July 4, 1933. B. J. WOLFE 1,917,178

COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Filed May 27, 1930 5 Sheets-Sheet 1

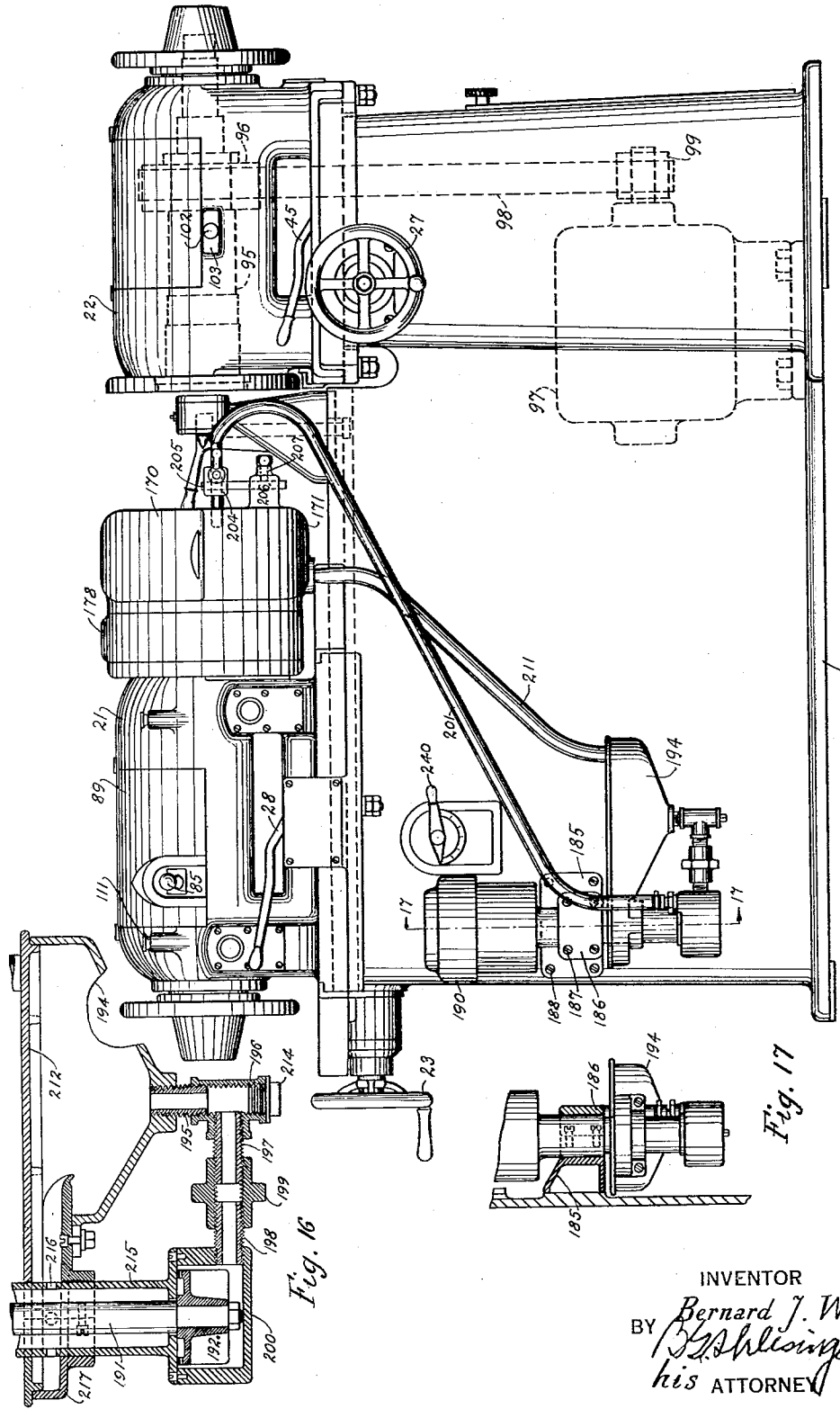


Fig. 1

Fig. 16

Fig. 17

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COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Filed May 27, 1930 5 Sheets-Sheet 2

