Oct. 25, 1966

C. H. MOTZ ETAL

3,280,467

AUTOMATIC GEAR CHECKER FOR INTERNAL GEARS

Filed March 25, 1963

2 Sheets-Sheet 1

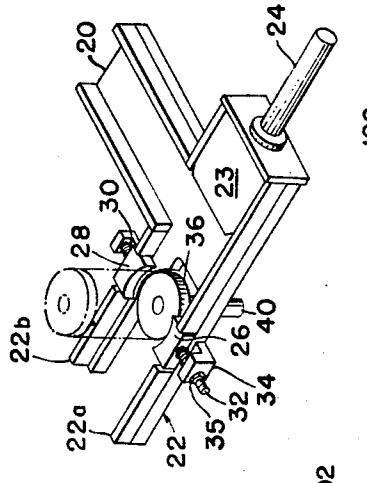


FIG.5

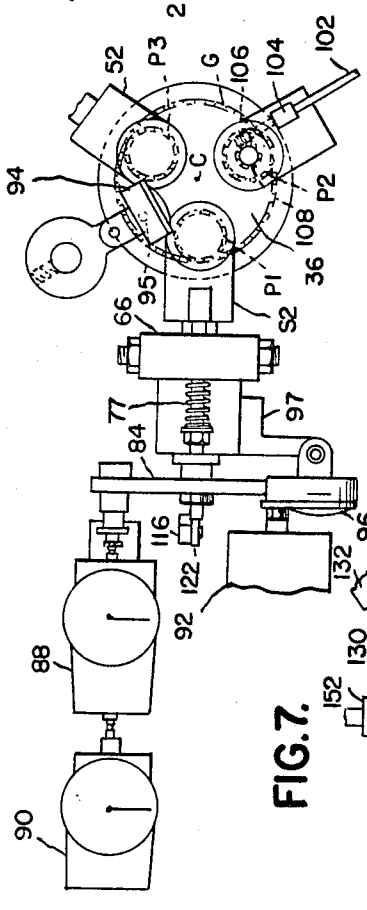


FIG.1.

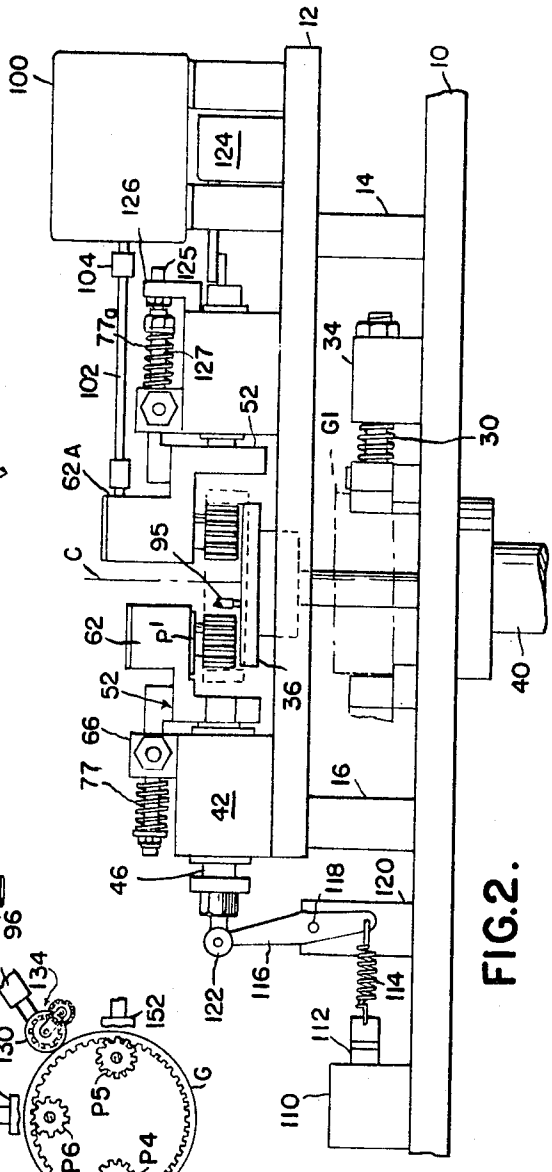


FIG.2.

