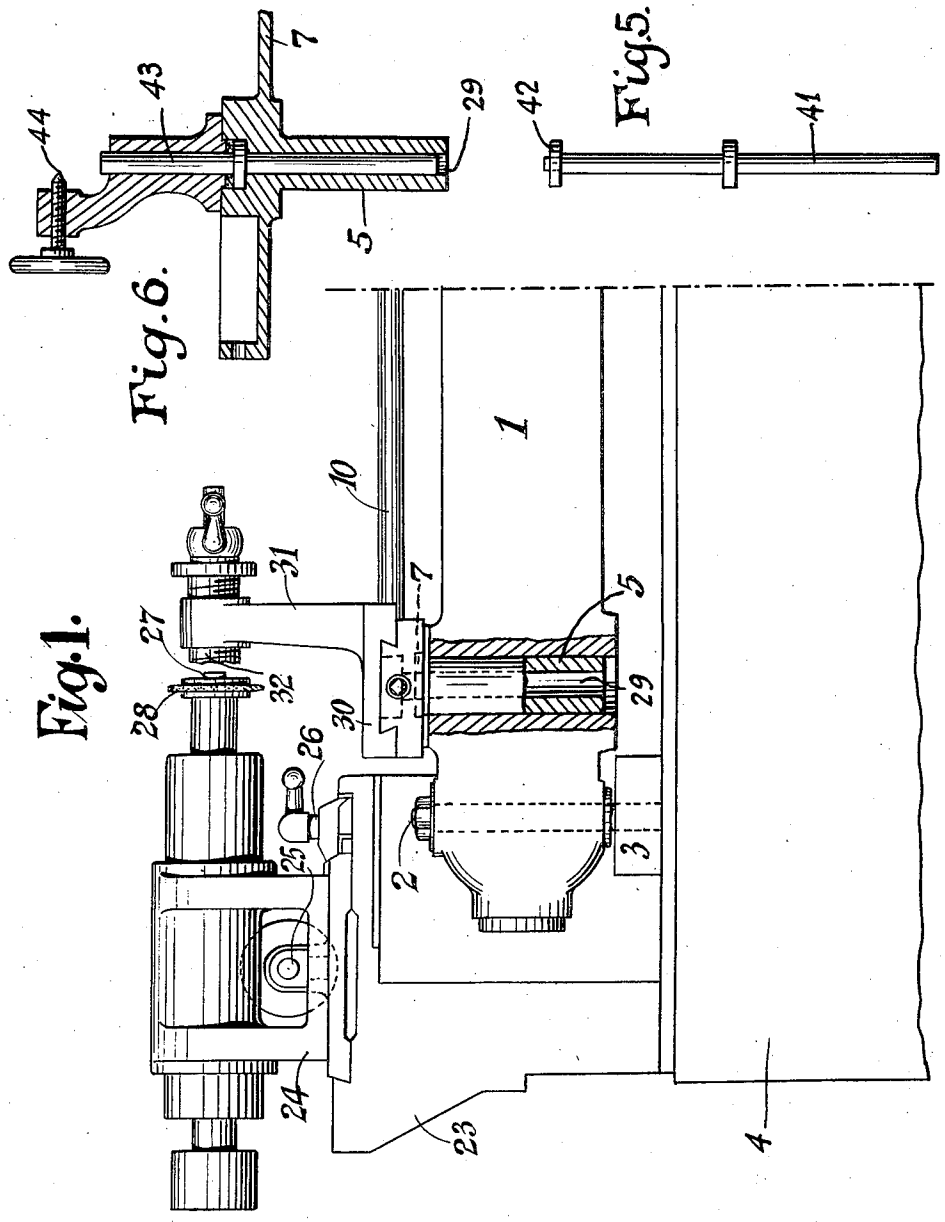
Aug. 29, 1939. C. DAY 2,171,211

MACHINE FOR GRINDING ARTICLES TO PREDETERMINED FORMS

Filed April 22, 1938 4 Sheets-Sheet 1



Inventor.
Charles Day.

