Sept. 23, 1952 C. T. RHODES 2,611,221

APPARATUS FOR PRECISION GRINDING

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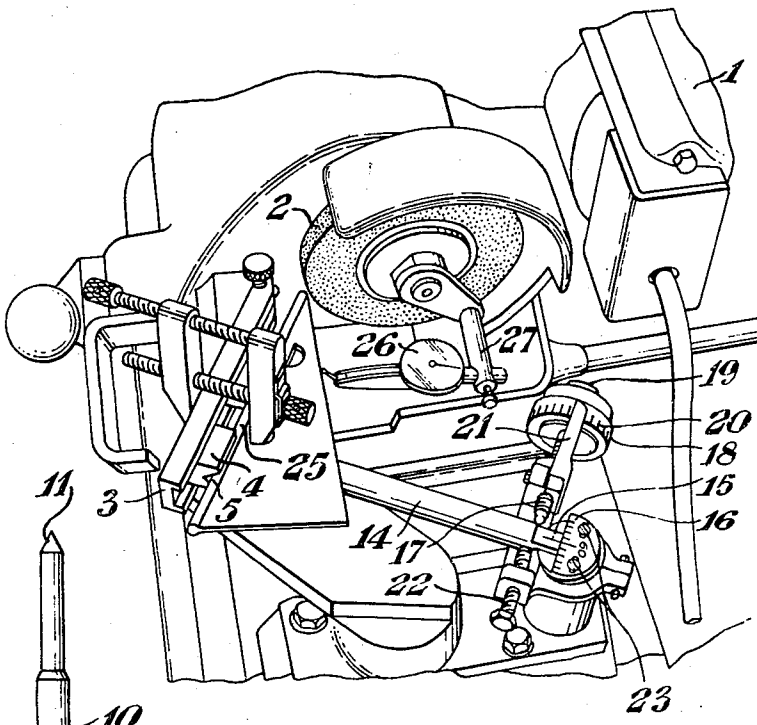

Fig. 1.

Fig. 2.

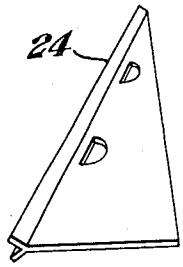

Fig. 3.

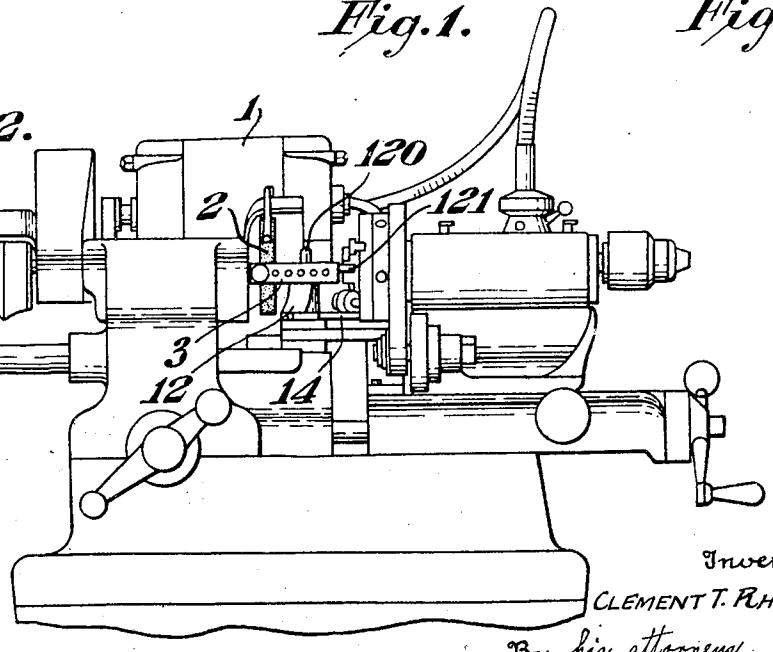

Fig. 4.

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APPARATUS FOR PRECISION GRINDING

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4 Claims. (Cl. 51—103)

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This invention relates to apparatus for precision grinding and more particularly for the precision grinding of parts which are required to have an accurately ground, tapered, circular sectioned surface which is accurately tapered to a required angle and is accurately concentric with a shank or other circular sectioned non-tapered surface of said part. The primary application of the invention is to the precision grinding of the needles of the valves of diesel engine fuel injection pumps or atomisers and of so-called grinding laps for truing the seats of such valves.