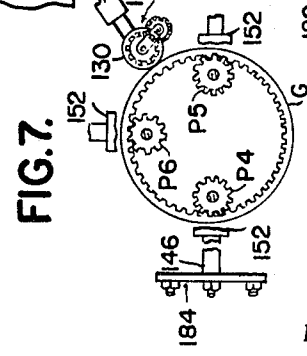


FIG.7.

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2 Sheets-Sheet 2

FIG.3.

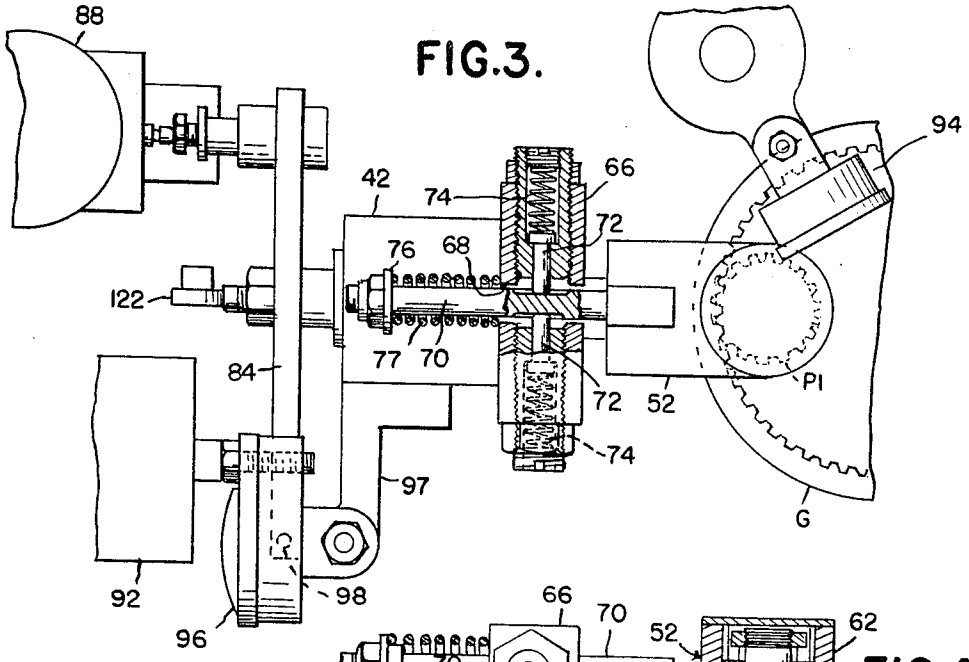


FIG.4.