per Ferdinand Broeder Bonhardt
Attorney

Aug. 29, 1939. C. DAY 2,171,211

MACHINE FOR GRINDING ARTICLES TO PREDETERMINED FORMS

Filed April 22, 1938 4 Sheets-Sheet 2

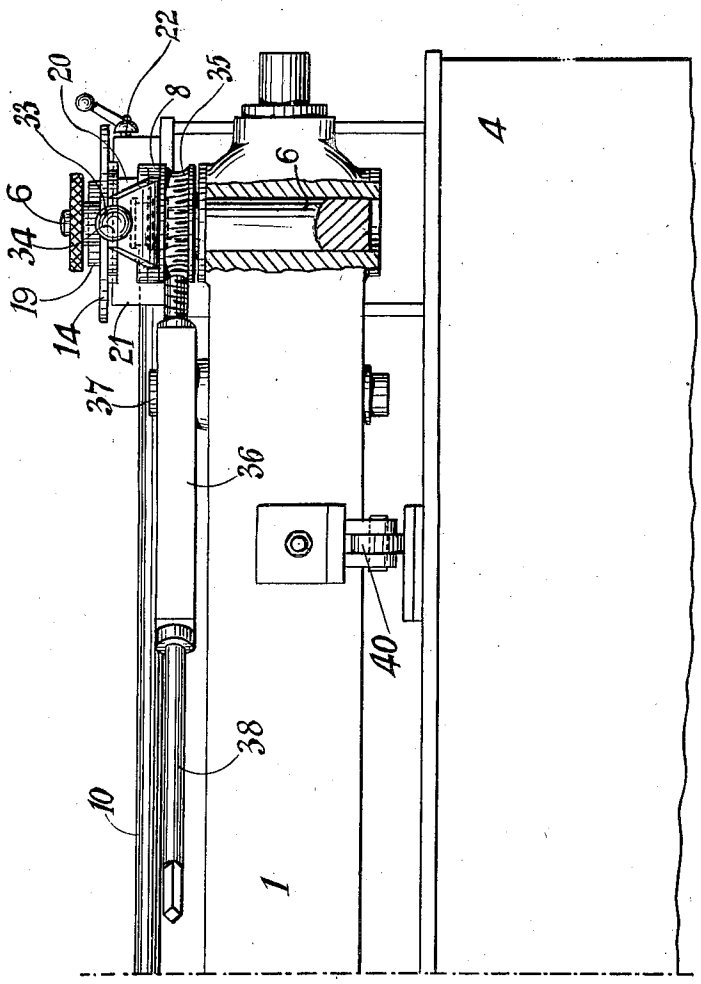


Fig. 2.

Inventor:
Charles Day.

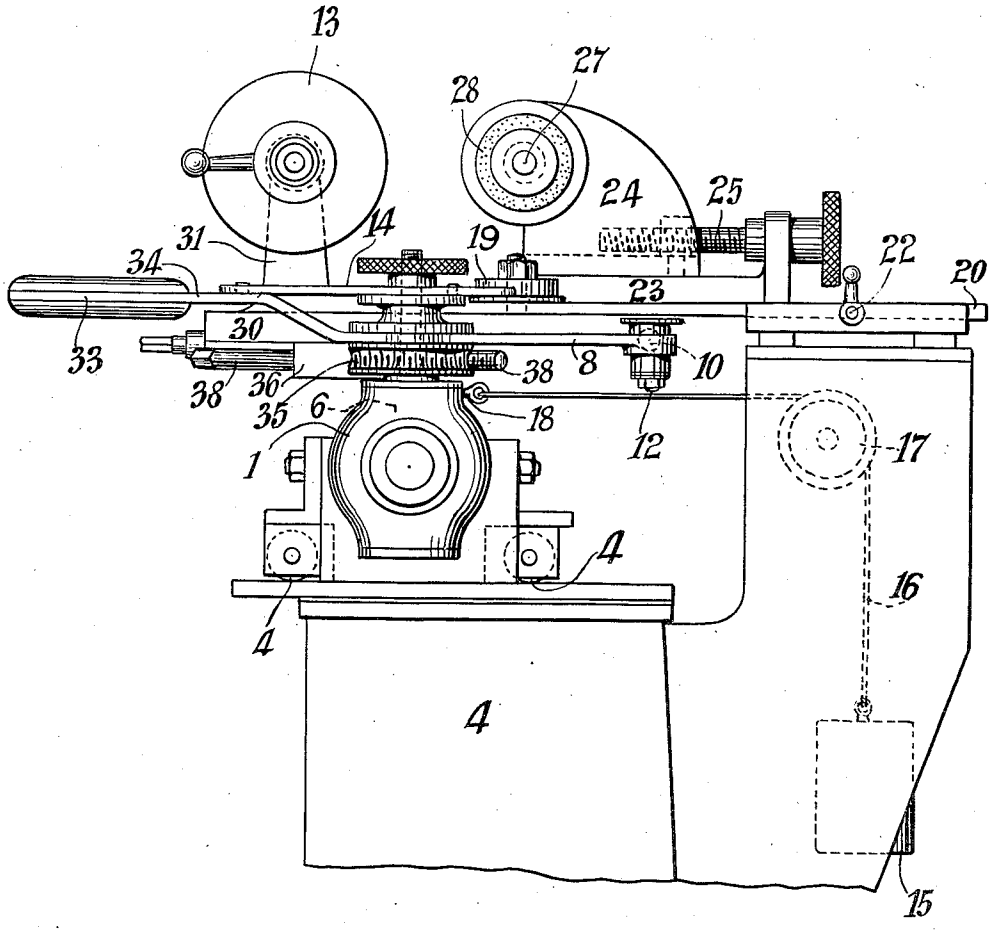
per Ferdinand Broster Bosshardt
Attorney.

