May 30, 1933. R. S. CONDON 1,911,435

GEAR TESTING MACHINE

Filed Sept. 20, 1930 2 Sheets-Sheet 1

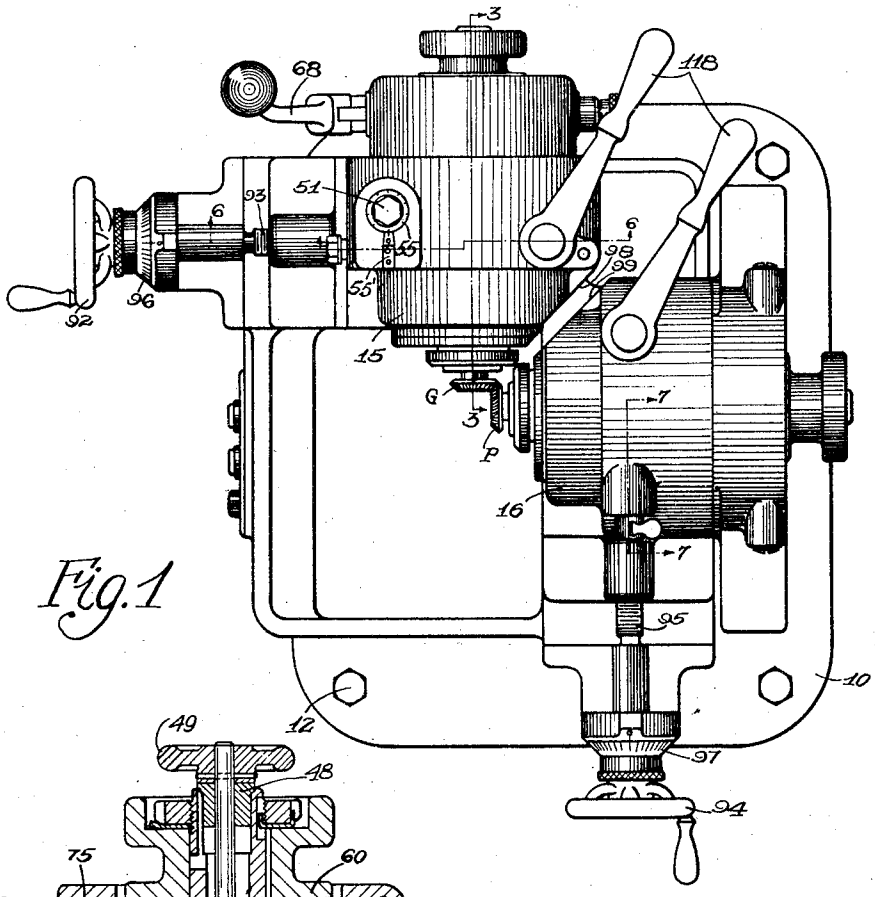


Fig. 1

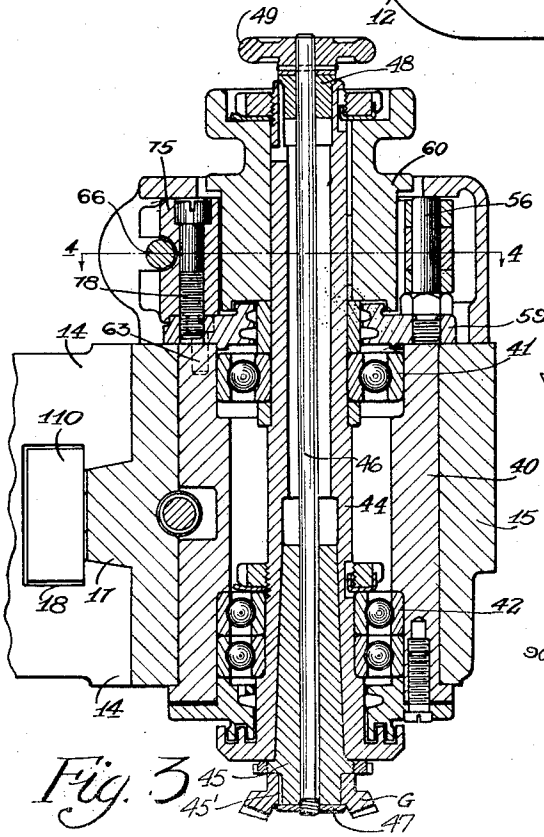


Fig. 3

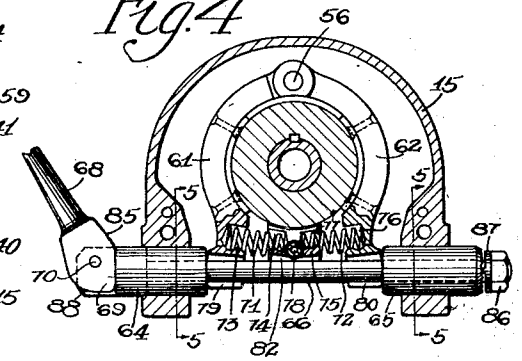


Fig. 4

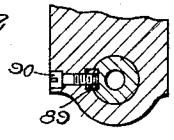


