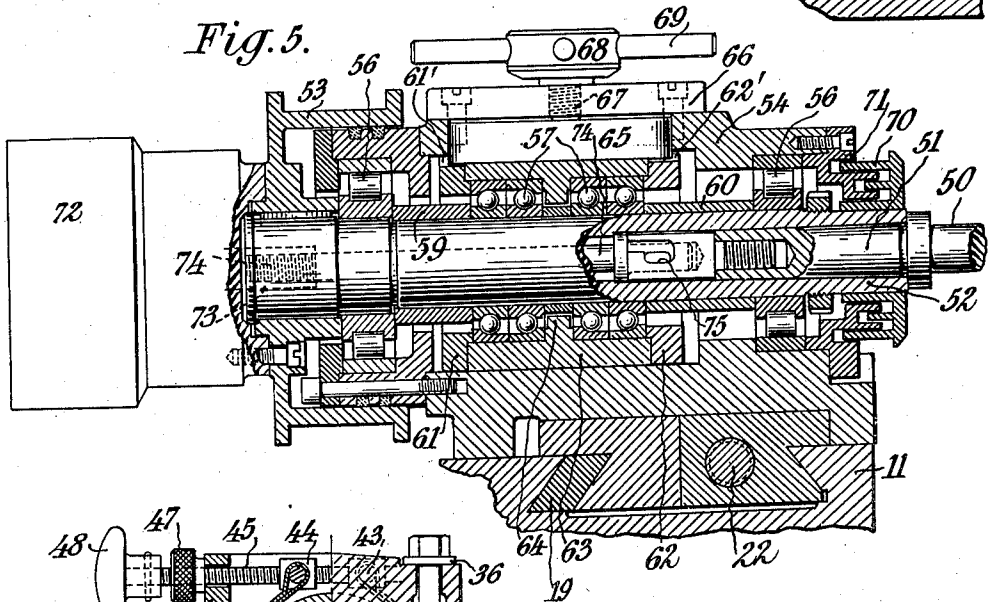
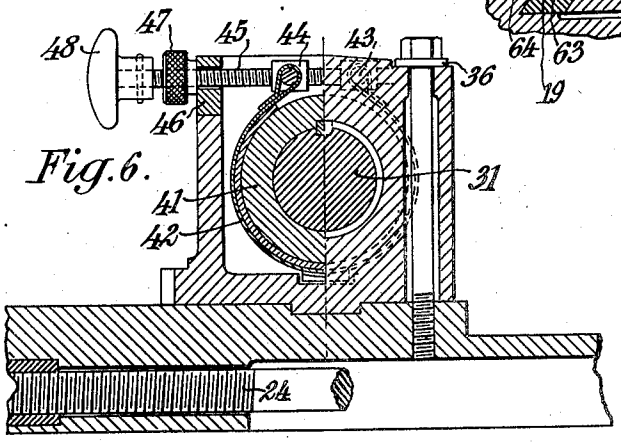


Fig. 6.



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2,114,616

GEAR LAPPING MACHINE

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Application May 27, 1935, Serial No. 23,674

6 Claims. (Cl. 51—26)

My present invention relates to gear-lapping machines and to the method of lapping gears, and aims to provide certain improvements therein.

An object of my invention is to provide more accurate gears than have heretofore been possible, through a novel method of lapping the gears and a novel relationship of the lapping gears with the subject gear to be lapped. This I accomplish in the following manner: (1) by the use of lapping gears which are larger in diameter than the subject gear and also preferably larger in diameter than the gear or pinion which will be used with the subject gear; and (2) by mounting the subject gear upon an arbor while being subjected to the lapping operation, thereby providing true concentricity with the axis of the subject gear together with uniformity of pitch.

According to (1) there is provided during the lapping operation a longer line of contact than will exist when the gear is actually at work, which longer line of contact provides a rather longer involute contour on the gear teeth than is actually necessary and thus insures that there will be at least sufficient involute contour to said teeth.

In order to get true concentricity with the axis of the subject gear irrespective of the accuracy of the lapping gears I preferably use lapping gears having prime numbers of teeth and also preferably using lapping gears with different numbers of teeth. In addition, the lapping gears, while having base circle diameters which are in direct proportion to the number of teeth and also in the same proportion as the subject gear, have nevertheless, pitch diameters which are disproportionate.