The well known diesel engine fuel injection pumps and atomisers now in widespread use include needle valves the seats of which are required to be of a slightly different angle (say, half a degree) from that of the needle. For example, it is common practice in atomiser needle valves to make the angle of the needle 60° and the angle of the seat 59½° the difference of ½° being adopted to ensure the necessary narrow ring-like contact. Because of this difference of angle, slight as it is, it is not possible to grind the needle directly in to the seat as is done, for example, with internal combustion engine poppet valves. The usual practice therefore is to grind the seats by means of a grinding lap of the correct seat angle. Owing to the high degree of accuracy required and in particular owing to the high degree of concentricity required between the tapered end of such a lap and the body or shank thereof, the grinding of such laps presents a quite serious problem and has hitherto had to be done by more or less expensive and complex grinding machinery. A similarly difficult problem arises in connection with the grinding of the needles themselves. Indeed, hitherto, when a needle or lap has been required to be ground it has had to be done at the factory making the pump or atomiser in question, the precision required being beyond the capabilities of most ordinary workshops—especially in remote or country districts. This is a serious practical defect since, of course, these needles and valve seats are subjected to considerable wear and have to be reground and trued fairly frequently. The present invention seeks to provide improved apparatus for grinding which shall enable devices such as the laps and needles above mentioned to be easily and accurately ground.

The present invention is primarily intended for use in conjunction with a machine as described in U. S. application Serial No. 211,247

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to enable such a machine to be set up accurately to grind a needle or lap to a predetermined angle.

The said co-pending application describes a machine for the precision grinding of an article required to have a circular sectioned part accurately ground in accurate concentricity with another circular sectioned part, said machine comprising a grinding wheel, a block having a hardened recess—preferably a V recess—adapted to receive the former part with the latter in contact with the grinding wheel, and a friction wheel arranged to press said latter part in said recess and simultaneously to rotate it in the recess by friction drive transmitted thereto.

According to this invention the recessed block in a machine as above set forth is carried in an angularly adjustable member which is associated with an index and scale, said scale and index being relatively adjustable with respect to one another and there is provided for setting up the machine with the block in a desired angular relationship with the axis of the grinding wheel a sector or triangularly shaped gauge (hereinafter termed "taper gauge") of predetermined apex angle one edge of which is arranged to lie in the recess in the block or alternatively against the work when in the block and another edge of which lies, when the carrier member is correctly angularly adjusted to the apex angle parallel to the line of continuation of the axis of the grinding wheel whereby by temporarily fitting a so-called micrometer gauge clock on a member fitted parallel to said axis and traversing the work head and with it the taper gauge in a direction parallel to the grinding wheel axis, accurate angular adjustment may be obtained by adjusting until the reading of the clock is constant during such traverse with the "feeler member" of the clock in contact with the second mentioned edge of the taper gauge. When this has been done the angular setting will be that of the apex angle of the sector gauge. The index and scale may then be adjusted to read that angle, the adjustment fixed, and the index and scale used to adjust to any angle within the range of reading. The expression "sector shaped" or "triangularly shaped" as applied to the taper gauge is employed in a wide sense and is not intended to limit the invention to taper gauges which are of sector or triangle shape in the strict geometrical sense. Any gauge of generally flat or approximately flat form with two main straight edge lengths at a predetermined apex angle to one another is sector shaped or triangularly

shaped gauge within the meaning of this specification even though, for example, the said edge lengths do not meet at a point.

The invention accordingly provides a taper gauge having two edges which are inclined to one another at the angle desired in the taper. One of these edges may be splayed so that in section it provides a V which is more or less a mirror image of the V in the work block so that in use this V may be positioned to lie against the shank of a needle or lap to be ground and which is placed in the work block. Alternatively the said edge may be made of part cylindrical section corresponding to the section of the shank of a needle or lap to be ground so that the arcuate edge of the gauge can be placed, instead of the work, in the V of the block.

The invention is illustrated in the accompanying drawings in which Figure 1 is a perspective view, Figure 2 is a grinding lap, Figure 3 shows another form of template, and Figure 4 is an elevation of the whole machine.

Referring to the drawings the machine therein shown is generally in accordance with the showing in my co-pending application Serial No. 211,247 and comprises a motor 1 driving an emery or other grinding wheel 2, a work holder 3 carrying a block 4 having a hardened V recess 5 in which the shank of the work to be ground may be placed, and a swivel work head adapted to carry and to drive a shaft 121 upon which is a rubber or similar disc or wheel 120 which is adapted to press the shank of the work into the block and simultaneously rotate said work, the whole arrangement being such that the part of the work to be ground is held against the grinding wheel and rotated during the grinding by friction drive transmitted to the shank. The swivel work head shaft and rubber wheel are driven from the motor 1 in a manner which need not be described here, being fully described in my co-pending application referred to. A typical example of work to be ground is shown in Figure 2 which illustrates a grinding lap having a shank 10 and a concentric tapered end 11 which must be accurately ground. The work holder is angularly adjustable about a vertical axis as set forth below so that the angle at which the work is presented to the grinding wheel may be adjusted as desired. The adjustment can be locked in any convenient way, e. g. by a clamp, by operating a locking handle.

