July 26, 1949. M. H. ARMS 2,477,508

INTERNAL SIZING MECHANISM

Filed June 2, 1945 3 Sheets-Sheet 1

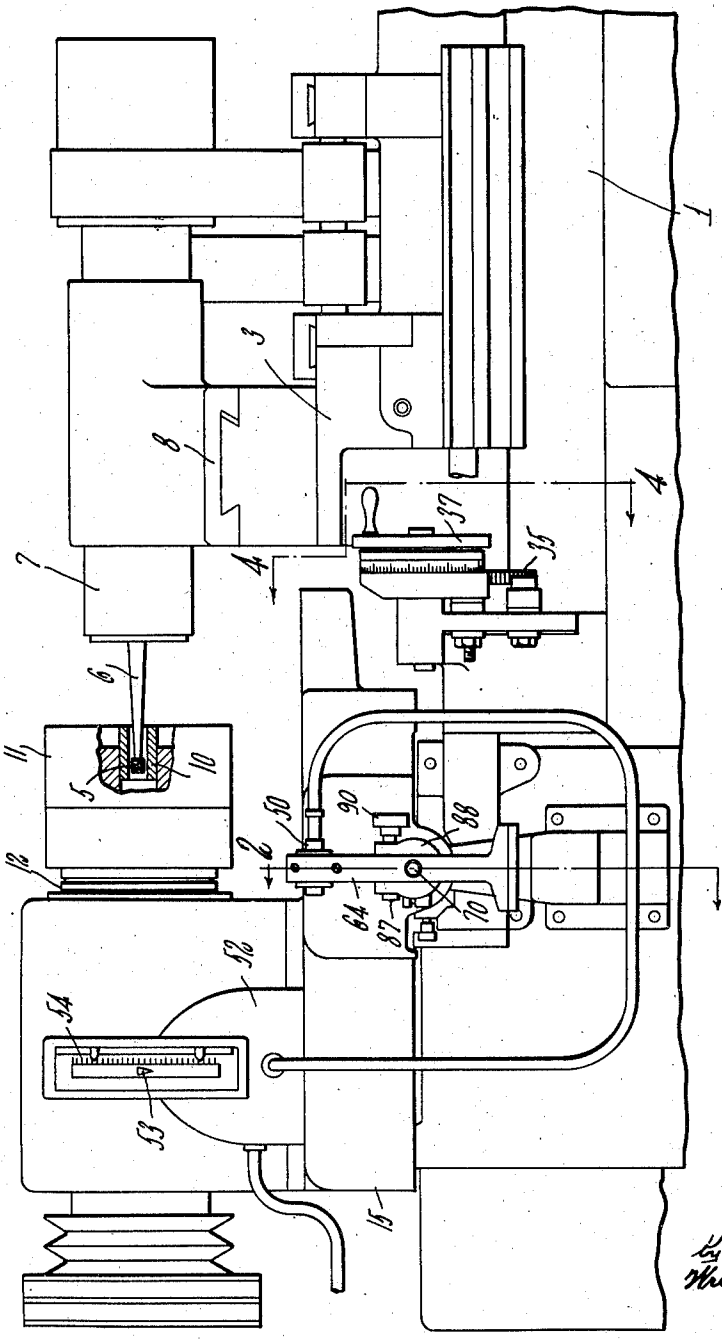

Fig. 1.

Inventor
Merton H. Arms
by Wright Brown Quinby & Clay
Attys.