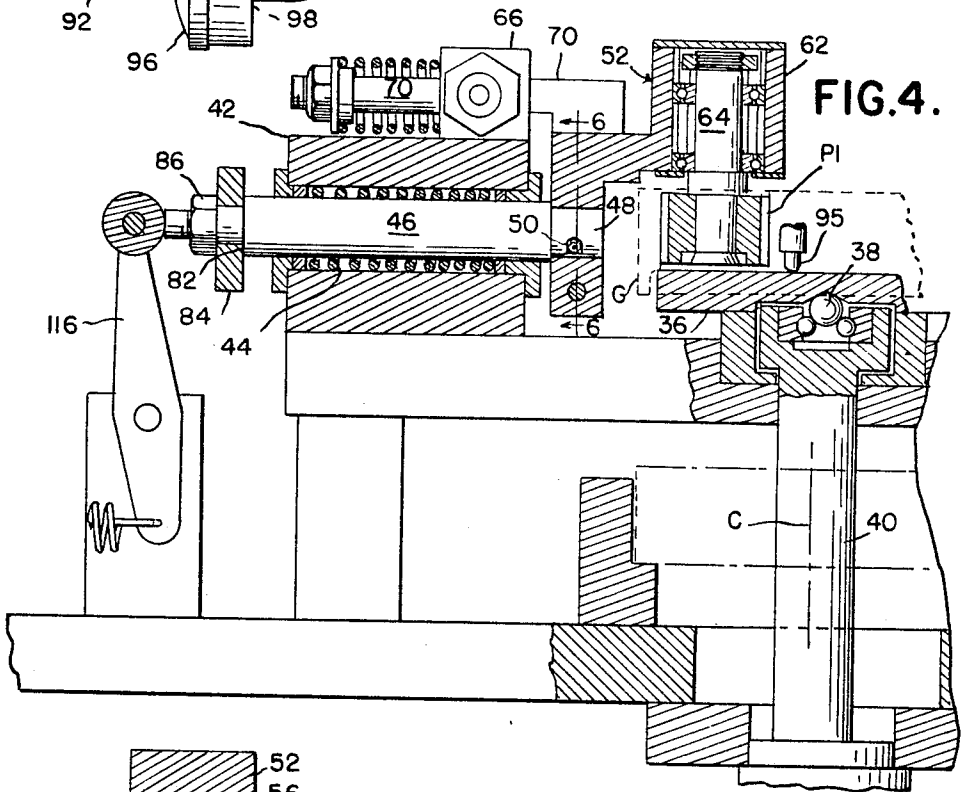
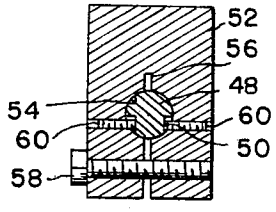


FIG.6.



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AUTOMATIC GEAR CHECKER FOR INTERNAL GEARS

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3 Claims. (Cl. 33—179.5)

The present invention relates to an internal gear checker.

It is an object of the present invention to provide an internal gear checker having three pinions at least one of which is movable toward and away from the other two in order to position the pinions close enough together to receive the work gear, after which outward movement of the pinion or pinions brings all of the pinions into check meshing engagement with the internal gear.

It is a further object of the present invention to provide a checker for an internal gear comprising three pinions adapted to mesh simultaneously with the internal gear, and means responsive to movement of one of said pinions toward and away from the other two to provide a measurement of a gear condition.

It is a further object of the present invention to provide a checker for an internal gear as described in the preceding paragraph, comprising means for driving the internal gear and pinions in rotation.

It is a further object of the present invention to provide an internal gear checker comprising three pinions mounted with their axes parallel and adapted to engage in full mesh with an internal work gear, in which all of said pinions are angularly movable about axes radial with respect to the gear.

It is a further object of the present invention to provide an internal gear checker comprising a plurality of pinions adapted to engage in full mesh with the teeth of an internal gear, in which one of the pinions is mounted for swiveling movement about an axis radial with respect to the internal gear, and means for measuring the angular position of said one pinion about its swivel axis as a measurement of the helix angle of the internal gear.

It is a further object of the present invention to provide an internal gear checker comprising means for supporting an internal gear for rotation, means for positioning three internal pinions in full mesh with the teeth of the gear, means mounting one of said pinions for movement radially of the internal gear, and means responsive to such radial movement to determine size, out-of-round, and tooth-to-tooth spacing or nicks on the teeth of the gear.

It is a further object of the present invention to provide an internal gear checker comprising three rotatable master pinions, automatic loading mechanism comprising a transfer platform for moving an internal gear into position surrounding said pinions, means for thereafter effecting radial outward movement between said pinions to bring about a condition of full mesh between the teeth of the internal gear and pinions, means for driving the internal gear and pinions in rotation, means mounting one of the pinions for movement radially with respect to the internal gear, measuring means responsive to movement of said one pinion, means for moving said pinions toward each other to produce clearance between said pinions and internal gear at the end of a checking cycle, means for thereafter lowering said platform, and means for thereafter advancing a second internal gear onto the platform in such a way as to push the previously checked internal gear off of the platform.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings,

illustrating preferred embodiments of the invention, wherein:

FIGURE 1 is a plan view of the internal gear checker with parts omitted for clearness.