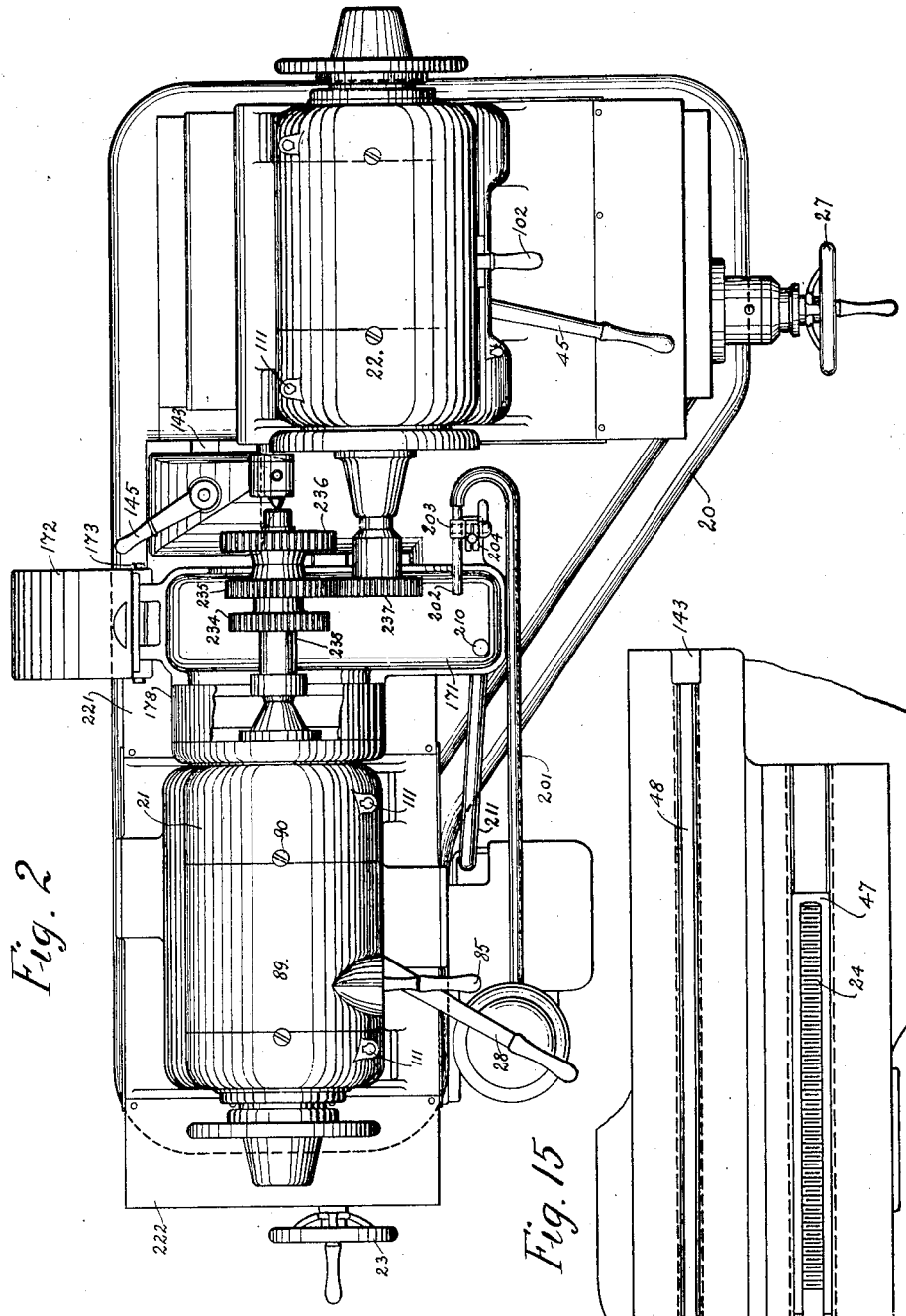


Fig. 2

Fig. 15

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COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Filed May 27, 1930 5 Sheets-Sheet 3

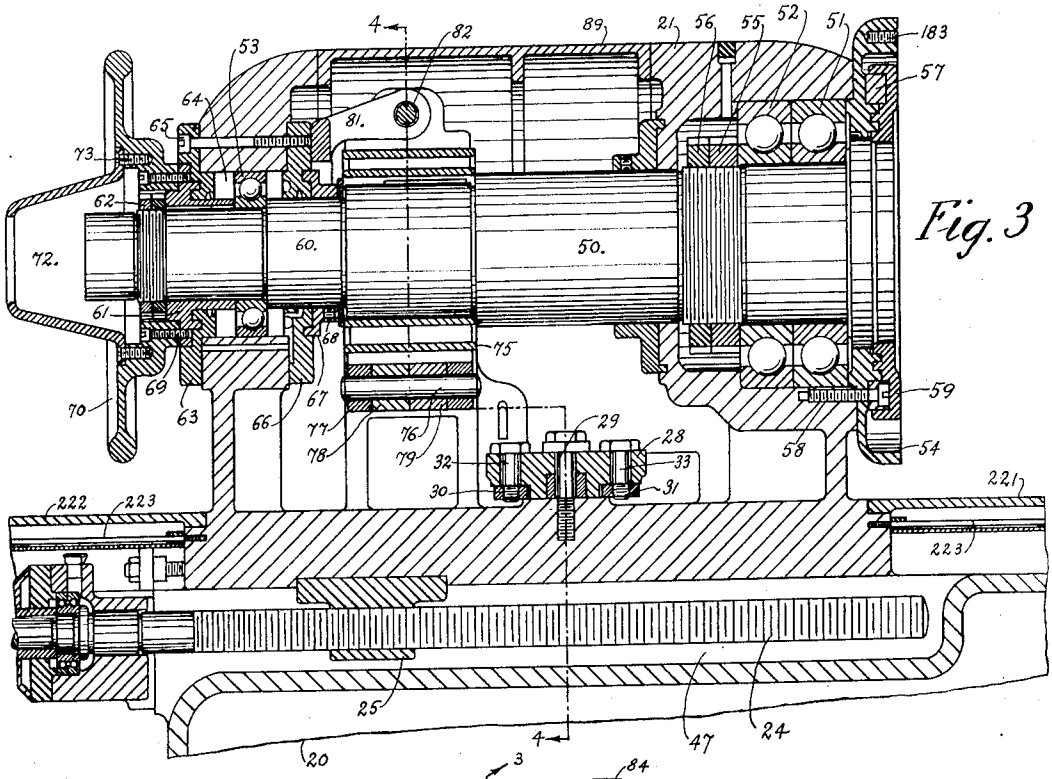


Fig. 3

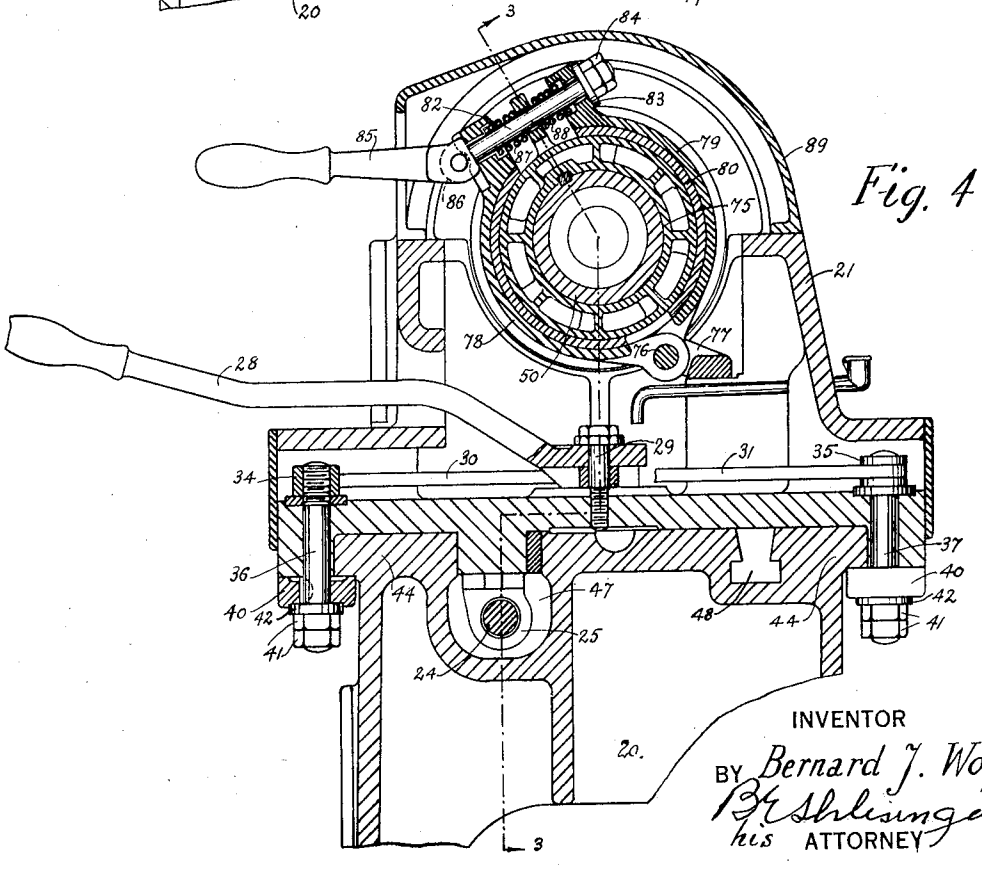


Fig. 4

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COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Filed May 27, 1930 5 Sheets-Sheet 4