Aug. 29, 1939. C. DAY 2,171,211

MACHINE FOR GRINDING ARTICLES TO PREDETERMINED FORMS

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Fig. 3.



Inventor:
Charles Day.

per Ferdinand Broster Borchardt
Attorney.

Aug. 29, 1939. C. DAY 2,171,211

MACHINE FOR GRINDING ARTICLES TO PREDETERMINED FORMS

Filed April 22, 1938 4 Sheets-Sheet 4

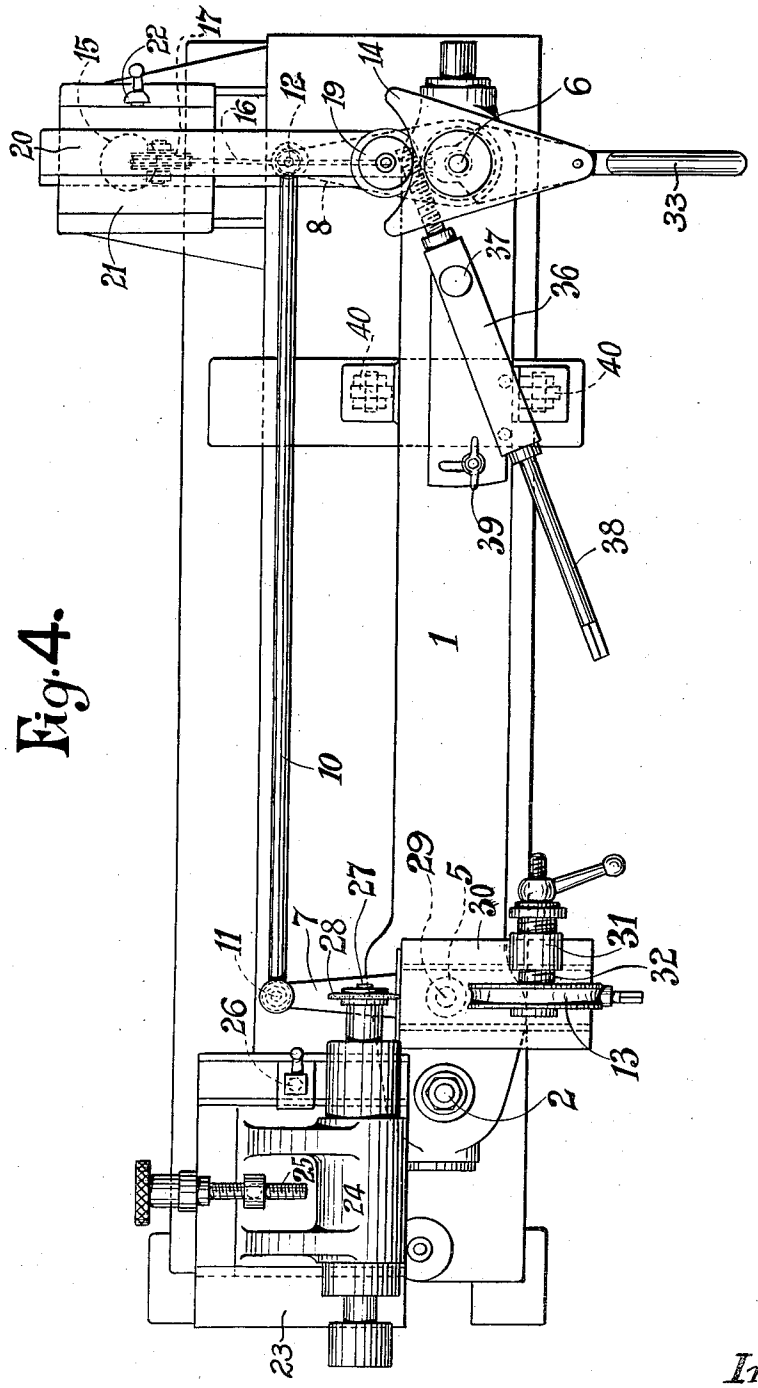


Fig. 4.