Fig. 5

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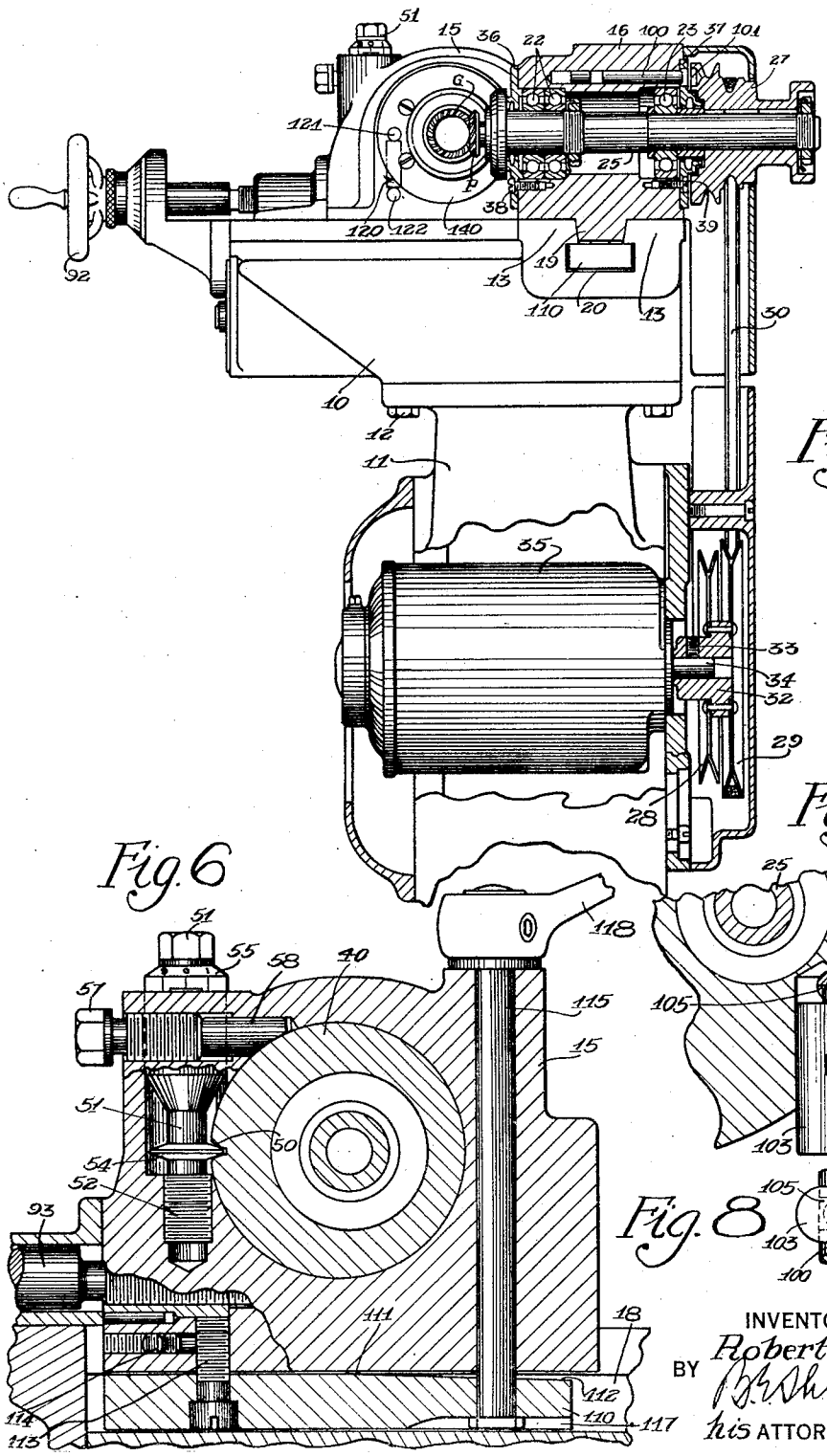


Fig. 2

Fig. 6

Fig. 7

Fig. 8

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GEAR TESTING MACHINE

Application filed September 20, 1930. Serial No. 483,266.