FIGURE 2 is a side elevation of the gear checker shown in FIGURE 1, with certain parts angularly displaced for clarity.

FIGURE 3 is an enlarged fragmentary view, with parts in section, showing the mounting for one of the pinions.

FIGURE 4 is an enlarged fragmentary view, partly in section, showing certain details of spring biasing means and pinion mounting means.

FIGURE 5 is a perspective view showing a portion of the automatic loading mechanism.

FIGURE 6 is a fragmentary section on the line 6—6, FIGURE 4.

FIGURE 7 is a schematic view of a modification of the present invention.

The checking mechanism for internal gears comprises a stationary frame structure comprising a plate 10 and a plate 12 rigidly interconnected by support members 14 and 16. Mounted on the upper plate 12 are separate support means for three master pinions designated respectively, P1, P2 and P3. Means later to be described are provided for shifting these pinions inwardly toward the vertical center line of the machine, this center line being designated C, to a position which permits an internal gear to be moved freely into position surrounding said pinions, after which the pinions are movable radially outwardly from the center line into positions of full mesh with respect to the work gear G. While the pinions are in full mesh with the work gear, one of the pinions is driven in rotation to effect a predetermined rotational movement of the internal gear, preferably at least 360 degrees. After the checking operation is complete the master pinions are moved inwardly and the checked gear is moved out of surrounding relation with respect thereto.

The movements of the work gears into and out of the checking relation is taken care of by automatic loading mechanism best illustrated in FIGURES 2, 4 and 5. The work gears are advanced in a chute 20 into alignment with an angularly disposed chute 22 comprising a pair of laterally spaced rails 22*a* and 22*b*. The chute 22 is provided with a slidable feeding member 23 actuated by a push rod 24 and adapted to engage a work gear at the juncture between chutes 20 and 22, and to advance it to a position in which it is disposed directly below the position which it will occupy in the checking cycle. In order to provide accuracy in registration of the work gear in this position a pair of spring pressed shoes 26 and 28 are provided, compression springs 30 urging the shoes inwardly. Each of the shoes is guided for inward movement by means of a rod 32 slidable in a bracket 34, and inward movement is limited by nuts 35 on the outer threaded ends of rods 32. The internal gears are sequentially lifted into checking relation with the pinions by means of a wobble plate 36 which is supported on a ball pivot 38 at the upper end of a lift shaft 40 operable by suitable means such for example as a fluid cylinder. The plate 36 is a circular disc dimensioned to pass between the rails and in its lowermost position it is beneath the path of travel of the gears. When a gear is pushed to located position between the locating shoes 26 and 28, the wobble plate 36 is raised moving a work gear G into checking position, as best illustrated in FIGURE 4. It will be observed in this figure that the work gears G as shown are provided with counterbores to provide locating surfaces extending perpendicular to the axes of the work gears, and that these locating surfaces rest upon the upper surface of the wobble plate 36. The counterbores also provide vertical

surfaces engageable by the edges of the plate 36, so that the plate prevents any substantial lateral movement.

When a gear has been completely checked, the wobble plate with the gear thereon is lowered to position the work gear in the same horizontal plane as the remaining gears in the chutes 20 and 22, at which time a new internal gear is pushed onto the wobble plate and located by the shoes 26 and 28. This operation pushes the previously checked internal gear off of the wobble plate into a discharge portion of the chute 22.

The structure for mounting and moving the master pinions P1, P2 and P3 is generally similar except for the mounting of the master pinion P1 whose movement is employed in the checking operation. Accordingly, only one of the pinion mounting structures will be described in detail.

As best seen in FIGURE 4, there is provided a ball bush or mounting 42 having ball bearings 44 therein supporting a shaft 46 for both axial movement and rotational movement in the ball bush. At its inner end the shaft 46 is reduced as indicated at 48 and is provided with flats 50 the purpose of which is apparent from an inspection of FIGURE 6. A bracket 52 is provided having an opening 54 therein for receiving the reduced end 48 of the shaft 46. The bracket is split as indicated at 56 and is provided with a clamping screw 58. When the screw 58 is loosened, the bracket may be angularly adjusted on the shaft portion 48 by respectively tightening and loosening the set screws 60.