Inventor.
Charles Day.

per Ferdinand Broster Bonhardt
Attorney.

Patented Aug. 29, 1939 2,171,211

UNITED STATES PATENT OFFICE

2,171,211

MACHINE FOR GRINDING ARTICLES TO PREDETERMINED FORMS

Charles Day, Stockport, England

Application April 22, 1938, Serial No. 203,566
In Great Britain May 31, 1937

3 Claims. (Cl. 51—100)

This invention relates to machines for grinding articles to forms which are copies on a reduced scale of patterns or templates. The invention has for its object the provision of means whereby such machines can be arranged and adjusted with facility to grind such articles with great accuracy.

Machines for grinding articles to correct form by utilization of a pattern plate or template and a pantographic arrangement of pivotal arms and links are already known.

The object of my invention is to provide a grinding machine of the said kind which due to a simple provision and arrangement of parts enables the whole machine to be constructed so robustly as to eliminate the possibility of slight copying errors arising from bending or accidental yielding of the pattern transferring elements and ensures that a reduced but otherwise absolutely exact copy of the pattern piece shall be produced on the article.

I attain this object by the means illustrated in the accompanying drawings, wherein—

Figure 1 is a fragmentary front elevation, partly in section, of a part of a machine for grinding articles to profiles which are copies on a reduced scale of patterns or templates, and Figure 2 is a fragmentary front elevation, partly in section, of the remaining part thereof.

Figure 3 is an end view thereof.

Figure 4 is a plan view of the entire machine.

Figure 5 is a front elevation of a mandrel and gauge disc.

Figure 6 is a detached, fragmentary end view in section of a part of the machine furnished with a trueing up device.

Referring to the drawings, in the construction shown therein, as applied by way of example to a machine for grinding rotary and non-rotary tools such as are used on metal milling machines and lathes or for grinding other articles to a predetermined shape, I employ a grinding machine which comprises a swingable member 1 pivoted at one end by a pivot 2 rotating in a bearing 3 formed in or attached to the machine bed 4. The member 1 carries pivots 5 and 6, the centres of the three pivots 2, 5 and 6 being in a straight line. The pivots 5 and 6 carried in the swingable member 1 have attached to them levers 7 and 8 respectively of equal length which are connected togethed by a pivotal connecting rod 10 at 11 and 12, thereby ensuring that any rotary movement of either of the pivots 5 and 6 is duplicated on the other. Instead of levers 7 and 8 and a connecting rod 10, the connection can be by means of a chain passing round chain wheels on the pivots 5 and 6, or an equivalent device.

The tool 13, Figure 4, to be ground is carried on the pivot 5, whilst the pattern or template 14 to be copied is attached to the pivot 6.

By means of a weight 15 or spring suitably attached to the swingable member 1, for example by a chord 16 passing over a pulley 17 and secured to an eye 18 on the member 1, the pattern or profile plate 14 is held against a stop consisting of a roller 19 rotatably mounted on a slide 20 which is transversely adjustable on an extension 21 of the machine bed 4 and can be locked in position by a screw 22. The bed 4 also carries a headstock 23 in which a suitable bearing or support 24 is mounted transversely slidable on the headstock 23 and can be adjusted by means of a screw 25 and can be locked by a screw 26. The support 24 carries the spindle 27 of the grinding wheel 28, the axis of the spindle 27 being parallel to the centre line of the swingable member 1 when the latter is in its central position. By sliding the support 24 the position of the grinding wheel 28 can be adjusted.

If the machine is arranged as shown so that the movement of the member 1 is in a horizontal plane, then the following conditions must be met to enable the grinding wheel 28 to produce profiles which are copies on a reduced scale of the shape of the pattern or template 14 employed.

The position of the grinding wheel 28 must be accurately adjusted so that the cutting point is in a verticle plane containing the pivot 2 of the swingable member 1 and the point of contact of the pattern 14 with the stop roller 19.