In gear tooth action there is a true rolling action on the pitch circles and rubbing action on other portions of the tooth contours. For lapping, rubbing action is required, and by arranging for two pitch circles as above set forth, there is obtained a rubbing action over the whole contour of the teeth and consequently a true lapping action.

According to my present invention I provide a lapping machine in which two lapping gears are disposed opposite to each other with the subject gear therebetween, each lapping gear being mounted on a spindle carried by a slide or saddle and the two saddles being connected to a floating screw provided with right and left hand screw-threaded portions, one of said saddles being mounted on the right hand threaded portion of the screw and the other saddle on the left hand threaded portion, which mounting permits of the simultaneous movement of the lapping gears into engagement with the subject gear and results in a differential action in the sense that the saddle with the least resistance moves so that each lapping gear exerts an equal pressure on the subject gear.

The invention will be better understood from the detailed description which follows, when considered in conjunction with the accompanying drawings, which show a preferred embodiment of my lapping machine and wherein,

Figure 1 is a front elevation of the lapping machine, parts thereof broken away.

Fig. 2 is an end elevation of the machine shown in Fig. 1, as viewed from the left hand end of said figure.

Fig. 3 is a top plan view of the machine shown in Figs. 1 and 2, with parts thereof broken away.

Fig. 4 is a section taken substantially along the planes of the broken lines 4—4 of Fig. 3.

Fig. 5 is a section taken substantially along the plane of the line 5—5 of Fig. 3.

Fig. 6 is a section taken substantially along the planes of the broken lines 6—6 of Fig. 4.

Referring to the drawings, let the reference numeral 10 indicate a standard or base upon which is mounted a bed 11 having a plane top face 12 formed with a dovetail groove 13 therein and with a lateral trough 14. Mounted on the bed 11 so as to be guided in longitudinal movement thereover is a left hand slide or saddle 15 and a right hand slide or saddle 16, said saddles having downwardly-extending complemental ribs 17 and 18, respectively, with plane mating faces (Fig. 5), so that in complemental relation they provide a dovetail slide which seats within the dovetail recess 13 of the bed. A gib 19 is provided for filling out and facilitating the assembly of the dovetail ribs 17 and 18 within said bed. The rib 17 on the left hand saddle 15 extends beyond the body proper of the saddle, as indicated at 20, and the rib 18 on the right hand saddle extends beyond the body of the saddle proper in the opposite direction, as indicated at 21, the extensions 20 and 21 of the respective saddles being in overlapping relation and serving to guide the relative movements of said saddles. The saddles 15 and 16 have aligned openings therethrough within which extends a floating screw 22, one end of which is formed with a right hand screw-threaded portion 23 and the other end with a left hand screw-threaded portion 24. The ends of the floating screw 22 beyond the threaded

portions may be flattened or formed with polygonal cross-sections, as indicated at 25, to provide wrench-engaging surfaces for rotating the screw. The threaded portions 23 and 24 of the screw 22 screw-threadedly engage nuts 27 and 28, respectively, carried by the slides 16 and 15, respectively, said nuts being held against rotation by locking screws 28'. It will thus be seen that upon the rotation of the screw 22 from either end thereof, the saddles 15 and 16 will move toward or away from each other, depending upon the direction of rotation of the screw. The saddles may be locked in their adjusted position by means of lock-screws 28*a* which extend vertically through the saddles 15 and 16 and engage slide-locks 28*b* positioned within said respective saddles and engaging the gib 19.

Each of the saddles 15 and 16 is provided at its upper face with a transversely-extending groove 29 within which is slidably seated a rib on a head 30, within which is mounted a spindle 31, on the outer end of which a lapping gear is to be held. Each of the heads 30 is adjustably mounted upon its respective saddle by means of a screw 32 carried by the saddle and passing through a depending flange or lug 33 on the head 30 and upon which screw a pair of adjusting or clamping nuts 34 are mounted for holding the flange 33, and hence the head 30 in definitely fixed relation to the saddle. For securing the heads in adjusted relation to the saddles, clamping bolts operating through clamping plates 35 and 36 are also used.

Each spindle 31 upon which a lapping gear is carried is suitably mounted within the head 30 through the aid of thrust and anti-friction bearings 37 and 38 against axial movement to make sure of the proper alignment of the lapping gear with the subject gear. To prevent access of any of the lapping compound into the spindle bearings, the housings 30 and spindles 31 are provided with interengaging labyrinth plates 39 and 40, respectively.