The present invention relates to a machine for testing gears and particularly to a machine for testing bevel and hypoid gears of very small size.

This primary purpose of this invention is to provide a simple, compact, yet efficient machine on which bevel and hypoid gears of small sizes can be given a running test under load or without load.

A further object of this invention is to provide a companion machine for small sized bevel and hypoid gear cutting machines to enable the operator to determine, from the changes required in position to secure a desired form of tooth bearing on a pair of cut gears, what changes are necessary in the setting of the cutting machine to insure that the desired form of tooth bearing will be obtained when a pair of gears are run in correct meshing position.

A still further object of this invention is to provide means whereby the maximum load under which a pair of gears is to be run may be predetermined so as to avoid any possibility of stripping the teeth of the gears when running in the load test.

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 plan view of a bevel gear testing machine constructed according to a preferred embodiment of this invention;

Figure 2 is a fragmentary side elevation of this machine, parts being shown in section;

Figure 3 is an enlarged sectional view of the driven head of the machine, the section being taken on the line 3—3 of Figure 1;

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

Figure 5 is a section on the line 5—5 of Figure 4;

Figure 6 is an enlarged sectional view through the driven head, the section being taken more or less generally on the line 6—6 of Figure 1;

Figure 7 is a fragmentary sectional view through the drive head of the machine, the section being taken on the line 7—7 of Figure 1; and

Figure 8 is a detail view looking at the end of the hand lever which operates the drive-pulley detent.

Referring to the drawings, 10 designates the base or frame of the machine, which is of generally rectangular shape as clearly shown in Figure 1. The base 10 is mounted upon a pedestal 11, which is of the proper height to bring the parts into position where they can be easily manipulated by an operator, and the base is secured to this pedestal by bolts 12.

The base is formed on its upper face with ways 13, 13, and 14, 14, respectively, and the ways 13, 13 extend at right angles to the ways 14, 14. Mounted on the base for sliding adjustment thereon in directions at right angles to one another are the two gear heads 15 and 16. The head 15 slides on the ways 14, 14 and is guided in its movement by the tongue 17 which engages in the slot 18 formed in the base 14. This slot 18 is of general T-shape for a purpose hereinafter to be described, and extends in a direction parallel to the ways 14, 14. The head 16 slides on the ways 13, 13 and is guided in its movement by a tongue 19 which engages in a slot 20 formed in the base 10. The slot 20 is of general T-shape and extends parallel to the ways 13, 13.

Journaled in bearings 22 and 23 in the head 16 is the drive spindle 25. This spindle 25 is adapted to carry the drive pinion P of the pair to be tested and this pinion is secured to the spindle in any suitable manner as, for instance, by a draw-bar and nut similar to that used to secure the gear G to its spindle as shown in Figure 3. Keyed to the spindle 25 is a step pulley 27 which can be driven at one or other of two different speeds by either the pulley 28 or the pulley 29 through the belt 30. The pulleys 28 and 29 are mounted on a hub 32 which is secured by the set screw 33 to the armature shaft 34 of the motor 35 which is mounted in the pedestal 11. To insure the utmost accuracy in the running of the spindle 25, the bearings 22 and 23 are mounted under load and labyrinth seals 36 and 37 are secured at each end of the head 16 to prevent entrance of dirt or grit into

the bearings. These seals 36 and 37 are secured to the head 16 by screws 38 and 39, respectively.