The distance of the cutting point of the grinding wheel 28 from the vertical axis of the pivot 2 of the swingable member 1 must be such that its ratio to the distance of the point of contact of the pattern or profile 14 with the stop roller 19 is the same as the ratio of the distance of the axis of the work pivot 5 from the axis of the pivot 2 of the swingable member 1 to the distance of the axis of the pattern pivot 6 from the axis 2 of the swingable member 1. This ratio is the ratio of the size of the finished ground article to the size of the pattern and is hereinafter called the reduction ratio of the machine.

If the stop against which the pattern or profile 14 moves is, as shown, a roller 19 of circular form, the grinding edge of the grinding wheel must also be of similar form or profile, but the

ratio of the radius of the said form of profile to that of the stop roller 19 must be the reduction ratio of the machine.

My invention provides means whereby the aforementioned conditions can be met in a practical way.

To set the grinding wheel in its correct position longitudinally I bore a cylindrical hole 29 along the axis of the work pivot 5 and fit therein a mandril 41, Figure 5. On this mandril is fitted a gauge disc 42 to which the grinding wheel 28 can be adjusted when the swingable member 1 is in its central position. The correct longitudinal position of the grinding wheel is thus secured.

To set the grinding wheel 28 in its correct position transversely I make the disc 42 with a radius which is in the same ratio to the radius of the pattern 14 at the point of contact of the pattern 14 with the stop roller 19 as is the distance of the axis of the work pivot from the axis of the pivot 2 to the distance of the axis of the pivot 6 from the axis of the pivot 2. Then whilst this point of contact is maintained the support 24 is adjusted transversely until the grinding wheel 28 just touches the said disc.

Before setting the grinding wheel 28 to its correct position transversely, it is ground to suit the particular pattern 14 employed. The shape to which the grinding wheel 28 is ground is determined by the pattern piece by the following means: A mandrel 43, Figure 6, is mounted in the hole 29 of the work support 5 and carries a diamond 44 which is positioned behind the axis of the pivot 5 a distance which is in the same ratio to the radius of the roller 19 as the work ratio of the machine. The grinding wheel 28 is fed transversely to the diamond until its periphery has been trued up thereby, the pattern 14 being turned during the trueing operation and thereby causing the diamond to advance towards and away from the axis of the grinding wheel and to turn about the axis of the pivot 5 in accordance with the shape and turning motion of the pattern 14. The profile of the cutting edge of the prinding wheel is thus automatically trued up to a shape which is absolutely correct for grinding the profile of the article to exactly the same shape (in miniature) as the pattern 14.

Having adjusted the grinding wheel 28 to its correct position in both directions, I attach the article 13 to be ground to the arm 31 of a slide 30 which is mounted on the work pivot 5 subsequent to the use and removal of the mandrels 41 and 43, the slide 30 being arranged so that the article can be adjusted transversely towards the grinding wheel until the desired grinding cut is attained.

To enable milling cutters and other circular objects to be ground I provide on the arm 31 of the slide 30 a pivot 32 on which the milling cutter can rotate, this pivot 32 being adjustable to suit cutters of different widths and permit of their correct location in relation to the grinding wheel 28.

When it is desired to make a pattern from an existing article or cutter I arrange to substitute for the grinding wheel 28 a piece of metal of the same shape as the grinding wheel. Then the article or cutter mounted on the slide 30 is maintained in contact with this metal wheel whilst the article is moved over its full width or oscillated to and fro. This enables the pattern to be marked off from the stop roller 19 or if a grinding wheel is used instead of the stop roller 19 the pattern can be ground to shape in position.

A handle 33 is provided, for example on an extension 34 of the arm 8, to enable the pattern or profile plate 14 to be rotated in a direct manner. To enable rotation of the pattern or profile plate 14 to be effected with greater force and control when required, a worn wheel 35 is connected to the arm 8 and a bracket 36, see Figures 1 and 2, is pivotally mounted at 37 on the member 1 and carries a rotatable screw 38 which can be swung into and out of mesh with the worm wheel 35. The bracket 36 can be locked to the member 1 with the screw 38 in mesh or out of mesh by a wing nut 39.

Rollers 40 may be provided on the member 1 to ride on the bed and thereby help to support the weight of the member 1.