Fig. 6

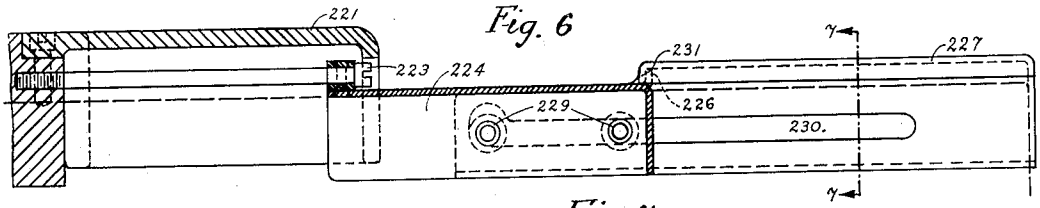
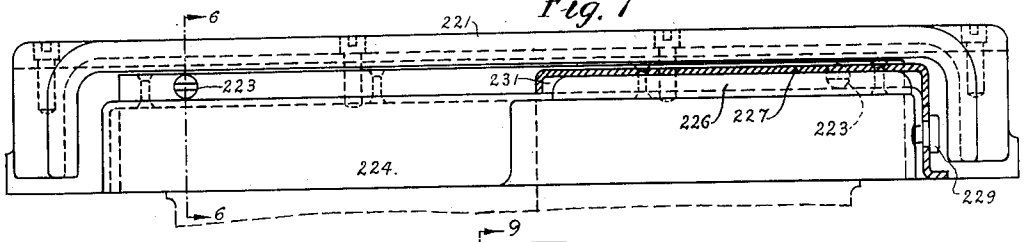


Fig. 7



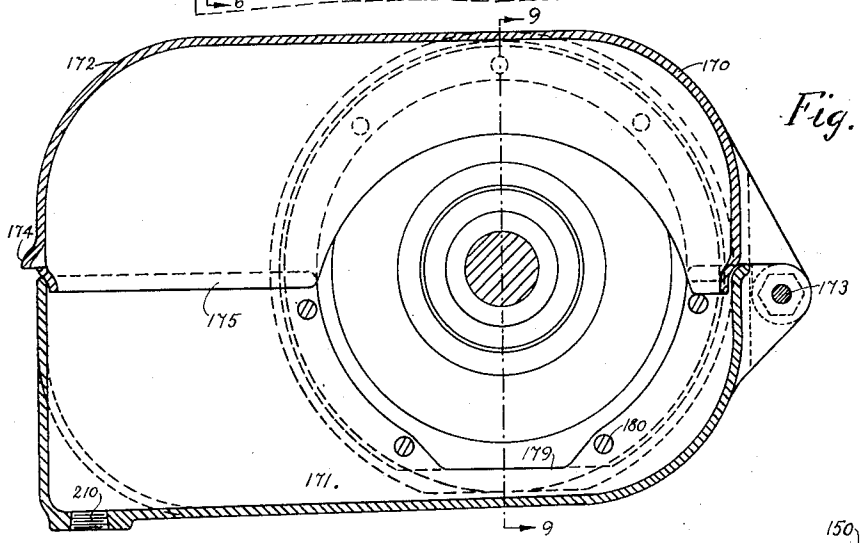


Fig. 8

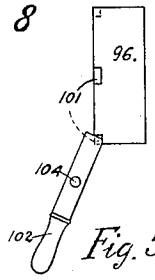


Fig. 5

Fig. 12

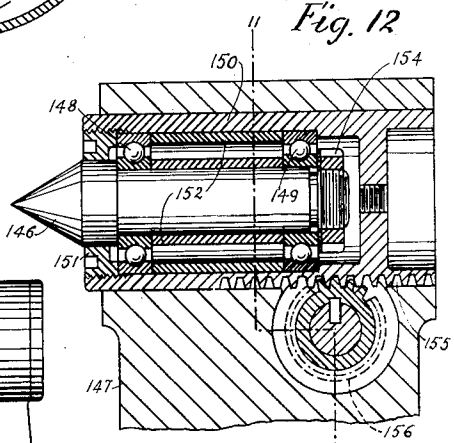
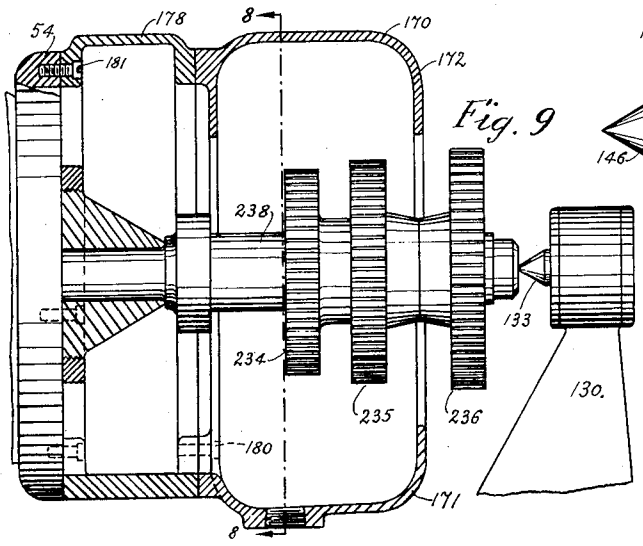


Fig. 9



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COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Filed May 27, 1930 5 Sheets-Sheet 5

