July 6, 1926.

W. E. COOK

1,591,017

POLISHING MACHINE

Filed Jan. 17, 1924

Fig. 1.

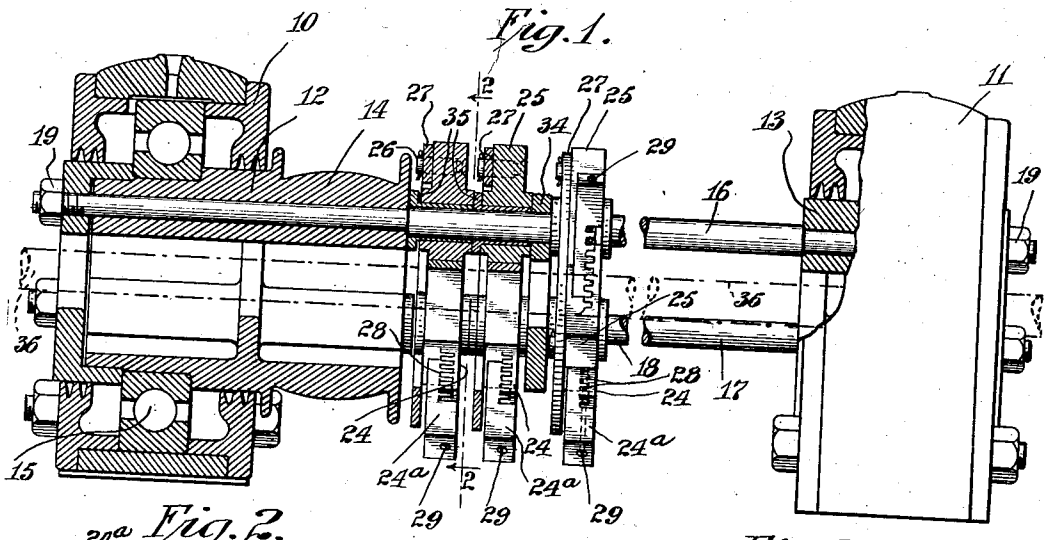


Fig. 2.

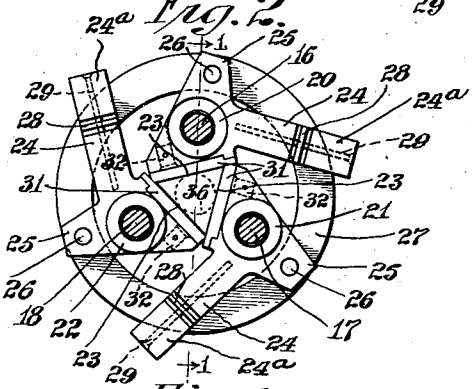


Fig. 3.

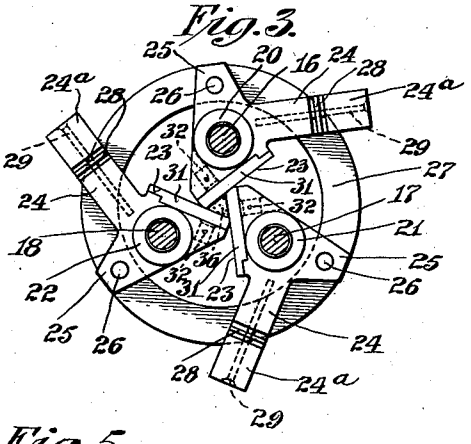


Fig. 4.

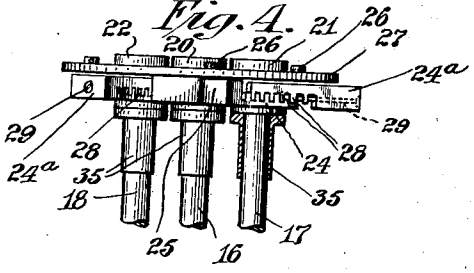


Fig. 5.