Mounted in the head 15 for rotatable adjustment therein, is a sleeve 40 and journaled in bearings 41 and 42 in this sleeve with its axis eccentric to the axis of the sleeve, is a spindle 44. The driven gear G of the pair to be tested is secured to this spindle 44 by chucking mechanism which may be of any suitable type. In Figure 3, one possible form of such a chucking mechanism is shown. Here the gear G is mounted on an arbor 45 which fits into the bore of the spindle 44. The gear G is secured to this arbor against rotation by the key 45′. A draw-bar 46 and nut 47 are used to chuck the gear on the arbor. The draw-bar is slidable in the bore of the arbor and in the bore of a block or guide 48 that has a pressed fit in the rear end of the bore of the work spindle 44. The draw-bar threads at its forward end into the nut 47 and there is a hand-wheel 49 secured to its rear end by which it may be rotated to release or draw-up the nut.

In practice, gear mountings are manufactured with a range of permissible error so that at times a pair of gears are mounted for use in position displaced from their theoretically correct running position. In testing a pair of bevel gears in a running test, it is desirable, therefore, to run them in various positions to determine the amount of adjustment that they have. The testing machine can be employed, also, as a companion machine to the cutting machine to determine the correctness of the settings of the cutting machine. In the latter case, the gears are adjusted relative to one another on the testing machine until the position of mesh is found in which they have the best form of tooth surface bearing. If this position in which the gears mesh on the testing machine is different from the position in which they were intended to mesh, the settings of the cutting machine are changed accordingly so that when other similar gears are cut, they will mesh in correct position with the desired amount of tooth surface bearing. To determine the amount of adjustment which the gears have and to use the testing machine as a check on the cutting machine, an adjustment is required which will permit displacing the gears different amounts relative to one another. The present machine is intended primarily for the testing of gears of small size and but slight adjustment is required. In the present machine a very simple means is provided for obtaining this adjustment.

The periphery of the sleeve 40 is notched at 50 (Fig. 6) and the sides of this notch have the shape of involute gear tooth profiles. The head 15 is bored and tapped to receive a stud 51. The lower end of this stud threads into the tapped recess 52 in the head while the stud has a bearing at its upper end in the head. Between the two ends there is formed on the periphery of the stud, a cylindrical rack tooth 54. This tooth engages in the groove 50 of the sleeve 40. It will be seen that when the stud is rotated, a rotary movement will be imparted to the sleeve 40 and that as the spindle 44 is journaled in the sleeve 40 eccentrically of the axis of the sleeve, the rotation of the sleeve will cause the axis of the spindle 44 to be displaced both vertically and horizontally with reference to the axis of the spindle 25. Thus, the positions of the two gears being tested can be shifted relative to one another and their axes offset relative to one another. As the projection 54 has the form of an involute rack tooth and as the sides of the notch 50 have the form of involute tooth profiles, it will be seen that for a definite amount of rotation of the stud 51, a definite rotary movement will be imparted to the sleeve 40. The stud can be very accurately graduated as at 55, therefore, to permit very accurate adjustments of the sleeve 40 and of the spindle 44 relative to the spindle 25. The graduations on the stud can be read against a pointer 55′ (Fig. 1) which is secured to the boss of the head 15 in which the stud is mounted.

The sleeve 40 can be secured in any adjusted position by threading up on the screw 57 which engages the block 58 whose inner end is formed on the arc of a circle to engage the periphery of the sleeve 40.

In testing gears by a running test, it is always desirable to test them under load. In the present machine, a very convenient means is provided for this purpose. Keyed to the gear spindle 44 (Fig. 3) is a brake-drum 60. A pair of pivoted brake-arms 61 and 62 are provided to cooperate with the brake-drum to apply a braking action resisting rotation of the spindle 44. These brake-arms are pivotally mounted upon a stud 56 which is threaded into the labyrinth guard 59 for the bearings 41 of the spindle 44. The labyrinth guard 59 is, in turn, secured to the sleeve 40 by screws 63. The arms 61 and 62 are lined with any suitable form of braking material. The arms are actuated into braking position by moving the blocks 64 and 65, which engage the free ends of the arms, toward each other. These blocks are slidably mounted in suitable bearings formed in the head 15 and are slidable on the rod 66. Pivotally mounted on the rod 66 at one end is an actuating hand-lever 68. This lever 68 is formed at its inner end with a cam surface 69 which engages the end face of the block 64. It will readily be seen that by moving the lever 68 in either direction about its pivot 70, the blocks 64 and 65 will be forced toward each other to compress the arms 61 and 62 and apply a brake-load to the spindle 44.