In the process of lapping gears it is desirable to apply and control the resistance to rotation of the lapping gears with respect to the subject gear, and for this purpose the spindles 31 are each provided with a brake-drum 41 over which is trained a brake-band 42, one end of which is fixedly supported to an anchorage 43 in the head, and the other end of which is supported upon lateral extensions on a nut 44 through which is threaded the free end of a brake-band screw 45, which also extends through a guide nut 46 and is held in adjusted relation by a lock nut 47. Manipulation of the brake-band screw is accomplished through a knob 48 at the outer end of said screw.

The subject gear or gear to be lapped is mounted upon an arbor 50 having a tapered shank 51 adapted to engage and be held within a rotatable spindle 52 on which a pulley 53 is keyed and through which the spindle is adapted to be driven. The spindle 52 is mounted within a center head 54, which is mounted on the bed 11 and secured thereto by bolts 55, said center head being cut away at its under face to clear the extensions on the saddles 15 and 16. The spindle 52 is floatingly mounted and adapted for limited axial movement within the center head on roller bearings 56 and thrust bearings 57, which latter are spaced from the roller bearings by sleeves 59 and 60. The thrust bearings 57 are held in definitely spaced relation by a cage consisting of end or thrust plates 61 and 62 and a spacing annulus 63 having an inwardly-directed annular rib 64. The thrust plates 61 and 62 at their tops are formed with aligned grooves or recesses 61' and 62', respectively, within which seats a key 65 which rests upon the annulus 63. Mounted on the center head above the key 65 is a clamp plate 66 having a central screw-threaded opening through which extends clamp screw 67 having an enlarged head 68 provided with hand-engaging pins 69. From the center head construction described it will be apparent that upon rotating the clamp screw 68 to apply radial pressure upon the key 65, and, in turn, upon the annulus 63, the spindle 52 can thereby be clamped against axial movement for preventing ingress of the lapping compound into the bearings of the spindle, the spindle and the center head are provided with interengaging labyrinth plates 70 and 71, respectively.

Mounted for rotation with the pulley 53 is a pneumatic cylinder 72 controlled by a double-acting valve (not shown) which gives limited longitudinal movement to a piston (not shown) within said cylinder and to which is connected a piston rod 73. The movement of the piston rod is transmitted through a connecting bolt 74 to the tapered end of the arbor 50 which is ejected or drawn into the tapered hole in the spindle, as required. To facilitate the rapid and efficient engagement and disengagement of the arbor with the connecting bolt there is provided a bayonet joint connection 75 between said elements.

Operation.—In the operation of the gear-lapping machine hereinbefore described, the work gear or subject gear A to be lapped is mounted upon an arbor 50 and held thereon by a nut 76. The arbor is then drawn into the tapered hole of the spindle 52 by operation of the valve within the pneumatic cylinder 72. Depending upon the size and number of teeth of the subject gear A, the lapping gears B and C are chosen. These lapping gears are preferably of different diameters and of larger diameter than the subject gear A or the pinion which is to be used with A. Also, the number of teeth on the lapping gears are preferably prime numbers or of a number of teeth having relatively large lowest common factors. By having the lapping gears with prime numbers of teeth or a number which has a large lowest common factor, it will be appreciated that as the gears lap with the subject gear every tooth of each of the lapping gears will make contact with every tooth in the subject gear. Also, in view of the disproportionate diameters of the pitch circles of the lapping gears, the subject gear will have two pitch circle diameters, in view of which a better rubbing or lapping action upon the subject gear teeth will ensue. In this manner a great advantage is obtained in that uniformity and accuracy of pitch and of involute or helical tooth contour are promoted.

The lapping gears having been chosen, they are mounted upon the lapping gear spindles 31 within the housings 30 and the screw 22 is rotated to move the lapping gears into meshing engagement with the subject gear, as hereinbefore explained, and when thus engaged the saddles 15 and 16 are locked to the bed. To prevent the saddles from contacting the subject gear, adjustable stop bolts 77 may be mounted on the center housing 54. In this connection it will be understood that the axes of the three gear spindles are all in a common horizontal plane and it is also desirable that the median planes of the gears all lie in a common plane. The thrust bearings of the spindles 31 will maintain the lapping gears B and C in alignment.

while the floating spindle 52 of the subject gear will permit alignment of the subject gear with the lapping gears, and when this has been effected the spindle 52 is locked to insure this alignment by rotation of the clamp screw 67, which, in turn, locks the thrust bearings 57 in definite relation to the spindle.