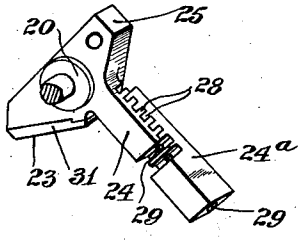
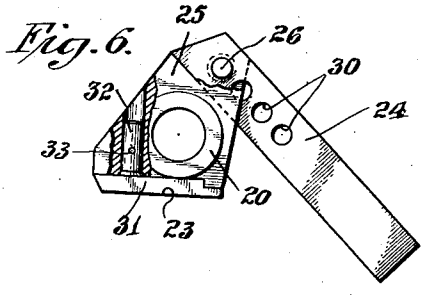


Fig. 6.



William E. Cook INVENTOR

BY Frank P. Wentworth

his ATTORNEY.

Patented July 6, 1926. 1,591,017

UNITED STATES PATENT OFFICE.

WILLIAM E. COOK, OF ST. GEORGE, NEW YORK, ASSIGNOR TO PEERLESS INSULATED WIRE AND CABLE COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

POLISHING MACHINE.

Application filed January 17, 1924. Serial No. 686,744.

My invention relates to polishing machines, and more particularly to a rotary machine of this type in which the polishing members will automatically adjust themselves to varying diameters in the surface being polished, while developing substantially uniform pressure, notwithstanding such adjustment.

A machine embodying my invention is designed more particularly for polishing the outer surface of insulated wire, and is so constructed that a plurality of groups or units of polishing elements may be employed which will operate progressively upon every portion of the entire length of wire, under substantially uniform conditions or if desired, under varying conditions as to the pressure exerted upon the wire by the polishing elements of succeeding groups or units.

Each of the polishing units is composed of a plurality of elements grouped and rotatable about a common axis, each of said elements being capable of movement toward and from this axis in developing the desired pressure upon a wire passing through the machine with its axis in substantial alinement with that of the axis about which each group of said elements has movement.

The movement of the various elements in adjusting themselves to a wire is entirely automatic, and the elements are free to move toward and from the axis of the wire, in a manner to accommodate themselves to varying diameters in different portions of the wire, and at the same time prevent likelihood of the abrasion of the surface of, or a partial stripping of the covering from the insulating body about, the wire.

In a machine embodying my invention, the arrangement of the polishing elements of each group or unit is such that the surface of the wire will be polished by both a relative rotary and longitudinal movement of the polishing elements and the wire, the longitudinal movement resulting from the axial traverse of the wire through the machine and in relation to said elements. The sole support for the wire while passing through the machine is the polishing elements and therefore, it is apparent that the arrangement, construction and functioning of these elements must be such as to support the wire while it is being polished by the elements.

To secure the desired high capacity in the machine, the construction and arrangement of parts must be such as to permit the operation of the machine at high speed, but without likelihood of twisting or distorting the wire or disturbing the insulation thereon. The high speed at which the machine is operated is relied upon, not only for securing the maximum polishing action with the minimum of time, but for developing that pressure required in the polishing operation.

In such a machine, the pressure developed may be varied by varying the speed of rotation of the polishing elements, or by means of adjustments in the polishing elements themselves, so as to vary the effect of centrifugal force upon said elements in developing the polishing pressure therethrough.

Since all of the polishing elements in their entirety are rotated at high speed or have planetary motion about an axis coincident with the axis of the wire, and each element is capable of pivotal movement about an axis parallel with that axis, I so construct the machine that the only movement of said polishing elements with relation to the axis about which the elements in their entirety rotate, will be this pivotal movement, the supporting means for the elements, being held with sufficient rigidity to prevent any movement of the elements as a result of the distorting of this supporting means.

I so construct and combine the polishing elements of each group or unit as to ensure simultaneous uniform movement of each of these elements toward and from the axis of rotation of the group, thus ensuring the proper centering of the wire in relation to the elements in each group or unit, and to adjoining groups or units or the simultaneous separation of the polishing elements to accommodate these elements to any slightly enlarged or reduced portion of the wire.