The springs 71 and 72 serve to urge the arms 61 and 62 constantly to released position. The spring 71 is interposed between the end wall of a socket 73 formed in the arm 61 and the end wall of a socket 74 formed in a block 75. The spring 72 is interposed between the end wall of a socket 76 formed in the arm 62 and the end wall of a socket 77 formed in the block 75. The block 75 is secured to the labyrinth guard 64 by a screw 78.

The free ends of the arms 61 and 62 are notched at 79 and 80 to engage over the rod 66 and the block 75 is similarly notched at 82. The blocks 64 and 65 are slidably mounted in the head 15 and the bottom walls of the notches 79, 80 and 82 are curved about the axis of the sleeve 40 as a center to allow of angular adjustment of the sleeve 40 to which the arms 61 and 62 are connected. The mounting of the arms 61 and 62 on the eccentric permits of a very compact arrangement of the braking mechanism.

In the case of very small gears, if too much of a brake-load were applied while the gears were running together, there would be danger of stripping the teeth of the gears. To avoid this, means is provided in the present machine which permits of definitely predetermining the amount of brake load which may be applied to a particular pair of gears during the testing. A portion 85 of the cam surface 69 of the lever 68 is made flat and the rod 66 is threaded at its free end to receive a nut 86. The block 65 is formed on the end adjacent the nut 86 with clutch teeth which are adapted to be engaged with a single clutch tooth formed on the cylindrical inner end 87 of the nut. Assuming that a pair of gears are to be tested with which care must be taken to avoid stripping, the operating lever 68 will be swung upwardly about its pivot 70 until the flat surface 85 of the cam portion 69 contacts the end of the block 64. With the lever in this position, the nut 86 can be adjusted on the rod 66 to adjust the blocks 64 and 65 a definite distance apart, definitely predetermining the maximum braking pressure which can be applied to the spindle 44 when, in testing the gears, the operating lever is swung upwardly. Before the test, the lever 68 is returned to the position shown in Figure 4 and when, in the course of the test, it is desired to apply the brake-load, it is swung so that the cam portion 85 engages the block 64 applying the predetermined brake-load. If for any reason the operator desires to apply greater load, the same can be applied by swinging the lever 68 downwardly until the cam portion 88 of the cam 69 is brought into operating position.

The blocks 64 and 65 are held against rotary movement on the rod 66 by pieces 89 (Fig. 5) which engage in slots cut longitudinally in each of the blocks and which are held in position, respectively, by screws 90. The clutch teeth formed on the adjoining ends of the nut 86 and block 65 hold the nut against rotation, then after the distance between the blocks 64 and 65 have been adjusted. In rotating the nut 86 to effect this adjustment the clutch tooth of the nut will simply ratchet over the clutch teeth of the block 65.

In testing a pair of bevel gears, the gears are ordinarily set-up initially with their axes intersecting and the sleeve 40 is accordingly set in the zero position of its adjustment, namely, the position wherein the axes of the spindle 25 and 44 lie in the same plane and are intersecting. After the gears have been chucked on their respective spindles 25 and 44, the heads 15 and 16 are adjusted to bring the gears into meshing relation. The adjustments of the two heads are effected by rotation of the hand-wheels 92 and 94, respectively, which are secured to screw shafts 93 and 95, respectively, that thread into the respective heads 15 and 16. Graduated dials 96 and 97 are provided to permit adjusting the heads accurately. For the testing of very small gears, it is necessary to bring the heads close together. To permit this to be done, the external surface of the head 15 is made flat, as indicated at 98, for the portion thereof which is contiguous to the head 16 and the external surface of the head 16 for the portion thereof which is contiguous to the head 15 is similarly made flat, as indicated at 99. The two flat surfaces 98 and 99 are inclined at an angle of 45° to the spindles 44 and 25, respectively, mounted in the two heads. With this construction, the two heads can be brought so close together as to permit testing even the very smallest of bevel gears.