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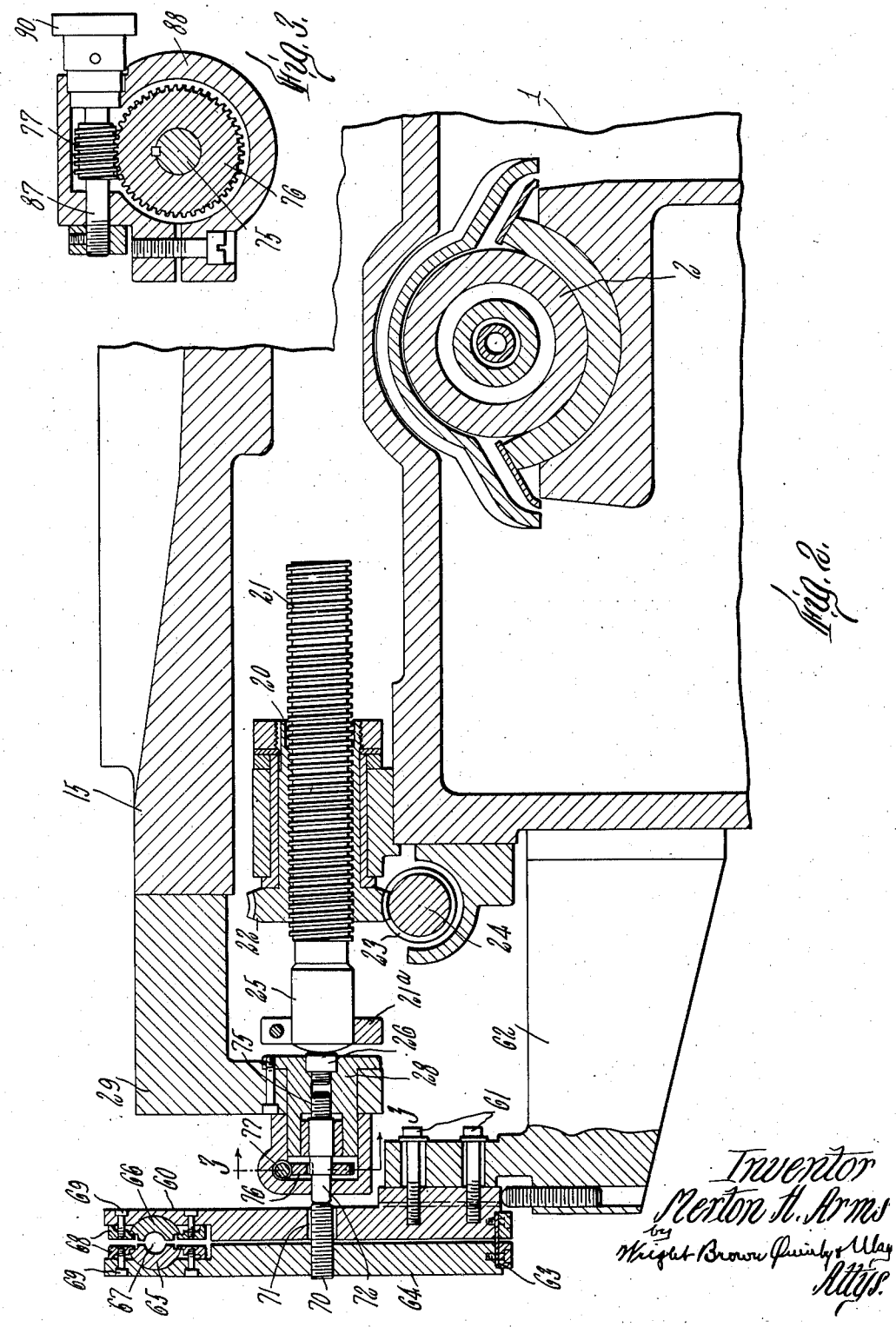

July 26, 1949. M. H. ARMS 2,477,508

INTERNAL SIZING MECHANISM

Filed June 2, 1945 3 Sheets-Sheet 3

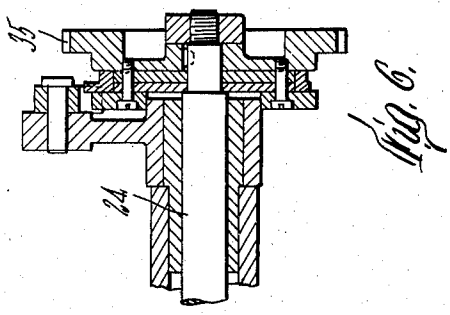

Fig. 6.

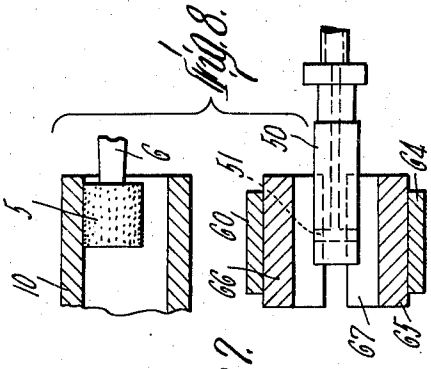

Fig. 8.