Fig. 11

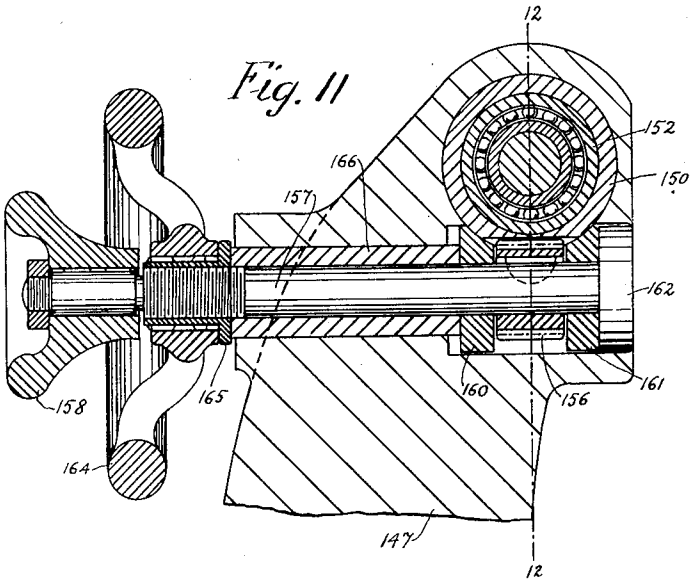


Fig. 10

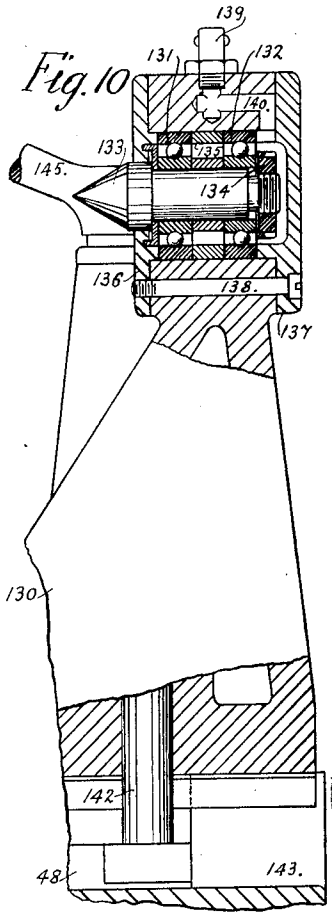


Fig. 13

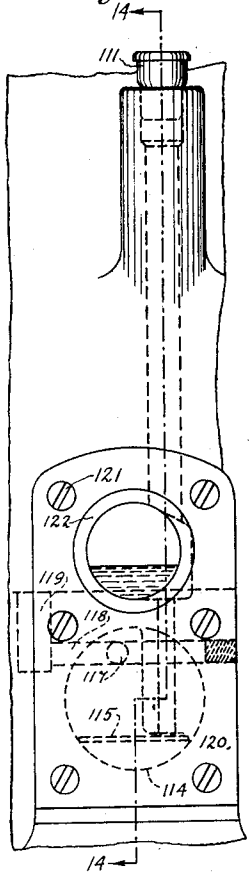
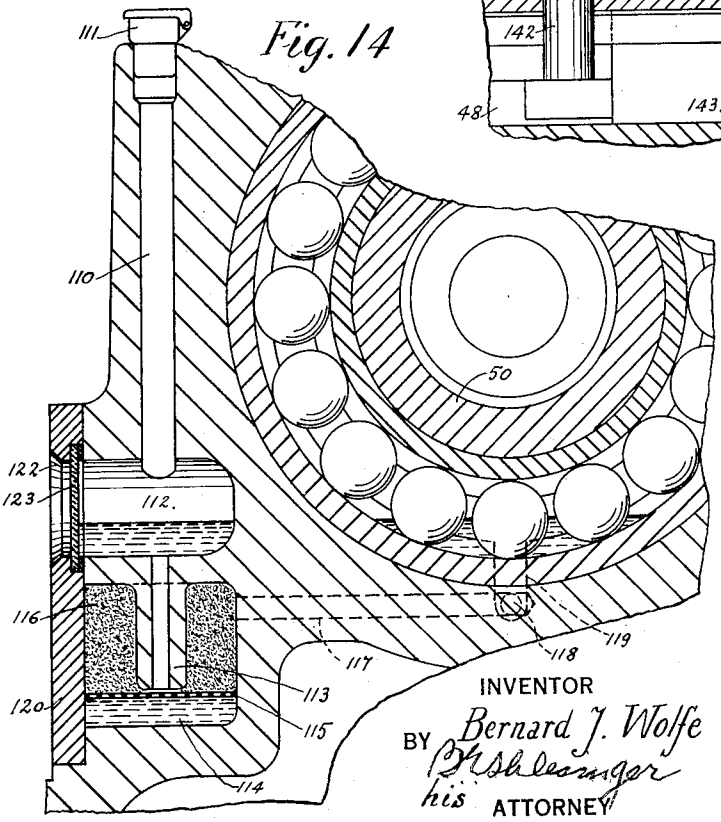


Fig. 14



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Patented July 4, 1933 1,917,178

UNITED STATES PATENT OFFICE

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COMBINATION LAPPING AND TESTING MACHINE FOR GEARS

Application filed May 27, 1930. Serial No. 456,006.

The present invention relates to a machine for the lapping and testing of gears and particularly of spur gears.

The primary purpose of this invention is to provide a machine on which spur gears of various sizes and descriptions may be quickly and expeditiously tested or lapped. To this end, one of the objects of this invention is to provide a combination lapping and testing machine in which the adjustments required for handling all gears within the range of the machine are reduced to a minimum.

A further purpose of this invention is to provide an improved method of lubricating the bearings of the machine, particularly the bearings of the two gear spindles.

A still further purpose of this invention is to provide an improved method of supplying the lapping compound to the gears, when the machine is being used for lapping, a method whereby "caking" of the lapping compound or settling out of the abrasive is absolutely prevented.

Another feature of the invention is the provision of an improved form of lapping guard whereby gears which have to be chucked at different distances from the noses of the gear spindles, can be adequately guarded during the lapping operation.

Other objects of the invention will appear hereinafter from the specification and from the recital of the appended claims.

In the drawings:

Figure 1 is a side elevation of a combination spur gear lapping and testing machine constructed according to this invention, with the gears removed from the two heads;

Figure 2 is a plan view of this machine, with the lapping guard thrown back, showing a set of gears mounted thereon for lapping;

Figure 3 is a vertical sectional view through one of the gear heads, the gear being removed, the section being taken on the line 3—3 of Figure 4;

Figure 4 is a section on the line 4—4 of Figure 3;

Figure 5 is a fragmentary view of the other head, showing a detail of the drive spindle;

Figure 6 is a vertical sectional view of the telescoping guards secured to the head shown in Figure 3, the section being taken on the line 6—6 of Figure 7;

Figure 7 is a section on the line 7—7 of Figure 6;

Figure 8 is a transverse sectional view of one section of the lapping guards, the view being taken on the line 8—8 of Figure 9;

Figure 9 is a sectional view taken on the line 9—9 of Figure 8;

Figure 10 is a view, parts being broken away, of one form of detachable tail-center or steady-rest which may be employed with this machine where the nature of the gear to be tested or lapped requires;

Figure 11 is a fragmentary sectional view of a different form of tail-center or steady-rest, the section being taken on the line 11—11 of Figure 12;

Figure 12 is a section taken on the line 12—12 of Figure 11;

Figure 13 is a fragmentary view of one of the gear heads, showing details of the oiling system for lubricating the spindle bearings;

Figure 14 is a fragmentary sectional view through the head, further illustrating the oiling system, the section being taken on the line 14—14 of Figure 13;

Figure 15 is a fragmentary plan view of the frame of the machine, showing details of the ways on which one of the heads slides;

Figure 16 is a fragmentary sectional view, showing details of the lapping-compound pump and reservoir; and

Figure 17 is a view showing details of the mounting of the lapping-compound pump, being a section taken on the line 17—17 of Figure 1.

Figures 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 16 are on an enlarged scale as compared with the scale of the other figures.

Referring to the drawings, 20 designates the base or frame of the machine, the shape of which is to be clearly seen in Figures 1 and 2. The frame is formed on its upper face with two sets of ways that extend at right angles to each other. Two heads 21 and 22, are mounted on the frame for slidable adjustment on these ways. One of the heads carries a spindle to which one of the

gears to be tested or lapped is secured and the other head carries the spindle to which the other gear of the pair being tested or lapped is secured.