The bracket 52 includes an offset journal portion 62 in which is journaled a shaft 64, the shaft carrying one of the master pinions, and in FIGURE 4, the master pinion P1, thereon.

Extending upwardly from the ball bush 42 is a centering housing 66 details of which are best seen in FIGURE 3. This housing has a transverse through opening 68 therein through which extends an arm 70, the inner end of the arm being fixed to the bracket 52. The arm 70 is centered in the enlarged opening 68 by centering pins 72, the pins 72 being engaged by centering springs 74 which operate to maintain the arm 70 centered except when displaced from centered position by rotation of the bracket 52 about the axis of its mounting shaft 46.

At its outer end the arm 70 carries a spring seat 76 and a compression spring 77 extends between the spring seat 76 and the housing 66, thus urging the bracket 52 radially outwardly from the center line C of the checker.

The aforementioned mounting of the pinion P1 permits swiveling of the pinion P1 about the axis of the shaft 46, which is radial with respect to the center line of the machine.

Referring again to FIGURE 4, it will be observed that at its outer end the shaft 46 is reduced to provide a shoulder 82 and a bar 84 is clamped against this shoulder by a nut 86. As the shaft 46 is moved axially in response to certain characteristics of the internal gear G, the bar 84 will transmit this motion to various checking instrumentalities, such for example as a device 88 for checking the out-of-round condition of the gear, a device 90 for checking size of the gear, and a device 92 which checks nicks or abrupt tooth-to-tooth spacing errors. The checking device 92 may be an inertia type device responsive only to relatively abrupt movement.

An additional check is provided by the wobble plate 36 and for this check there is provided an indicator 94 having a plunger 95 engageable with the upper surface of the wobble plate 36. Thus, as the gear is driven in rotation, as will subsequently appear, the wobble plate rotates with it and any out of true condition of the flat locating surface in the counterbore of the work gear will produce an indication on the indicator 94.

In addition, means are provided for measuring the helix angle or determining helix angle error in the teeth of the work gear. For this purpose an indicator 96 is mounted on a bracket 97 secured to the mounting 42. The indicator 96 has a plunger 98 adapted to engage the upper surface of the bar 84 adjacent one end thereof. It will be recalled that the bar 84 is rigidly affixed to the shaft 46 and at its other end the shaft 46 has the pinion mounting bracket 52 fixed thereto in a position which is adjustable by means of the set screws 60. Accordingly, if the bracket 52 is adjusted so that the arm 70 is accurately centered and the indicator 96 set to zero when the pinion P1 is in full mesh with the gear G, any variation in helix angle of a portion of the teeth of the gear G or of the teeth of a subsequently checked work gear, will cause rotation of the shaft 46 and inclination of the bar 84, thus producing a change in the reading of the indictaor 96.

It may be mentioned at this time that while indicators have been shown as conventional dial indicators actuated by plungers, it is to be understood that indicators of any type, either mechanical or electrical, may be employed.

Means are provided for rotating one of the pinions, as for example the pinion P2, and this means comprises a motor 100 connected by a shaft 102 and loose spline couplings 104 with a worm 106 engageable with a worm gear 108 connected to a shaft similar to the shaft 64 of FIGURE 4 but extending upwardly. In FIGURE 2 the housing, here designated 62*a*, is indicated as extending upwardly to a greater extent than does the housing 62. All of the pinions P1, P2 and P3 are mounted for angular adjustment about axes radial with respect to the center line of the checker, in the same manner as described in detail for the pinion P1. Thus, if errors are present in the helix angle of the teeth of the internal gear, this will permit the pinions to adjust themselves so that the helix angle error will not influence checking of other gear characteristics. As previously described however, this swiveling movement of the pinion P1 is measured to provide a check as to the helix angle of the teeth of the internal gear.