The invention consists primarily in a polishing machine embodying therein a plurality of polishing elements, supports for said elements whereby they are grouped about a common axis, means whereby said supports are rotated, and means operative upon each element whereby rotation of said supports at high speed will cause each ele-

ment to have movement toward the axis of rotation of said supports; and in such other novel features of construction and combination of parts as are hereinafter set forth and described, and more particularly pointed out in the claims hereto appended.

Referring to the drawings:—

Fig. 1 is a side view partly in elevation and partly in section of a polishing machine embodying my invention;

Fig. 2 is a section on the line 2—2 of Fig. 1, showing one of the polishing units with the elements separated;

Fig. 3 is a similar view showing the polishing elements positioned nearer the axis about which they are grouped;

Fig. 4 is a plan view of one of the polishing units;

Fig. 5 is a detail perspective view of one of the polishing elements; and

Fig. 6 is a similar view of another form of polishing element.

Like numerals refer to like parts throughout the several views.

In the embodiment of my invention shown in the drawings, 10 and 11 are end bearing housings for rotatable members 12 and 13, one of which, as 12, carries a driving pulley 14 or other means by which the members 12 and 13 are rotated.

Since the members 12 and 13, and the parts carried thereby are designed to be rotated at high speed, from 1,000 to 1,500 R. P. M., ball bearings are preferably provided for each of these members as shown at 15 in connection with the member 12.

Extending between the members 12 and 13 are shouldered tie rods 16, 17 and 18 secured in position with relation to said members by means of the nuts 19. These tie rods act as supports for a plurality of groups or units of polishing elements arranged in parallel relation one with the other so as to cause every portion of a wire passing through the machine to be progressively brought into the operative relation with each of the polishing elements of each of these units.

The tie rods 16, 17 and 18 are arranged at equal distances from a common center, which center is the axis of rotation of the members 12 and 13, and are spaced apart 120° in arc with relation to the rotary movement of said rods. This arrangement is equivalent to having the axis of each of these rods represent the point of an equilateral triangle.

The detailed construction of each of the polishing groups or units is the same as that of the others, so that a description of but one unit is necessary, it being understood that any desired number of such units may be employed although heretofore, I have used but six such units upon each machine.

Each of said units or groups, comprises three polishing elements 20, 21 and 22, each of the same conformation as every other. One of these elements 20 is mounted upon the rod 16, another, 21 upon the rod 17, and the third, 22 upon the rod 18, each of said elements being capable of rotating freely upon its rod.

Each of the elements 20, 21 and 22 has a polishing surface 23, presented towards the axis about which the rods 16, 17 and 18 are rotated, this polishing surface being of a width to bring it into close juxtaposition to the corresponding element of the adjoining group or unit. The polishing surface 23 is a substantially flat, smooth surface, which is required more particularly because different portions of this face may become operative as determined by the diameter of the wire being polished, or by variance in the diameter of different parts of a wire.

The surface 23 is of greater length than width, in part to provide for this change in the relation of this surface to the wire, or different wires, and in part to assist in maintaining the different elements in their desired co-operating relation, although other means are also provided for this purpose.

Each element 20, 21 and 22 is provided with a weighted extension 24, one end of which is connected to its element, and the other end of which extends outwardly of the axis about which the rods 16, 17 and 18 are rotated, in a manner to cause this weighted extension to have movement as a result of centrifugal action developed by the rotation of the polishing unit in its entirety. Hence, while the machine is in operation, each element will have rotary movement about the axis of the wire, and movement toward this axis so as to bring the polishing surface 23 thereof into engaging relation with the wire and develop a substantially uniform continuous pressure upon the surface of the wire. This pressure, however, will be a yieldable pressure to the extent that the element may receive movement counter to its movement under the control of the extension 24, as when an enlarged portion of the wire is encountered, or towards the wire as a result of a reduced portion of the wire passing the elements.

Each rod 16, 17 and 18, has mounted thereon, its own polishing element provided with a polishing surface 23, and a weighted extension 24.