The head 21 can be adjusted on the frame by rotating the hand-wheel 23 (Figure 1) which is secured to the screw 24 (Figures 3 and 4) that threads into the nut 25 which is secured to the bottom of the head 21.

The head 22 can be adjusted on its ways on the frame in a similar manner by rotation of the hand-wheel 27 (Figure 1) which is secured to a screw similar to the screw 24 that threads into a nut, similar to the nut 25, which is secured to the head 22.

The head 21 can be secured in any adjusted position by rotating the clamp-lever 28 (Figures 1 and 4) which is journaled on the stud 29 (Figures 3 and 4) that is threaded into the head 21. The lever 28 is connected at points diametrically opposed with reference to the stud 29, with two links 30 and 31. These connections are by means of the studs 32 and 33 which are pivotally mounted in the inner end of the lever and thread into the two links. The two links are pinned at their outer ends to nuts 34 and 35, respectively, which thread onto bolts 36 and 37, respectively. The bolts 36 and 37 are keyed to gibs or clamp-plates 40 against rotation relative thereto, as clearly shown in Figure 4. The lock-nuts 41 and washers 42 hold the gibs 40 on the bolts. The gibs 40 engage beneath the guide-rails 44 of the frame. It will be readily seen that when the lever 28 is moved in one direction, the nuts 34 and 35 will be threaded up on their respective bolts 36 and 37 to clamp the head 21 to the frame and when the lever is rotated in the opposite direction, the gibs 40 will be released to permit adjustment of the head on the frame.

By mechanism of identical construction, operated by the lever 45 (Figure 1), the head 22 can be clamped in any adjusted position on the frame.

It will be noted that the frame is cast with a longitudinal groove, as indicated in Figures 3, 4 and 15, to receive the screw 24 and nut 25. In addition, the frame is formed with a T-slot 48 (Figures 4 and 15) which extends parallel to the screw 47, that is, in the direction of adjustment of the head 21, the purpose of which will appear hereinafter.

The frame is formed with a groove similar to the groove 47 but which extends at right angles to the groove 47, in which the screw and nut controlled by the hand-wheel 27 operate.

Journaled in the head 21 is a spindle 50 to which is secured one of the gears which is to be lapped or tested. This spindle is mounted in the head so that its axis extends in a direction parallel to the direction of adjustment of the head. The spindle 50 is mounted in the head on anti-friction bearings 51, 52 and 53. The bearings are a special matched type of ball bearing mounted under an initial load to eliminate radial or axial deflection of the spindle.

The bearings 51 and 52 are held on the spindle against axial movement by means of a collar 54 and the nuts 55 and 56, the latter being threaded onto the spindle. The collar 54 is secured in position by means of the ring 57 and the screws 58 which secure the ring to the head 21. A cap 59 mounted on the spindle forms, with the collar 54, a labyrinth seal, preventing dirt or the lapping compound from getting into the bearings.

The bearing 53 is held in position by means of a shoulder 60 formed on the spindle and a collar 61. The collar 61 is held in position by means of the nuts 62 which thread onto the spindle. The collar 61 forms, with a plate 63, a labyrinth seal preventing dirt or compound entering the bearing 53. The plate 63 is secured in the bore 64 of the head, which receives the bearing 53, by means of the screws 65, the heads of which engage the plate 63 and which thread into a plate 66 mounted at the opposite end of the bore 64. The plate 66 is formed to provide, with the spacer-disc 67, which is secured to the spindle by a set-screw 68, a labyrinth seal at the inner end of the bearing 53.

The collar 61 is keyed to the spindle 50 and has secured to it, by means of screws 69, a hand-wheel 70. The hand-wheel 70 serves to rotate the spindle 50 as for bringing the gear secured to the spindle into proper meshing relation with its mate gear on the spindle carried by the head 22, or for observing the bearing on the teeth of the gear secured in the spindle 50, etc. A guard 72 is secured to the hand-wheel by means of screws 73 to protect the operator when the machine is in operation.

Keyed to the spindle 50 intermediate its end is a brake-drum 75. Pivotally mounted on a pin 76 mounted in the ears 77 cast in the head 21, are the two arms 78 and 79 of a brake that operates on the drum 75. These arms are lined with a suitable brake-material, indicated at 80.

Slidably mounted in a lug 81 secured to the head 21 is a bolt 82. The bolt carries at one end a washer 83 which is held by the nuts 84 in engagement with the end of the brake-arm 79. The bolt is of T-shape and at the end opposite that which carries the washer 83, and on the short arm of the T is pivoted a lever 85. Mounted on the bolt 82 and interposed between the arms 78 and 79, respectively, and the lug 81 are a pair of springs 87 and 88. These springs serve to hold the brake in normally released position. The arms 78 and 79 are forced together against the action of the springs to apply the brake by depression of the lever 85, the inner end of

the lever 85 being cam-shaped to operate on depression of the lever.

Access can be had to the brake and to the spindle by removing the cover-plate 89 which is cast so as to be flush with the adjacent surfaces of the head and which is held in position solely by the heads of the screws 90 (Figure 2) which thread into the head 21.

The spindle 95, which is adapted to carry the gear that mates with the gear carried by the spindle 50, is journaled in the head 22 so that its axis is parallel to the axis of the spindle 50.

The work-head 22 and spindle 95 are identical in construction, respectively, with the work-head 21 and spindle 50, except that instead of a brake and brake-drum, the spindle 95 has secured to it a pulley 96 (Figures 1 and 5). The pulley 96 is driven from the motor 97, which is mounted in the base of the machine, by means of the belt 98 which connects the pulley 96 with the pulley 99. This pulley 99 is secured to the armature shaft of the motor. The pulley 96 serves to rotate the spindle 95 to cause the two gears being lapped or tested to rotate together when they are in mesh.

The pulley 96 is notched at several points around its periphery, as indicated at 101 in Figure 5. A hand-lever 102 (Figures 1 and 2) which extends through an opening 103 in the head 22 and is pivoted on a pin 104 secured in the head, can be engaged with any one of these notches 101 to hold the spindle 95, or, if the gears are in mesh, both the spindle 95 and the spindle 50 against rotation when the gear chucks are being tightened up or released, in event that an ordinary manually operated draw-bolt and nut are used as the chucking apparatus.

Ball bearings are preferably used as the spindle bearings so that the machine itself may be substantially noiseless in operation to permit the operator to detect the more readily any noises emanating from the gears being tested on the machine.

The ball bearings in both heads are lubricated by a hand-oiling system which forms one of the novel features of the present machine. This system filters the oil before it reaches the bearings. Thus the machine is further protected from wear, a feature of special importance in the case of a machine operating with an abrasive. There are separate oiling systems for the front and rear bearings, but as the oiling systems are the same for the two sets of bearings in both heads, only one system will be described here.