In the cycle of the machine, which is repeated automatically so as to produce automatic checking of a sequence of gears, means are provided for shifting all of the pinions radially inwardly to provide clearance for insertion and removal of the internal gears into the plane of the pinions P1, P2 and P3. For the checking pinion P1, this radial movement is controlled by a solenoid 110 having a plunger 12 connected by a spring 114 to a lever 116 pivoted as indicated at 118 to a post 120. At its upper end the lever 116 carrier a roller 122 which is engageable with the outer end of the shaft 46.

The remaining two brackets 52 are also provided with spring means 77*a*, similar to spring means 77 previously described, but substantially stronger to insure location of pinions P2 and P3 by abutments to be subsequently described, urging them outwardly, and solenoid means as seen at 124 for urging the pinions inwardly into clearance position when the solenoids are energized. The position of the pinions P2 and P3 when the solenoids 124 are de-energized is determined by an abutment 125 carried by a bracket 126 and engageable by the radially outer ends of arms 127 corresponding to the arm 70 associated with the pinion P1. Thus, when the solenoids 124 are de-energized the pinions P3 and P2 are spring biased into predetermined positions. At this time the pinion P1, which is mounted for radial movement with respect to the center line C of the checker, is spring urged into full mesh engagement with the gear G and maintains the gear in full mesh with the locating pinions P2 and P3.

In the automatic cycle the solenoids 110 and 124 are energized to move the pinions inwardly into clearance position. Suitable means are provided for de-energizing the solenoids when the wobble plate 36 has moved the work gear G into partially overlapping relation with respect to the pinions P1, P2 and P3. At this time the pinions P2 and P3 remain in a fixed position and the pinion P1 is movable radially with respect to the center line C of the checker in accordance with variations in characteristics of the gear G. At the end of the checking

cycle, when the pinion P2 has driven the gear G through at least 360 degrees of rotation, the solenoids are again energized, moving the pinions inwardly into clearance and at the same time the wobble plate is moved quickly downwardly into a position in which the checked gear may be discharged and a new gear positioned thereon.

When the gear to be checked is fully meshed with the pinions P1, P2 and P3 it is supported by the pinions in a horizontal plane and if helix angle error exists, the pinions swivel as required about radial axes to accommodate themselves to helix angle error. Rotation of the work gear at this time will accordingly result in radial motion of the checking pinion P1, the pinions P2 and P3 remaining fixed against radial displacement and thus providing an indicating location for the work gear.

If ovality or out-of-round exists with respect to the work gear, the shaft 46 will move slowly and the indicator 88 will measure and record the departure from a true circular condition. If the gear G is over or undersized, this will be determined by the measuring device 90. If abrupt movement is imparted to the shaft 46 as by tooth-to-tooth spacing errors or nicks, the indicator 92 will respond. Any deviation from proper helix angle will be measured and if desired, recorded by the indicator 96. If the locating surface formed by the bottom of the counterbore on the gear is not in line, this condition will be observed by the indicator 94 as a result of movement of the wobble plate 36.

It will of course be understood that the measurements of the various gear characteristics may be recorded by conventional means if desired and that further, departure from acceptable limits as to the various gear characteristics may if desired actuate means for sorting the checked gears into categories consistent with the observed deviations.