To ensure the application of polishing pressure by the elements 20, 21 and 22 with the proper relation to the axis of the wire, and also to ensure simultaneous movement of these elements to the same extent, I preferably provide each of these elements with a heel 25 connected by means of a pivot 26

with a ring 27 so that movement of any element will, through this ring, control the quantity of movement of each of the other elements, or simultaneous movement of the elements 20, 21 and 22 will act upon this ring in a manner to equalize the movement of, and the pressure developed by, each of the other elements.

It is sometimes desirable to cause all of the elements to act with greater or less pressure upon the surface of the wire, or to have the elements of succeeding units act with greater or less pressure. To meet this condition, I so construct the weighted extension 24 that it may be adjusted to bring the end thereof to a greater or less distance from the axis about which the elements 20, 21 and 22 have pivotal movement.

In the form of the invention shown in Figs. 1 to 5, I make the extension of two parts, one of which as 24ª may be adjusted longitudinally of the other. These two parts are provided with interlocking teeth 28 extending across these two parts so as to resist any tendency of the part 24ª to move under centrifugal force with relation to the other part of the extension, the two parts of the extension being secured together by means of a lock screw 29 screw threaded in the extension 24 and passing through the various teeth 28. In this manner there is no likelihood of the accidental separation of the two parts of the extension as a result of the high speed at which the machine operates.

In the form of the invention shown in Fig. 6, the heel 25 is forked, and the dimensions of the extension 24 are such as to permit it to have a tight fit within the forks of this heel. The extension 24 in this form of the invention is provided with a sequence of openings 30 through any of which the pivot 26 is adapted to pass so that the length of the effective end of the extension may be varied to a desired extent through the selection of the opening 30 through which the pivot is passed. This form of the invention may be utilized to vary the normal unbalanced condition of the element with greater nicety than the form of the invention shown in Figs. 1 to 5, since the adjustment of the extension 24 to shorten its length will add weight to the portion of the element at the other side of the rod upon which it is mounted. This form of the invention can also be more cheaply produced since little or no machine work is required.

I have found by actual experience that when each element 20, 21 or 22 is made in one casting, the surface 23 wears very rapidly, notwithstanding that the surface upon which it operates is a saturated fibrous material such as cotton braid impregnated with asphaltum or other similar composition. The slight hollow thus formed in the surface 23 will interfere with the proper functioning of the machine. To correct this condition, I form the surface 23 upon a hardened plate 31 having a stem 32 extending within the body of the element and secured in position by means of a tapered pin 33. A tapered pin is used so as to ensure a tight fit between the plate 31 and the body of the element which forms the backing for this plate.

The construction of each element 20, 21 and 22, apart from the extension 24, is such that irrespective of the position which this element may assume, the weight of the element will be so distributed as to result in a substantially balanced condition, the weight of the extension being relied upon for imparting the desired movement of the surface 23 toward and into engagement with the wire and the pressure with which this surface operates upon the wire.

To prevent bulging or flexure of the rods 16, 17 and 18, due to centrifugal force while the machine is in operation, I pass these rods through stay plates or rings 34 arranged at spaced distances along the rods. The polishing elements 20, 21 and 22 of each unit are mounted upon a shouldered bushing 35 upon the rod, these bushings acting as spacers to accurately position adjacent units with relation to each other and afford the proper clearance for the operation of the polishing elements of each unit.

The insulated wire being operated upon is indicated at 36 in Figs. 1 and 3 of the drawings.

The operation of the herein described polishing machine is substantially as follows:—

When the machine is at rest, at least two of the extensions 24 will have movement toward the axis of rotation of the rods 16, 17 and 18, thus oscillating the various elements 20, 21 and 22 in a manner to separate the polishing surfaces 23 thereof. This is due to the triangular arrangement of the pivots 18 causing two of the weighted portions 24ª to act in opposition to the remaining weighted portions. The ring 27 and pivots 26 will cause all of the elements to have this movement, since with the triangular arrangement of the rods 16, 17 and 18, at least two of the extensions will be acting to impart this movement, even though the third extension may be so positioned as not to have this effect but rather a tendency to oppose such a movement of the ring.