The heads are drilled adjacent each of the sets of forward and rear bearings to provide a vertical oil-duct 110 (Figures 13 and 14). A small oil-cup 111 of any usual or suitable construction is secured in the upper end of each duct 110. Each duct 110 leads into a pocket 112 bored into the side of the head. A duct 113 drilled in the head leads from the pocket 112 to a point near the bottom of a reservoir 114. Both the pocket 112 and reservoir 114 are generally cylindrical in shape. There is a screen in the reservoir chamber of a size such that it will rest on the walls of the chamber above the bottom of the chamber, as clearly shown in Figures 13 and 14. This screen is designated by the reference numeral 115. A mass of wool or other suitable filtering material, designated at 116, is placed on top of this screen. A duct 117 drilled into the head leads from the upper end of the reservoir chamber 114 into a duct 118 drilled into the head at right angles to the duct 117. The duct 118 communicates with a vertical duct 119 which conducts the oil to the chamber of the ball-race.

A plate 120 which is secured to the side of the head by screws 121 serves as the outside wall of the chamber 114. This plate 120 is formed with an opening 122 extending through it and in this opening is secured a sight-glass 123. The glass 123 serves as the outside wall of the pocket 112.

As the oil must pass from the ducts 110 and 113 through the screen 115 and the filtering material 116 before it can reach the bearings, it will be seen that all dirt and foreign matter will be removed from the oil before it reaches the bearings. Thus, the bearings are protected against wear with its inevitable inaccuracies. The whole system is of sufficient size to provide an abundant supply of oil for the bearings and the large, unsightly oil-cups heretofore required are done away with. As the ducts are all drilled into the head, the head can be made very attractive in appearance and smooth outlines maintained. The level of oil in the pocket 112 will be always the same as the level of oil in the ball-race, so that by a glance through the sight-glass 123, the amount of oil in the race can be determined.

The gears to be tested or lapped can be secured to their respective spindles 50 and 95 by any suitable type of chucking mechanism. Where cluster gears, such as shown in Figure 2, or other gears, which require to be mounted at a considerable distance from the nose of the spindle 50, are to be lapped or tested, it is advisable to employ a tail-center or steady-rest to support the gear shaft at its outer end. For this purpose, there is a detachable tail-center or steady-rest provided with this machine. One form of such rest is shown in Figure 10 and another form in Figures 11 and 12.

Referring first to Figure 10, 130 designates the tail-stock or support. This support 130 is bored to receive the ball-bearings 131 and 132 in which the center 133 is mounted. The center is secured in position by the nut

134 and the ball bearings are held in place by the spacer 135 and the end-plates 136 and 137, the latter being secured together by the bolts 138. The bearings can be lubricated from the fitting 139 through the duct 140.

The support 130 is adapted to be held in position on the machine with the tail-center 133 in alignment with the axis of the spindle 50 by means of a T-bolt 142, the head of which can be engaged with the T-slot 48, already referred to (Figures 4 and 10). The T-slot 48 is open at its inner end as indicated at 143 in Figures 2, 10, and 15 so that the head of the bolt can be readily lifted out of the slot or inserted in the slot to permit removal from or positioning of the support on the frame. As the slot 48 extends parallel to the axis of the spindle 50, it will be seen that the support 130 can be adjusted on the frame to any desired distance from the nose of the spindle 50 and the center 133 will always remain in alignment with the axis of the spindle 50. The bolt 142 can be tightened to secure the support 130 in any adjusted position by means of a lever 145 (Figures 2 and 10), which threads onto the upper end of the bolt.

The tail-stock or support 147 (Figs. 11 and 12) is secured on the frame in the same manner as the support 130, namely, by means of a T-bolt, the head of which is engaged with the slot 48. This support 147 differs in construction from the support 130 in that the center itself is adjustable in the support. Hence, with the support 147, a rough adjustment can be had by moving the support 147 itself on the frame and a finer adjustment can be had by moving the center 146 in the support 147.

The center 146 is journaled in the bearings 148 and 149 which are secured in a sleeve 150 by means of a nut 151. A spacer 152 maintains the bearings at the proper distance apart and the center 146 is secured in the bearings by the nut 154. A series of rack teeth are cut in the sleeve 150, as indicated at 155. These teeth mesh with the teeth of a spur gear 156 which is keyed to a shaft 157 which can be rotated by the handwheel 158 that is keyed to its outer end. The sleeve 150 can be clamped in any adjusted position by means of the blocks 160 and 161 which have curved faces to engage the periphery of the sleeve 150. The block 161 is held in position by the headed end 162 of the shaft 157, while the two blocks are forced together by manipulation of the hand-wheel 164. This hand wheel 164 is keyed to a nut 165 which is threaded on the shaft 157 and which has a flanged inner end which engages the sleeve 166 that is mounted on the shaft 157 and engages at its inner end, the block 160. By tightening up on the hand-wheel 164, the blocks 160 and 161 can be moved toward each other to clamp the sleeve 150 in any adjusted position and when the blocks are released by turning the hand-wheel 164 in the opposite direction, the hand-wheel 158 can be rotated to adjust the sleeve and with the sleeve the center 153.

The gears are lapped on this machine by applying a lapping compound to them and running them together in mesh. To prevent the lapping compound from being sprayed all over the machine and the operator, guards are provided to enclose the gears during the lapping operation. The improved type of guard supplied with this machine will now be described.

The guards are made in sections and are detachable. One section is always used during the lapping operation. This section will be described first. This section which is of general box-shape and open at both ends is designated generally by the reference numeral 170 (Figures 1, 8 and 9). It consists of a lower cast or sheet-metal trough-member 171 and an upper cast or sheet-metal cover-member 172 which is hingedly connected at 173 to the lower part 171. The cover part 172 is formed with a lip 174 so that the operator can readily lift it up out of the way. The upper part 172 is flanged to fit closely in the lower part 171 when the guard is closed. The front walls of the two parts are provided with openings of sufficient area to permit the shafts of the gears to be tested to pass therethrough.

The section 170 can be secured directly to the end-plate 54 of the spindle 50 or to a spacing section 178 which in turn may be secured to the plate 54.

The spacing section 178 is of general drum-shape. It is open front and rear to permit the passage of the gear shaft clamped in the spindle 50 therethrough. The adjacent walls of the sections 170 and 178 are cut away, as indicated at 179 in Figure 8, to permit the lapping compound to drain from the section 178 back into the trough of the section 170.

A series of sections 178 can be provided which are of different lengths. By taking one of these sections 178 off of the machine and substituting another of a different length therefor, the section 170 can be disposed at the proper distance from the nose of the spindle 50 to enclose the gears which are being lapped. In cases where the gears to be lapped have but little overhang, the section 178 can be taken off entirely and the section 170 secured directly to the spindle-plate 54, as indicated above. The section 170 is secured to the section 178 or to the spindle-plate 54 by screws 180. The section 178 can be secured to the spindle-plate 54 by screws 181. The screws 180 and 181 are of the same size and are spaced the same distances apart on the sections 170 and 178, respectively, so that either set of screws can be threaded into the holes 183 in the flange of the plate 54 to

secure the section 178 or the section 170 to the plate 54, as described.