In applying the present invention to a precision grinder as above described the work holder is angularly adjustable about the vertical pivot axis 12 and is provided with a radial arm 14 the other end of which has an index mark 15 reading against a scale 16. The position of rotation of the arm 14 is determined by an abutment micrometer screw 17 on which is a micrometer head 18 which can be adjustably rotated with respect to the screw and locked in any position by a lock nut 19. The head 18 carries a scale 20 reading against a mark 21. For example the main scale 16 may be marked in degrees and the scale 20 in minutes, one revolution of the head (when locked to the screw 17) giving the appropriate alteration of the position of the arm. A second abutment screw 22 enables the arm to be pressed up against the screw 17 after adjustment thereof. The main scale is adjustable in position over a small angle, being held by screws 23 which pass through slotted holes in the scale member. There is also provided for use in setting up the machine a taper gauge in the form of a generally flat metal plate; one edge may be splayed out into a V as shown at 24 in Figure 3 so that it will rest against the shank of a lap or needle in the V of the block or may be cylindrically formed as shown at 25 in Figure 1 so that it can rest directly in the V in place of a lap or needle.

The taper gauge used in any particular case is chosen to have an included angle between the two angularly related straight edges which is exactly a predetermined known angle. In use a so-called micrometer gauge clock 26 is mounted temporarily on a member 27 temporarily attached to the spindle of the grinding wheel and the taper gauge is placed with the splayed V edge or the cylindrical edge on the shank of the work in the V of the block or in the V of the block (as the case may be). The work holder is then angularly adjusted until the plain edge of the taper gauge is parallel to the axis of the grinding wheel. This may be tested for by adjusting the micrometer gauge clock until its "feeler point" is in contact with the plain edge of the taper gauge and then moving the work head in a direction parallel to the grinding wheel axis by the normally provided longitudinal traversing mechanism operated by the normally provided handle (not shown) which moves the work head along the bed of the grinding machine. When the work holder is correctly adjusted to its proper position the plain edge of the taper gauge will slide along the feeler point and the reading at the gauge clock will remain constant during this sliding action. When this has been done the angular setting will correspond to the apex angle of the taper gauge and the main scale 16 and micrometer head 18 may then be adjusted until the scales 16 and 20 jointly read this angle correctly. They may then be locked and the machine is set up ready for use and can be adjusted, by means of the scales to grind any angle within the scale range.

The invention provides two most important practical advantages. The first is that it enables the grinding machine to be correctly set up either against the work when actually in position or against the work block. The second advantage is that the operator can readily test for faults such, for example, as grinding wheel bearing faults in the machine itself.

In practice the invention greatly facilitates accurate grinding and enables what would otherwise be the difficult and lengthy operation of setting up the grinding machine to grind a taper of predetermined angle to be performed quickly and with comparative ease by comparatively unskilled and semi-skilled labour.

I claim:

1. A machine for the precision grinding of an article required to have a circular sectioned part accurately ground in concentricity with another circular sectioned part comprising a grinding wheel, a recessed block having a hardened recess adapted to accommodate the second mentioned part with the first mentioned part in contact with said grinding wheel, an angularly adjustable member carrying said block and adjustable about an axis perpendicular to the axis of the grinding wheel, said member having a radial arm, a friction engagement wheel for engaging said second mentioned part and holding it in the recess, means for rotating said friction wheel to rotate said second mentioned part in said recess, means for locking said member in any position of adjustment, scale and co-operating index means one of which moves with said member and indi-

cates the movement thereof against the other, and means for adjusting and fixing in any position of adjustment the position of one of said means to adjust the scale reading for any given position of adjustment of said member, said scale and co-operating index means including an index on said arm and reading against an angularly adjustable but otherwise fixed scale, a micrometer screw, said arm abutting against the end of said micrometer screw, a drum head carried by said screw provided with a fine reading scale reading against a second index, said head being rotatably adjustable on said screw and provided with means for locking the same to the screw in any position of relative adjustment.

2. A machine as claimed in claim 1 wherein the end of the arm abuts against the end of the micrometer screw and is positioned between said end of said micrometer screw and the end of a second screw.

3. A machine as claimed in claim 1 wherein the angularly adjustable scale is adjustable over a small angle and is held by screws passing through slots in the member on which said scale is marked to permit said member to be locked

in any position of adjustment within the range determined by said slots.

4. A machine as claimed in claim 1 wherein the end of the arm abuts against the end of the micrometer screw and is positioned between said end of said micrometer screw and the end of a second screw, the angularly adjustable scale being adjustable over a small angle and held by screws passing through slots in the member on which said scale is marked to permit said member to be locked in any position of adjustment within the range determined by said slots.

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