The lapping operation is continued for as long a period as is thought necessary, use being made of a suitable lapping or abrasive compound which is contained within the trough 14. A suitable guard plate, such as 78, may be mounted in the trough to confine the lapping compound within the trough. Depending upon the character and size of the teeth of the subject gear and the character of abrasive employed, the resistance to rotation of the lapping gears B and C is controlled by adjustment of the brake-bands 42.

The construction and cooperative arrangement of parts of the gear-lapping machine as disclosed, greatly facilitates and expedites the operation of lapping gears, and in view of the method disclosed, with particular regard to the size and number of teeth of the lapping gears with relation to the subject gear, it will be appreciated that gears with more perfect involute contours can be produced according to applicant's invention than has heretofore been possible of accomplishment.

The machine and the method hereinbefore described are considered by me to embrace a preferred embodiment of my invention but it is to be understood that I do not wish to limit myself to the details of construction disclosed, since changes therein may be made within the range of engineering skill without departing from the spirit of my invention.

What I claim is:

1. A gear-lapping machine comprising a bed, two saddles mounted on said bed and each having a spindle adapted to accommodate a lapping gear thereon, a subject gear spindle disposed between said saddle spindles and adapted to have a subject gear mounted thereon, the three spindles being disposed parallel to each other in a common plane and independently axially adjustable to truly align the gears in a common plane when mounted on said spindles, and a single operating means for moving the lapping gear spindles toward and away from the subject gear spindle in said common plane.

2. A gear-lapping machine comprising a bed, two saddles mounted on said bed and each having a spindle adapted to accommodate a lapping gear thereon, a subject gear spindle disposed between said saddle spindles and adapted to have a subject gear mounted thereon, the three spindles being disposed parallel to each other in a common plane and independently axially adjustable to truly align the gears in a common plane when mounted on said spindles, the subject gear spindle being floatingly mounted and axially movable to permit alignment of the subject gear with the lapping gears when mounted on said spindles, and means for locking said subject gear spindle against axial movement.

3. The method of lapping herringbone gears, which comprises mounting upon a floating spindle a subject herringbone gear with the apices of its teeth in substantially a common plane with the apices of the teeth of a plurality of lapping herringbone gears, moving the lapping gears into lapping relation with the subject gear, rotating the subject gear to bring about self-true alignment of the apices of the teeth of the subject gear with the apices of the teeth of the lapping gears and then locking the subject gear spindle against axial movement.

4. A gear-lapping machine comprising a bed, two saddles slidably mounted on said bed and each having a spindle with a lapping gear thereon, a subject gear spindle disposed between said saddle spindles and adapted to have a subject gear mounted thereon, the three spindles being disposed parallel to each other in a common plane, and the gears on said spindle lying in a common plane, and a floating screw provided with right and left hand screw-threaded portions, one of said saddles being mounted on the right hand threaded portion of the screw and the other saddle being mounted on the left hand threaded portion of the screw for simultaneously moving the saddles toward and away from said subject gear spindle while maintaining the spindles in said common plane.

5. A gear lapping machine, comprising a spindle for mounting a subject gear, two spindles for lapping gears disposed on opposite sides of the subject gear spindle, the three spindles being disposed parallel to each other in a common plane, means for independently adjusting the lapping gear spindles in said common plane toward and away from the subject gear spindle and means for independently adjusting said spindles in an axial direction.

6. A gear lapping machine comprising a bed, two saddles mounted on said bed and each having a spindle with a lapping herringbone gear thereon, a subject gear spindle disposed between said saddle spindles and adapted to have a subject herringbone gear mounted thereon, the three spindles being disposed parallel to each other in a common plane and independently axially adjustable in said plane to truly align the apices of the teeth of the three gears in a common plane, the subject gear spindle being floatingly mounted so as to permit self-alignment of the apices of the teeth of a herringbone gear mounted thereon with the apices of the teeth of the lapping gears.

WILLIAM E. SYKES.