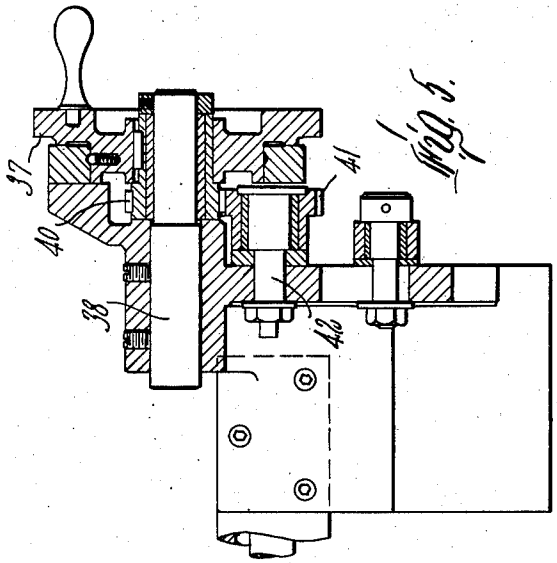

Fig. 5.

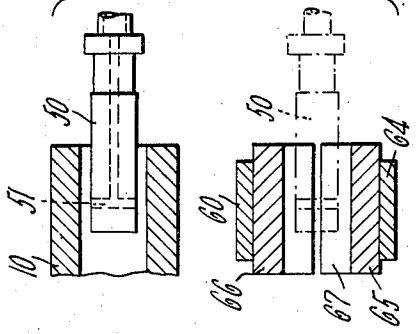

Fig. 7.

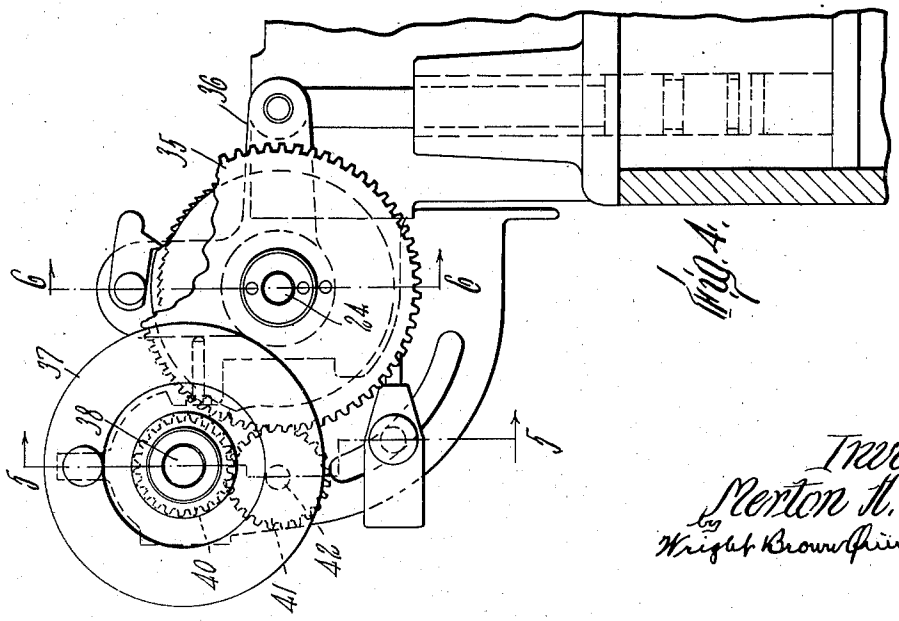

Fig. 4.

Inventor
Merton H. Arms
by
Wright Brown Quinby & Clay
Attys.

Patented July 26, 1949

2,477,508

UNITED STATES PATENT OFFICE

2,477,508

INTERNAL SIZING MECHANISM

Merton H. Arms, Springfield, Vt., assignor to Bryant Chucking Grinder Company, Springfield, Vt., a corporation of Vermont

Application June 2, 1945, Serial No. 597,346

7 Claims. (Cl. 51—165)

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This invention relates to internal sizing mechanism and has for an object to provide a mechanism which will facilitate the internal sizing of work to very great accuracy.

A sizing gage capable of measuring internal sizes with very great accuracy comprises a hollow stem having orifices along its sides, this stem when supplied with air under pressure and inserted within the work showing on a suitable indicator operatively connected thereto size variations much magnified to the millionth part of an inch.