When the gears have been adjusted into mesh, the machine can be started up by starting the motor 35 which rotates the pinion spindle 25 through the belt and pulley connection shown. The spindle 25 drives the spindle 44 through the meshing action of the gears P and G being tested. The gears can be shifted out of position to determine their amount of adjustment or to check up on the cutting machine by adjusting the sleeve 40 by means of rotation of the stud 51. The gears can be tested under load by moving the brake-lever 68. The amount of braking action can be predetermined beforehand by setting the nut 86 when the portion 85 of the cam 69 is engaged with the block 64 or, if the gears are not particularly delicate, the operator can judge for himself the amount of load to be applied and simply swing down the brake-lever 68 to apply more or less braking pressure by engagement of the portion 88 of the cam 69 with the block 64.

The brake can be used, also, to hold the gear spindle against rotation when chucking or dechucking the gear G. To hold the pinion spindle 25 against rotation during chucking

or removal of the pinion from the spindle, a stop-rod 100 is provided (Figs. 2, 7 and 8). This rod is adapted to be moved into engagement with a notch 101 formed in the drive-pulley 27 to lock the pulley and the pinion spindle 25 against rotation. The rod 100 is moved into locking position or out of locking position by rotating the handle 102 which is secured to a stud 103 that is formed at its inner end with a crank-pin 104 which engages in a slot 105 in the rod 100. The stud 102 is held in the head 16 by a set-screw 107.

The heads 15 and 16 are held, respectively, in any adjusted position by gibs 110, one of which is shown in Figure 6. These gibs engage in the T-slots 18 and 20, respectively. The upper faces of the gibs 110 are parallel to their lower faces for approximately half of their length but are slabbed or beveled off from the center 111 toward one end as indicated by the numeral 112 in Figure 6. Each gib is secured to its head adjacent one end by a screw 113, which is locked by a set-screw 114. A bolt 115, the head of which fits into a groove 117 in the lower face of the gib, passes through each gib near the other end of the gib. Each bolt 115 passes, also, through the corresponding head 15 or 16 and carries at its upper end a nut which is operated by a hand-lever 118. When the hand-lever 118 is rotated to tighten up on either nut, the corresponding head is clamped in its adjusted position.

The screw 113 is adjusted initially so that the gib fits the T-slot 18 or 20, as the case may be, snugly enough to hold the head 15 or 16 frictionally in position while still permitting the head to be moved on the base.

The virtue of the gibbed clamping arrangement described lies in the fact that in the case of both the head 15 and the head 16, the point 111 from which the gib is slabbed off lies not only in the central plane extending front and rear of the head but also in the central plane extending from one side to the other of the head. Thus, although the clamping bolt 115 is itself offset from the central plane, the clamping action itself is exerted in the central plane and each head can, accordingly be clamped in position by a very slight rotation of the lever 118 without any tendency to shift out of its adjusted position.

For very accurate settings of the axial position of the gear G a precision block 120 (Fig. 2) may be used. The correct block can be engaged between the pin 121 secured in the sleeve 40 and the pin 122 secured in the head 15.

While the invention has been described in connection with a machine for testing bevel gears, it will be understood that it is applicable to the testing of hypoid gears, also, and in this case the adjustment of the sleeve 40 may be employed to adjust the gear into the correct offset relation with reference to the pinion as well as to test the two in different positions. In certain aspects, also, the invention is applicable to machines for testing other types of gears in a running test as, for instance, spur gears. In general it may be said that 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 heads adjustable on the frame, a spindle journaled in one of said heads and adapted to have a gear detachably secured thereto, a sleeve mounted in the other head for rotatable adjustment therein, a second spindle adapted to have a gear detachably secured thereto and journaled in said sleeve with its axis eccentric to the axis of said sleeve, said sleeve being formed with a notch in its periphery, the sides of which are of the shape of gear tooth profiles, a toothed member mounted in the second head and engaging the notch in the periphery of said sleeve, means for moving said toothed member to rotate said sleeve, 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 heads adjustable on the frame, a spindle journaled in one of said heads, a sleeve mounted in the other head for rotatable adjustment therein, a second spindle journaled in the sleeve with its axis eccentric to the axis of said sleeve, said spindles being adapted to carry the gears to be tested, said sleeve being formed with a notch in its periphery, the sides of which are of the shape of gear tooth profiles, a member threaded into said head, a cylindrical rack tooth formed on the periphery of said member and adapted to engage the notch of said sleeve whereby on rotation of said member, the sleeve is adjusted on its axis, and means for rotating one of said spindles for rotating said gears in mesh.