The lapping compound might be applied to the gears by hand, by chain, or by air. I have found it advantageous to pump the compound onto the gears automatically and in this connection it is to be noted that one of the features of the machine illustrated is the novel system for pumping and circulating the lapping compound. This will now be described.

The pump may be of any suitable construction. I have found it preferable, however, to employ a centrifugal pump. The pump is secured in a bracket 185 by means of a clamp 186 and screws 187 and the bracket is itself, in turn, secured to the frame of the machine by means of screws 188. The pump is driven from a direct-connected motor 190 that is connected directly with the propeller spindle 191 of the pump. This spindle 191 carries the vaned-impeller 192.

The lapping compound is pumped from a covered trough or reservoir 194 (Figures 1, 16 and 17) through the pipe 195 that threads into an opening in the bottom of the trough or reservoir, the T 196, and the pipes 197 and 198 which are connected by the union 199. The pipe 198 threads into an opening provided in the side wall of the pump chamber 200.

The impeller 192 forces the compound out of the chamber 200 through the flexible hose 201 and the pipe 202 (Figures 1 and 2) onto the gears. The pipe 202 is secured in a split-clamp 203 which is in turn connected to a split-clamp 204 that engages a rod 205 which is vertically adjustable in an opening provided in a lug 206 secured to the trough-part 171 of the lapping guard section 170. A set screw 207 serves to hold the rod 205 in any adjusted position. By means of the split-clamp and the rod, the pipe 202 is capable of universal adjustment to direct the lapping compound onto the gears at any desired point. In Figure 2, the pipe 202 is shown swung away from the gears to permit the other parts to be clearly illustrated.

The trough-part 171 of the lapping guard section 170 has an opening at one end as indicated at 210 in Figures 2 and 8, and the bottom wall of this trough-part is inclined toward this opening to cause the compound dripping off of the gears to flow out of the guards through this opening. A suitable coupling connects the flexible hose 211 with the opening 210. This hose 211 serves to return the lapping compound, after use, to the reservoir 194, the compound returning to the reservoir through an opening in the cover 212 of the reservoir, the hose 211 being suitably connected by a coupling to this opening.

Lapping compounds are made by mixing abrasive powder with oil. Considerable difficulty has been experienced heretofore in maintaining the desired consistency of the mixture. The abrasive powder tends to settle out and cake. This tendency is completely overcome with the circulating system construction just described. It will be noted that the pump pumps the compound out of the bottom of the reservoir. Thus, the compound has no opportunity to cake. Moreover, as the bottom of the reservoir 194 is above the level of the pump chamber 200, there is no low spot in the system in which the compound can settle. The clean-out plug 214, which threads into the T 196 is provided primarily to permit cleaning the compound out of the system after it has been used for a long time so as to allow a fresh supply of compound to be used.

It is not always possible to keep the lapping compound from getting past the impeller blades and up along the shaft 191. Accordingly, holes 216 are provided in the sleeve 215 in which the shaft 191 is held, through which any compound getting up past the impeller blades can return to the reservoir, being directed back into the reservoir by the lip-member 217 which surrounds the sleeve 215 and extends over the reservoir, being covered, like the reservoir, by the cover-plate 212.

The ways of the machine are protected to avoid wear because of abrasive getting between the ways and the heads. The way-guards are of a telescoping character.

Secured to the head 21, at its front and rear ends, as by means of screws 220, are aprons 221 and 222, respectively. Threaded into the head beneath each of these aprons are a pair of rods 223 (Figures 3, 6 and 7). These rods 223 serve as guides for the telescoping guard section 224. The section 224 attached to the rear end of the head is simply a piece of sheet-metal, turned down on three sides. The guard 224 for the front end of the head is of similar shape, except that part of its front side is slit and turned up to form a lip 226.

The guards for the rear portion of the ways on which the head 21 slides comprise simply the apron 222 and the telescoping section 224. For the front portion of the ways, there is provided, in addition, a detachable guard section 227, which is of approximately half the width of the guard section 224. The guard section 227 is intended to cover the forward end of the T-slot 48 when a tail-center is not being used and this section 227 is removable to permit use of the tail-center. For the purpose of detachably securing the section 227 to the forward section 224, a pair of headed pins 229 are secured in one side of the guard 224 for engagement in the bayonet-slot 230 formed in one side of the guard section 227. In addition, the guard section 227 has a flange 231 at its rear end which is

adapted to engage over the lip 226 of the guard section 224. The skirts of the guard sections 224 and 227 are of sufficient depth to extend down over the ways 44 of the frame so that as the head 21 is adjusted on the frame, the guard sections adjust themselves automatically to the position of the head, telescoping or extending, as required.

The guards for the ways on which the head 22 slides are of a character similar to the guards 222 and 224 secured to the rear of the head 21 and further description of these guards is deemed unnecessary.

In operation, the gears to be tested or lapped are secured to the two spindles 50 and 95. In the drawings, (Figures 2 and 9), one member 235 of a set of cluster gears 234, 235, and 236 is shown meshed with its mate gear 237 so that these two mating gears can be lapped. Because of the overhang of the shaft 238, on which the cluster gears are mounted, the use of the steady-rest has been deemed advisable. Hence, the forward guard section 227 of the head 21 has been removed from the machine and the head of the T-bolt 142 engaged in the T-slot 48. The steady-rest is adjusted until the center engages the shaft 238 to form with the spindle 50, a rotary support for this shaft.

The gears 235 and 237 are adjusted into engagement by moving the head 21 and the steady-rest on the frame in the direction of the axis of the spindle 50 to bring the gears into the proper operating plane and by adjusting the head 22 on the frame in a direction perpendicular to the axis of its spindle 95 to engage the gears with their axes at the proper center distance. These adjustments are made, as described, by rotating the hand-wheels 23 and 27, respectively, and after the head has been adjusted into proper relation, the two heads are locked in position by manipulation of the levers 28 and 45, respectively, as described. It will be noted that only two adjustments are required to bring any gears within the range of this machine into proper meshing relation. These two adjustments are the adjustment of the head 21 in the direction of the axis of its spindle, which brings the two gears into the proper meshing plane and the adjustment of the head 22 in a direction perpendicular to the axis of its spindle which causes the gears to engage at the proper center distance.

If the gears to be lapped overhang from the nose of the spindle 50 a distance such as shown in the drawings, both a lapping guard section 170 and a spacing section 178 are employed. The length of the spacing section is determined by the amount of overhang of the gears. In cases, where the gears to be lapped are chucked close to the noses of their respective spindles, a spacing guard section 178 is unnecessary and the guard section 170 is secured directly to the front plate 54 of the spindle 50.