With the separation of the surfaces 23 of the polishing elements, clearance is afforded for the passage of the insulating wire 36 or other material to be polished, through the space between these surfaces,

the end of this wire being secured to a rewind reel not shown in the drawings, but which may be operated to continuously impart traverse to the wire, as desired.

When the wire is in position within the space afforded within the polishing surfaces 23 of the elements 20, 21 and 22 of each group or unit, power is applied to the machine. As the members 12 and 13 rotate, they will carry with them the rods 16, 17 and 18 and the various polishing elements 20, 21 and 22 of each group or unit. The rotary movement of these rods will cause the extensions 24 of each element of each group or unit to move outwardly, thus forcing the polishing surfaces 23 of each of the elements toward the axis about which the members 12 and 13 rotate.

Since the elements of each group or unit are connected with a ring 27, the elements of each unit will have similar simultaneous movement which will have the effect of accurately centering the wire 36 with relation to these elements. The flat surface of the polishing surfaces 23 will permit these surfaces to have movement across the wire while the wire is being thus centered. Thereafter the continued running of the machine will result in the weighted extensions 24 having a constant tendency to force the polishing surfaces 23 of the elements of each group or unit toward each other, thus developing the desired polishing pressure of the surfaces 23 against the wire 36. This pressure will remain substantially constant and uniform so long as the machine has the same R. P. M. and irrespective of any slight changes in the diameter of the wire as to different portions thereof, which condition is common in insulated wires. In fact while the polishing surfaces 23, when the machine is in operation, will automatically move into, and remain in engagement with the surface of the wire, or other material being polished, with the requisite pressure to give the desired finish to the surface of this material, the polishing elements of each unit are free to move toward or away from each other to accommodate themselves to varying diameters of different portions of this material without any perceptible variation in the pressure exerted by the surfaces 23. This flexibility, or yieldability, in the polishing mechanism will avoid any likelihood of abrasion of the covering material of the wire and will prevent all possibility of stripping the outer surface of the insulation, or of the covering therefor, from the wire.

A plurality or sequence of polishing units are employed so as to permit a fairly rapid rate in the traverse of the wire 36 or other material being finished, and yet subject the wire to the polishing pressure for a sufficient interval to secure the desired finish. Furthermore, if desired the elements of succeeding units may have the extensions 24 thereof set differently so that the pressure developed by the different units may vary, thus permitting the application of a light polishing pressure to the wire as it first enters the machine, with a progressive increase of this pressure, or a heavier initial pressure with the progressive lightening of the pressure as the wire progresses through the machine.

The adjustability of the length of the extensions 24 permits the machine to be set for any desired pressure conditions of the various units, and also the regulation of the pressure to accommodate the machine to different conditions of use.

The stay plates or rings 34 arranged at spaced distances along the rods 16, 17 and 18 will check any tendency of these rods to flex outwardly as a result of the high speed of rotation of the members 12 and 13 carrying these rods, rigidity in these rods being required to ensure the desired uniform action of the polishing elements of each unit.

The surface being polished is subjected to a rapid smoothing action by perfectly flat surfaces, which has been found to give highly efficient results. At all times there are three triangularly arranged points of contact between the wire and the polishing surfaces 23 of the elements of each unit, which points of contact will serve to adequately support the wire or other material and hold it with sufficient stability to ensure the effective application of the polishing pressure which, however, is not heavy.

The arrangement of the elements of each unit is such as to permit the escape of any fluff which may be separated from the insulation of the wire, although with freshly coated wire, likelihood of the removing of fine particles from the surface thereof as a result of polishing, is reduced to a minimum.

The wire after leaving the machine will have a smooth, even finish, the surface being sufficiently burnished to give the desired appearance to the wire, and while the machine primarily is for the purpose of imparting this finish to the wire, it is apparent that it will also have the effect of compacting any soft parts of the insulation and thus act in a measure to "size" the wire.