3. In a machine of the class described, a frame, a pair of heads adjustable on the frame in directions at right angles to each other, a spindle journaled in one head, a sleeve mounted in the other head for rotatable adjustment therein, a second spindle journaled in said sleeve with its axis eccentric to the axis of said sleeve and angularly disposed to the axis of the first spindle, said spindles being adapted to carry the gears to be tested, said sleeve being formed with a

notch in its periphery, the sides of which are of the shape of involute gear tooth profiles, a member threaded into the second head, said member having a cylindrical involute rack tooth formed on its periphery to engage the notch of said sleeve whereby on rotation of said member said sleeve is adjusted about its axis, means adapted to be engaged with the periphery of said sleeve to secure the sleeve in any adjusted position, means for rotating one of said spindles to rotate said gears in mesh, and means for applying a brake-load to the other of said spindles.

4. In a machine of the class described, a frame having a pair of T-slots formed therein at an angle to one another, a pair of heads adjustable on the frame in directions at an angle to one another, a pair of spindles rotatably mounted in the two heads with their axes angularly disposed to one another and adapted to carry the gears to be tested, means for adjusting one of said spindles to adjust the relative positions of mesh of the two gears, means for rotating one of the spindles to rotate the gears in mesh, means for securing each head in any adjusted position on the frame comprising a gib secured to each head adjacent one end and engageable in one of the T-slots formed in the frame, said gib having its upper face beveled from a point approximately beneath the center of the head to the other end thereof, and means engaging the free end of the gib to flex said gib to clamp the head to the frame.

5. In a machine of the class described, a pair of work heads, a spindle journaled in one of said heads, a sleeve mounted in the other head for rotatable adjustment therein, a second spindle journaled in said sleeve with its axis disposed eccentrically of the axis of said sleeve, said spindle being adapted to carry the gears to be tested, a brake-drum secured to the second spindle, a pair of brake-arms secured to said sleeve and adapted to engage the periphery of said drum, means for actuating said brake arms, and means for rotating the first of said spindles to rotate said gears in mesh.

6. In a machine of the class described, a pair of work heads, a spindle journaled in one of said heads, a sleeve mounted in the other head for rotatable adjustment therein, a second spindle journaled in said sleeve with its axis disposed eccentrically of the axis of said sleeve, said spindles being adapted to carry the gears to be tested, means for rotating the first of said spindles to rotate said gears together, a brake-drum secured to the second spindle, a pair of brake arms pivotally mounted on said sleeve and adapted to engage the periphery of said drum, spring means normally holding said arms in released position, and means for actuating said arms into engagement with the drum comprising a pair of blocks slidably mounted in said second-mentioned head and adapted to engage, respectively, the free ends of said arms, a rod on which the blocks are slidably mounted, and means for forcing said blocks together.

7. In a machine of the class described, a pair of work heads, a pair of spindles, one of which is journaled in each work head, and each of which is adapted to carry a gear, means for rotating one spindle to rotate the gears in mesh, a brake-drum secured to the other spindle, a pair of brake-arms pivotally mounted in the corresponding head and adapted to engage the periphery of said drum, and means for actuating said arms into braking position comprising a pair of blocks, one of which engages the free end of each arm, a rod on which said blocks are slidable, an actuating member pivotally mounted on said rod and provided with a peripheral cam surface adapted to engage an end face of one of said blocks to control the distance between said blocks, one part of said cam surface being flat, and means for adjusting said blocks on said rod to predetermine the distance between said blocks when the flat portion of the cam surface of the actuating member is in engagement with the adjacent block.

8. In a machine of the class described, a pair of work heads, a spindle journaled in one head, a sleeve rotatably adjustable in the other head, a second spindle journaled in the sleeve with its axis eccentric to the axis of the sleeve, said two spindles being adapted to carry the gears to be tested, means for rotating the first mentioned spindle to rotate the gears in mesh, and means for applying a brake-load to the gears comprising a brake-drum secured to the second mentioned spindle, a pair of brake arms pivotally mounted on the sleeve and adapted to engage the periphery of said drum, a pair of blocks engageable with the free ends of said arms and slidable in bearings in said second mentioned head, a rod on which the blocks are slidably mounted, said arms being slotted at the free ends to engage over said rod and permit angular adjustment of the sleeve without disengagement of the arms from said rod, and an actuating lever pivotally mounted on said rod having a cam surface formed thereon to engage the end of one of said blocks.

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