In operation, the weight 15 by pulling on the arm horizontally keeps the pattern 14 constantly in contact with the roller 19. When the pattern 14 is turned by means of the handle 34 or spindle 38, it turns with the pivot 6 and the arm 8. Due to the connection of the pattern 14 by the arm 8, rod 10 and arm 7 the pivot 5 and therefore the milling cutter 13 carried thereby are positively forced to turn synchronously with the pattern 14. Therefore at each change in the point of contact on the pattern piece 14 with the same or a different point on the periphery of the roller 19, the equivalent point on the profile of the cutter 13 is brought into contact with the same or a different point of the grinding wheel 28, the last named point being the equivalent point to said point on the roller, whilst also at each change in the angle of the pattern surface relative to the roller, and exactly corresponding change of the angle of the cutter 13 to the grinding wheel 28 takes place. Consequently the movements of the pattern 14 relative to the roller 19 are exactly and minutely imitated by the cutter 13 relative to the grinding wheel 28, which by its mode of setting and trueing up has a grinding surface profile which is an exactly reproduced miniature of the curvature of the periphery of the roller 19.

If the radii of different points along the pattern surface of the pattern, as measured horizontally from the centre of the pivot 6, differ from each other, the arm 1 will be forced by the pattern surface to turn on its pivot 2 away from the roller 19 as each point of increasing radii of the said surface is brought into contact with the roller 19 by the turning of the pattern 14 and to turn towards the said roller as each point of decreasing radii of the said surface is brought into contact with the roller 19 by the said turning of the pattern 14. These movements of the arm produce movements of the pivot 5 towards and away from the grinding wheel 28 which are exact, reduced reproductions of the movements of the pivot 6 towards and away from the roller 19. It therefore follows that as the arrangement produces at the cutter 13 and grinding wheel 28 an entirely faithful copy in miniature of the conditions of the pattern piece 14 and roller 19 in all positions thereof, the grinding wheel must grind on the cutter a profile which is an absolutely exact, reduced reproduction of the shape of the pattern surface of the pattern piece. Each tooth of the cutter 13 is ground successively, the cutter 13, after the grinding of one tooth being rotated on the pivot

32 to the extent of one tooth and locked in the new position ready for grinding the next tooth.

I claim:

1. A grinding machine comprising in combination, a machine bed, a grinding headstock mounted laterally adjustable on the same bed, a grinding spindle mounted on the grinding headstock, a grinding wheel mounted on the said spindle, a vertical pivot on the said bed in the vicinity of the grinding headstock, a longitudinal swing arm mounted horizontally on the said pivot, a vertical pivot on the said arm, a slide bed mounted horizontally on the second named pivot, a slide mounted slidably on the slide bed, a bearing carried by the slide, a work holding spindle mounted axially adjustably and rotatably in the said bearing, a radius arm on the said slide, a link rod pivotally connected at one end to the radius arm, a hand lever pivotally connected to the said link rod at the other end of the said rod, a vertical pivot mounted on the swing arm and rotatably connecting the hand lever to the swing arm, a pattern holder provided on the hand lever for rotating a pattern plate by means of the hand lever, a tail stock on the machine bed, an adjustable roller on the tailstock for abutment of the periphery of the pattern piece thereagainst, and means connected to the swing arm for pressing the pattern piece against the said roller.

2. A grinding machine comprising in combination, a machine bed, a grinding spindle supported thereby, a grinding wheel on the grinding spindle, a swing arm mounted at one end horizontally swingable on the said bed, a vertical hollow spindle rotatably mounted on the swing arm intermediate of the ends of the swing arm, a second vertical spindle mounted on the swing arm at the other end thereof, a pattern plate connected to the second spindle for rotation of the second spindle with the pattern plate, means connecting the two spindles for rotation of the hollow spindle with the second spindle, a vertical mandrel mounted in the hollow spindle, and a gauge disc mounted in the said mandrel.

3. A grinding machine comprising in combination, a machine bed, a grinding spindle supported thereby, a grinding wheel on the grinding spindle, a swing arm mounted at one end horizontally swingable on the said bed, a hollow spindle rotably mounted on the swing arm intermediate of the ends of the swing arm, a slide bed provided on the said spindle, a second spindle mounted on the swing arm at the other end of the swing thereof, a pattern plate holder provided on the second spindle, an arm on the slide bed, an arm on the pattern plate holder, a pivotal link rod connecting the arms together for causing synchronous circular movement of the slide bed and pattern plate holder, a removable mandrel mounted coaxially on the slide bed and rotating therewith and hollow spindle, and a grinding wheel trueing tool mounted on the mandrel.

CHARLES DAY.