In accordance with the present invention the hole in the work is gaged by such an instrument somewhat before the hole reaches the desired final size. The gage is then placed in a variable size orifice which is so mounted as to be gradually opened as the tool, such as a grinding wheel, is fed into the work, the size of the orifice being first adjusted relative to the feeding mechanism until the indicator registers the same as it did when gaging the work. This indication will show the extent of feed necessary to bring the work to the desired size, and as the feed continues up to that point, the gage, remaining in the variable orifice which continues to open as the feed continues, registers nearer and nearer to the desired indication. The indicator and the feed mechanism may be checked against each other, and when close to the desired point, the actual size of the hole may be checked again with the gage, and if necessary the feed and orifice may be further adjusted until the work is brought to final size.

For a more complete understanding of this invention, reference may be had to the accompanying drawings in which

Figure 1 is a fragmentary front elevation of an internal grinding machine equipped in accordance with this invention.

Figure 2 is a detail sectional view to a larger scale on line 2—2 of Figure 1.

Figure 3 is a detail sectional view on line 3—3 of Figure 2.

Figure 4 is a detail sectional view to a larger scale on line 4—4 of Figure 1.

Figures 5 and 6 are detail sectional views on lines 5—5 and 6—6, respectively, of Figure 4.

Figures 7 and 8 are diagrammatic views showing the work piece and orifice in corresponding conditions, the gage being shown in full lines in the work and in dotted lines in the orifice, Figure 8 showing the work nearer to final size than Figure 7, the difference, however, being much exaggerated.

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This invention is shown as embodied in an internal grinding machine of the type shown in the Arms Patent No. 2,310,338, granted February 9, 1943, for Metal working machine.

This machine comprises a bed 1 having a hollow axially movable bar 2 to which is secured a carriage 3 which supports an internal grinding wheel 5. This wheel 5 is mounted on a spindle 6 journaled in a grinding head 7 on a cross slide 8, but for the purpose of this invention the head 7 is given no lateral motion, but is merely moved axially with the bar 2. The work to be ground at 10 is carried by a suitable chuck 11 on a rotary spindle 12, this spindle being carried by a work head on a carriage 15 supported for motion transverse to the bar 2, and a feed motion between the wheel and the work is produced by this motion of the carriage 15. As shown in the Arms patent, to which reference has been made, and as shown in Figure 2, this feeding motion is produced by rotation of a nut 20 on a screw 21, the screw being held against rotation by a stationary clamping collar 21*a*. The nut 20 has a worm wheel portion 22 with which meshes a worm 23 on a feed shaft 24. The forward end of the screw 21 has a head 25 which bears against an abutment screw 26 threaded in a plug 28 carried by an apron 29 depending from the front edge of the carriage 15, suitable means being provided, such as a spring (not shown), for holding the abutment 26 into contact with the forward end of the screw 21. Thus as the nut 20 is rotated, the screw is moved axially and the carriage 15 moves correspondingly. The right hand end of the worm shaft 24 is provided with a feed wheel 35 to which is connected the automatic feed including an hydraulically operated rock lever 36 as shown in the Patent No. 2,310,338 to which reference has been made. However, it is desirable, at least for the final portion of the grinding, that a finer feed be produced with the close tolerances sought for in accordance with this invention, so that the feed is accomplished by hand and through rotation of a hand wheel 37 journaled on a shaft 38 and connected to the gear 35 through the small gear 40 keyed to the hand wheel 37, and an idler 41 journaled on the stub shaft 42, and meshing with the large gear 35. The automatic feed may be used, if desired, for the rough sizing.

For the purpose of measuring the hole in the work when the grinding wheel is retracted, an air gage may be employed, this air gage comprising a hollow stem 50 shown in Figure 7 provided with lateral orifices 51. This stem is in-

serted into the work as shown in the upper portion of Figure 7, and air under pressure is directed to the interior of the stem to escape between it and the inner wall of the work. The change in pressure of the air, due to variations of the space between the stem and the interior of the work, is registered on an indicator shown generally at 52 in Figure 1 and which may be mounted on any suitable part of the machine. The particular gage shown is one made by Sheffield Corporation, of Dayton, Ohio, and per se is not my invention. A pointer 53 takes a position along a scale 54 corresponding to the size of the hole in the work when the gage stem is placed therein and the indications are graduated in very small fractions of an inch, such as millionths.