Referring now to FIGURE 7 there is schematically illustrated a variation in arrangement of the parts. Pinions P4, P5, and P6 are supported on brackets 152 and movement of the bracket supporting the pinion P4 is transmitted by shaft 146 to bar 184, corresponding to the shaft 46 and bar 84 seen in FIGURE 4. In this case the work gear G as before, is engaged with a checking master pinion designated P4 which is mounted on the bracket 152. It is found that the determination of size of the pinion and out-of-round conditions thereof can be measured much more accurately if one of the locating pinions, as for example the pinion P5, is located 180 degrees from the pinion P4, or in a position diametrically opposite thereto. In this case the third locating pinion P6 is positioned intermediate the pinions P4 and P5, or spaced 90 degrees from each. It will be understood that if only two pinions are provided, such as the pinions P4 and P5, located 180 degrees apart, the gear G is not sufficiently stabilized against movement transverse to a line joining the pinions P4 and P5. For this reason the stabilizing pinion P6 is provided which of course stabilizes the gear G against movement downwardly as viewed in the figure. However, the pinion P6 alone affords no stability against movement upwardly as seen in FIGURE 7. Accordingly, with the pinions P5 and P6 in the position shown in FIGURE 7, proper stability to the gear is provided by a roller 130 suitably connected to an actuator which may be in the form of a solenoid 132 capable of retracting the roller 130 into a clearance position for loading and unloading the gear and for releasing the roller 130 for spring pressed engagement with the outer cylindrical surface of the gear G. Because the roller 130 is located intermediate the pinions P5 and P6 it maintains the gears in full mesh with the pinions P5 and P6 and thus provides accurate location thereof. The pinion P4 is radially movable as before and is connected to the bar 184 which transmits movement of the checking pinion P4 to instruments for measuring and/or recording variations in gear characteristics. It will be understood that the pinions P5 and P6 are connected to suitable means such as solenoids similar to the solenoids 124 previously described, to shift the pinions inwardly to clearance position, together with means operable to locate the pinions P5 and P6 in accurately predetermined locating position when the solenoids are de-energized.

In some cases it is desirable to eliminate the positive drive connection to one of the pinions P4, P5 or P6, and this can be conveniently accomplished by providing means 134 to drive roller 130, which in this case will have a friction surface for driving the internal gear G.

The drawings and the foregoing specification constitute a description of the improved automatic gear checker for internal gears in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What we claim as our invention is:

1. Apparatus for use with an internal gear having a smooth outer periphery, said apparatus having an imaginary center line, in which the internal gear is mounted with its axis coincident with the center line, three rotary pinion supports for supporting pinions in a common plane coincident with the plane of the gear and adapted to mesh therewith, pinions on said supports, means mounting two of said supports in fixed operative position and mounting said other support for movement in said plane radially with respect to the center line, said supports being spaced substantially equidistant from said center line, a drive roller engageable with the smooth outer periphery of the internal gear at a point intermediate the zones of meshing engagement between the internal gear and pinions carried by said two supports, said roller being in frictional driving engagement with the internal gear, and means for driving said roller in rotation one of said pinion supports being mounted for angular movement about an axis extending radially with respect to the aforesaid center line, and means for measuring angular movement of said last mentioned pinion support during rotation of the internal gear.

2. Apparatus for checking size, helix angle and out-of-round conditions of an internal gear comprising three pinion supports for mounting pinions in a common plane with their axes substantially perpendicular thereto, pinions on said supports, means operable in conjunction with the pinions on said supports for mounting an internal gear in the plane of said pinions in mesh therewith, two of said pinion supports being located in fixed positions during a checking operation, the other one of said pinion supports being movable in a direction radial of the internal gear in mesh with the pinions and angularly movable about an axis radial of the internal gear and the pinion on said one support, means urging said one pinion support radially outwardly from the center of the internal gear, means for driving the pinions and gear in rotation, the gear being checked being laterally movable as required to maintain the gear in tight mesh with said pinions, and means for sensing the position and the movement of said movable pinion support.

3. Apparatus for checking size and out-of-round conditions of an internal gear comprising three pinion supports for mounting pinions in a common plane with their axes substantially perpendicular thereto, pinions on said supports, means operable in conjunction with the pinions on said supports for mounting an internal gear in the plane of said pinions in mesh therewith, two of said pinion supports being located in fixed positions during a checking operation, the other one of said pinion supports being movable in a direction radial of the internal gear in mesh with the pinions, means urging said one pinion support radially outwardly from the center of the internal gear, means for driving the pinions and gear in rotation, the gear being checked being laterally movable as required to maintain the gear in tight mesh with said pinions, and means for sensing the position and the movement of said movable pinion support, said pinion supports

each being rotatable about an axis radial of the internal gear and the pinion thereon to eliminate error in size measurement resulting from a helix angle error.

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