The lapping operation is effected by running the gears together while pumping the lapping compound onto them at their meshing points. The gears are rotated form the motor 97 which drives the spindle 95 through the pulleys 99 and 96 and the belt 98. The gear 237 secured to the spindle 95 drives the gear 235. The lapping compound is applied to the gears by action of the lapping compound pump which pumps the compound from the reservoir 194 through the hose 201 and the pipe 202 onto the gears. The lapping compound returns after use through the hole 210 in the bottom 171 of the guard 170 and the hose 211 to the reservoir 194. The brake on the spindle 50 may be used, if desired, during the lapping operation by depressing the handle 85, thereby to apply pressure to the gears to accelerate the lapping operation. The gears are preferably run first in one direction and then in the other. The reversal of motion may be controlled from the reversing switch 240 (Figure 1) which controls the direction of rotation of the motor 97.

The gears can be tested, if desired, at different stages of the lapping operation to determine the progress of lapping and the character of tooth-bearing by simply shutting off the lapping pump and running the gears together with or without load. Loads comparable to those encountered in use can be applied, if desired, by depressing the brake-lever more or less to exert different amounts of braking pressure on the spindle 50. The gears can be run in both directions by reversing the motor 97.

When the machine is to be employed testing a quantity of gears, the lapping guards are removed and the lapping pump shut off. The gears are run together both with and without load to test their quietness and, by applying red-lead or a similar substance to the teeth, to determine the location of the tooth-bearing. As before, loads comparable to those encountered in use can be applied to the gears by depressing the brake-lever 85. In the test, the gears are run in both directions.

While I have described my invention in connection with a particular embodiment and a particular use for that embodiment, it will be understood that the invention is capable of various further modifications and that the features of the invention are capable of various further uses. This application is intended to cover any adaptations, uses, or embodiments of the present invention following, in general, the principles of the invention and including such departures from the present disclosure as come within known or customary practice in the gear art and as may be applied to the essential features hereinbefore

set forth and as fall within the scope of the invention or the limits of the appended claims.

Having thus described my invention, what I claim is:

1. In a machine of the class described, a frame, a pair of slides adjustably mounted on the frame, a spindle journaled in each slide so that the axes of the two spindles are parallel, a tail-stock with a rotatable center journaled therein adjustable on the frame in the direction of adjustment of one slide and adapted to cooperate with the spindle carried by said slide to detachably support a spur gear therebetween, means for detachably securing a spur gear to the other spindle, means for adjusting one of said slides in a direction parallel to the axis of its spindle, means for adjusting the other slide in a direction at right angles to the direction of adjustment of the first slide, cooperating means on the frame and tail-stock for guiding the tail-stock in its adjustment, and means for rotating one of said spindles to rotate the gears in mesh.

2. In a machine of the class described, a frame, a pair of slides adjustably mounted on the frame, a spindle journaled in each slide so that the axes of the two spindles are parallel, means for adjusting one of said slides in a direction parallel to the axis of its spindle, means for adjusting the other slide in a direction at right angles to the direction of adjustment of the first slide, a tail-stock adjustable on the frame in the direction of adjustment of the first slide, a rotatable center carried by the tail-stock, means for guiding the tail-stock in its adjustment so that the center remains aligned with the axis of the spindle carried by the first slide throughout the adjustment of said tail-stock, said tail-stock cooperating with said spindle to detachably support a spur gear therebetween, means for detachably securing a spur gear to the other spindle, and means for rotating one of said spindles to rotate the two gears in mesh.

3. In a machine of the class described, a frame, a pair of slides adjustably mounted on the frame, a spindle journaled in each slide so that the axes of the two spindles are parallel, means for adjusting one of said slides in a direction parallel to the axis of its spindle, means for adjusting the other slide in a direction at right angles to the direction of adjustment of the first slide, said frame being formed with a T-slot in its upper face extending in the direction of adjustment of the first slide, a tail-stock mounted on the frame for adjustment in the direction of adjustment of the first slide, a T-bolt the head of which is engageable in said T-slot for securing the tail-stock in any adjusted position, a center rotatably mounted in the tail-stock adapted to cooperate with the spindle carried by the first slide to support a spur gear therebetween, means for detachably securing a spur gear to the other spindle, and means for rotating one of said spindles to rotate the two gears in mesh.

4. In a machine of the class described, a frame, a pair of slides adjustably mounted on the frame, a spindle journaled on each slide so that the axes of the two spindles are parallel, means for detachably securing a spur gear to each of said spindles, means for adjusting one of said slides in a direction parallel to the axis of its spindle, means for adjusting the other slide in a direction at right angles to the direction of adjustment of the slide, said frame being formed with a T-slot in its upper face extending in the direction of adjustment of the first slide, a set of telescoping guards secured to the first slide and adapted to cover the exposed parts of the frame and slot as said slide is adjusted on the frame, one of said guards being detachable to permit a tail-stock to be adjustably secured to the frame, said tail-stock having a center rotatably mounted thereon in alignment with the axis of the first spindle, said center being adapted to cooperate with the first spindle to mount a spur gear therebetween, a T-bolt carried by said tail-stock, the head of which is engageable in said T-slot to secure the tail-stock in any adjusted position on the frame, said slot being open at one end to permit engagement of the head of the bolt therewith and removal therefrom to permit the tail-stock to be secured to or removed from the frame, and means for rotating one of said spindles to rotate the gears in mesh.

5. In a machine of the class described, a frame, a pair of slides adjustably mounted on the frame, a spindle journaled in each slide so that the axes of the two spindles are parallel, means for adjusting one of the slides in a direction parallel to the axis of its spindle, means for adjusting the other slide in a direction at right angles to the direction of adjustment of the first slide, a tail-stock adjustable on the frame in the direction of adjustment of the first slide, a rotatable center carried by the tail-stock in alignment with the axis of the spindle carried by the first slide and adapted to co-operate with said spindle to detachably support a spur gear, said center being mounted on anti-friction bearings in a sleeve carried by said tail-stock, means for securing the tail-stock in any adjusted position, means for adjusting the sleeve relative to said tail-stock to move the center toward and from the spindle with which it co-operates, means for locking the sleeve in any adjusted position, means for securing a spur gear to the other spindle, and means for rotating one of said spindles to rotate the two gears in mesh.

6. In a machine of the class described, a frame, a pair of slides adjustable on the frame, a spindle journaled in each slide so that the axes of the two spindles are parallel, means for detachably securing a spur

gear to each of said spindles, a guard formed to project over and surround the gear mounted on one of the spindles, a second guard formed to project over and surround both of the gears when in mesh, said first guard being adapted to be detachably secured to one of said slides, and the other guard being adapted to be detachably secured either to the first guard or directly to said slide, said first guard forming one of a set of guards which may be used selectively the projecting portions of which are of different lengths, said guards permitting, therefore, accommodation of gears which require to be chucked at different distances from the noses of the two spindles, and means for rotating one of said spindles to rotate the two gears in mesh.

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