In order to employ the gage in accordance with this invention, a variable orifice, the size of which varies in accordance with the feed position of the carriage 15, is employed, as shown in Figure 2. This orifice is formed between a fixed or stationary member 60 secured to the bed of the machine as by screws 61 carried by a fixed bracket 62 and a movable member 64 fulcrumed as on a leaf spring 63 to the fixed member 60. This member 64 extends adjacent to the member 60 and the confronting faces of the members 60 and 64 remote from the fulcrum spring 63 are formed to have secured thereto opposed elements 65 and 66 recessed opposite to each other to form an orifice 67 variable in width in accordance with the relative positions between the members 60 and 64. These elements 65 and 66 are adjustably clamped in position by the clamping blocks 68, and screws 69, and are arranged to be removable so that other elements defining orifices of different basic sizes may be applied thereto as desired. The movable member 64 carries a screw 70 which extends freely through a hole 71 in the fixed member 60 midway between the axis of the orifice and the fulcrum spring 63 and abuts against the end of a shaft 72 journaled in the plug 28 and having its inner end, as at 75, threaded thereinto. This shaft 72 with its threaded connection in the block 28 provides an extensible connecting link of adjustable length between the movable member 64 and the carriage 15. Keyed on the shaft 72 is a worm wheel 76 with which meshes a worm 77 carried by a shaft 87 (see Figure 3) journaled in a casing 88 which houses the outer end of the plug 28. One end of the worm shaft 87 carries a knurled head 90 by which it may be rotated, thus to adjust the angular position of the shaft 72 and through its threaded connection with the plug 28, the angular position of the movable member 64 relative to the fixed member 60 and the lateral dimension of the variable orifice for any given position of the work carriage 15.

With elements 65 and 66 chosen in accordance with the desired internal size of the work piece and placed in position, when the work piece has been brought to near finished size, its internal diameter is gaged by inserting the gaging element 50 into the work while the wheel is retracted, and the indication of the pointer 53 is noted. The gage stem 50 is then removed from the work and a gage stem, preferably the same stem 50, though a second similar stem associated with the indicator might be used, is placed within the variable orifice formed by the parts 65 and 66 with the air escape openings therein positioned laterally. The knurled wheel 90 is then adjusted to vary the spacing of the upper ends of the members 64 and 60 until the reading of the indicator pointer 53 is the same as that shown by the indicator when the gage stem was in the work.

Grinding then proceeds while the work is fed slowly, this feeding action not only feeding the work relative to the grinding wheel, but also causing the orifice between the parts 65 and 66 to increase in size double the extent of feed just as the hole in the work increases in size by double the amount of feed since this grinding wheel removes stock in all radial directions. As the gage stem is left in the orifice during further grinding, the indicator pointer 53 shows progressively the amount by which the width of the orifice is increasing as the grinding proceeds, this corresponding to the increasing diameter of the hole in the work, the feed of the carriage 15 not only feeding the work and wheel relatively but also widening the orifice.

The feed mechanism as shown has fine micrometer graduations thereon which can be checked against the indications of the pointer 53 of the gage as the grinding proceeds. If desired, when the work has been brought further toward final size, its internal size may be tested again by inserting the gage stem therein. This new gage reading may then be checked against the indications on the feed wheel, and the indications of the size of the variable orifice after the stem has been returned thereto, additional adjustment of the knurled wheel 90 being then made, if desired, until finally the work piece is reduced to the desired dimension within the very close tolerance limits required.

From the foregoing description of an embodiment of this invention, it should be evident to those skilled in the art that various changes and modifications might be made without departing from the spirit or scope of this invention.

I claim:

1. In combination with a grinding machine having a support for internal work, a grinding wheel, and means for feeding the wheel and support relatively, of a gage including a gaging element constructed to be inserted into an orifice and an indicator for indicating the size of such orifice when such element is placed therein, such a gaging element being arranged for insertion in a hole to be ground in the work, mechanism defining an orifice of variable size, means operatively connecting said mechanism and feeding means to increase the size of said orifice in accordance with the feeding relation between the work support and wheel in the same relation as the size of the hole in the work increases as the grinding operation proceeds, and means for adjusting the size of said variable orifice independently of said feed mechanism to permit said orifice to be adjusted to give the same reading on said indicator when said element is therein as when such an element associated with said indicator is within the hole in the work.

2. In combination with a grinding machine having a support for internal work, a grinding wheel, means for rotating said wheel, means for relatively moving said wheel and work to cause said wheel to grind a cylindrical hole in the work, said relative moving means including mechanism for feeding the wheel and work relatively, of a stationary member, a member movable relative to said stationary member, and operative connections from said feeding mechanism to said movable member to cause the feeding actuation of said mechanism to move said movable member

away from said stationary member, said members having confronting face portions oppositely recessed to form together an orifice variable in width in accordance with the feed position of said mechanism, whereby said orifice increases in size as the size of the hole in the work increases, the measurement of such orifice size thus giving an indication of the hole size without requiring access to said hole.

3. In combination with a grinding machine having a support for internal work, a grinding wheel, means for rotating said wheel, means for relatively moving said wheel and work to cause said wheel to grind a cylindrical hole in the work, said relative moving means including mechanism for feeding the wheel and work relatively, of a stationary member, a member movable relative to said stationary member, operative connections from said feeding mechanism to said movable member to cause the feeding actuation of said mechanism to move said movable member away from said stationary member, said members having confronting face portions oppositely recessed to form together an orifice variable in width in accordance with the feed position of said mechanism, and means for adjusting said operative connections to adjust the spacing of said members corresponding to any specific feed condition of said mechanism, whereby said orifice increases in width as the size of the hole in the work increases, the measurement of such orifice width giving an indication of the hole size without requiring access to said hole.

4. In combination with a grinding machine having a support for internal work, a grinding wheel, means for rotating said wheel, means for relatively moving said wheel and work to cause said wheel to grind a cylindrical hole in the work, said relative moving means including mechanism for feeding the wheel and the work relatively, of a stationary member, a movable element hinged to said stationary member, opposed elements secured to said members and spaced from said hinge defining an orifice of variable width depending on the angular relationship between said members, said movable member being biased toward said stationary member, and operative connections between said movable member and feed mechanism causing the spacing of said members to be controlled by the position of said feed mechanism, whereby measuring of such spacing provides a measurement of the size of the hole in the work.

5. In combination with a grinding machine having a support for internal work, a grinding wheel, means for rotating said wheel, means for relatively moving said wheel and work to cause said wheel to grind a cylindrical hole in the work, said relative moving means including mechanism for feeding the wheel and work relatively, of a stationary member, a movable member, a leaf spring hinging said movable member to said stationary member, opposed elements secured to said members spaced from said spring and together defining an orifice of variable width depending on the angular relationship between said members, said movable member being biased toward said stationary member by said leaf spring, operative connections including an extensible link engaging said movable member connecting said movable member and feed mechanism and causing the spacing of said elements to be controlled by the position of said feed mechanism, and means for adjusting the length of said link to thereby

adjust the relation between the spacing of said members and the position of said feed mechanism, measuring of the spacing of said member providing a measurement of the size of said hole.

6. In combination with a grinding machine having a support for internal work, a grinding wheel, means for rotating said wheel, means for relatively moving said wheel and work to cause said wheel to grind a cylindrical hole in the work, said relative moving means including mechanism for feeding the wheel and work relatively, of a stationary member, a movable member adjacent to said stationary member, a leaf spring hinging said movable member to said stationary member at one end of each, opposed elements secured to said members spaced from said spring and together defining an orifice of variable width depending on the angular relationship between said members, said movable member being biased toward said stationary member by said spring, said stationary member having a hole therethrough midway between said spring and the axis of said orifice and transverse to the pivotal axis of said spring, a link extending loosely through said hole and engaging said movable member, means adjustably securing said link to said feed mechanism, said link causing the spacing of said elements to be controlled by the position of said feed mechanism, and means for adjusting said securing means to adjust the spacing of said elements corresponding to a position of said mechanism whereby measurement of such spacing provides a measurement of the size of said hole.

7. In combination with a grinding machine having a support for internal work, a grinding wheel, and means for feeding the wheel and support relatively, of a gage including a gaging element constructed to be inserted into an orifice and an indicator for indicating the size of said orifice when said element is positioned therein, such a gaging element being arranged for insertion in a hole to be ground in the work, mechanism comprising a pair of members relatively movable from and toward each other and defining between them an orifice of variable size, means for so relatively moving said members connected to said feeding means for simultaneous actuation therewith to increase the size of said orifice between said members at the same rate as the size of the hole in the work increases as the grinding operation proceeds, and means for adjusting said relative moving means independently of said feeding means to permit said orifice to be adjusted to give the same reading on said indicator when said element is therein as when such an element associated with said indicator is within the hole in the work.

MERTON H. ARMS.

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