It is apparent that while the pressure developed may be regulated by the adjustment of the length of the extensions 24, the speed of operation of the machine will in a measure control the extent of this pressure, since the higher the speed, the greater will be the effect of centrifugal force upon these extensions and therethrough upon the polishing elements.

It is not my intention to limit the invention to the precise details of construction shown in the accompanying drawings, it be-

ing apparent that such may be varied without departing from the spirit and scope of the invention.

Having described the invention what I claim as new and desire to have protected by Letters Patent, is:—

1. A polishing machine embodying therein a plurality of polishing elements, each of said elements having a substantially flat, smooth, extended surface presented towards the axis of rotation of said elements, supports for said elements whereby they are grouped about a common axis, means whereby said supports are rotated, and means operative upon each element whereby rotation of said supports at high speed will cause each element to have movement toward the axis of rotation of said supports.

2. A polishing machine embodying therein a plurality of polishing elements, each of said elements having a substantially flat, smooth, extended surface presented towards the axis of rotation of said elements, supports for said elements whereby they are grouped about a common axis, means whereby said supports are rotated, means operative upon each element whereby rotation of said supports at high speed will cause said element to have movement toward the axis of rotation of said supports, and means permitting adjustment of said last named means whereby the pressure resulting from movement thereof may be increased or decreased.

3. A polishing machine embodying therein a plurality of polishing elements, supports for said elements whereby they are grouped about a common axis, means whereby said supports are rotated, means operative upon each element whereby rotation of said supports at high speed will cause said element to have movement toward the axis of rotation of said supports, and connections between said elements whereby they will all have similar, simultaneous movement.

4. A polishing machine embodying therein a plurality of polishing elements, supports for said elements whereby they are grouped about a common axis, means whereby said supports are rotated, means operative upon each element whereby rotation of said supports at high speed will cause said element to have movement toward the axis of rotation of said supports, means permitting adjustment of said last named means whereby the pressure resulting from movement thereof may be increased or decreased, and connections between said elements whereby they will all have similar, simultaneous movement.

5. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said elements having a substantially flat, smooth, extended surface presented towards the axis of rotation of said elements, and a weighted extension carried by and operative upon each element whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support, and cause a portion thereof to move toward the axis of rotation of said supports.

6. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said elements having a substantially flat, smooth, extended surface presented towards the axis of rotation of said elements, a weighted extension carried by and operative upon each element whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support, and cause a portion thereof to move toward the axis of rotation of said supports, and means whereby each of said weighted extensions may be adjusted toward or from the support for the element carrying it, to regulate the pressure developed by said element.

7. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, a weighted extension carried by and operative upon each element whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support, and cause a portion thereof to move toward the axis of rotation of said supports, and connections between said elements whereby they will all have similar, simultaneous movement about their supports.

8. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, a weighted extension carried by and operative upon each element whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support, and cause a portion thereof to move toward the axis of rotation of said supports, means whereby each of said weighted extensions may be adjusted toward or from the support for the element carrying it, to regulate the pressure developed by said element, and connections between said elements whereby they will all have similar simultaneous movement about their supports.

9. A polishing machine embodying there-

in a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said polishing elements having a flat smooth extended polishing surface presented toward the axis of rotation of said supports, and a weighted extension carried by and operative upon each element, whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support and cause said flat extended polishing surface to move toward the axis of rotation of said support.

10. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said polishing elements having a flat smooth extended polishing surface presented toward the axis of rotation of said supports, a weighted extension carried by and operative upon each element, whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support and cause said flat extended polishing surface to move toward the axis of rotation of said support, and means whereby each of said weighted extensions may be adjusted toward or from the support for the element carrying it, to regulate the pressure developed by said element.

11. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said polishing elements having a flat extended polishing surface presented toward the axis of rotation of said supports, a weighted extension carried by and operative upon each element, whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support and cause said flat extended polishing surface to move toward the axis of rotation of said support, each of said elements having a heel extending radially of its support, a ring concentric with the axis of rotation of said supports, and pivotal connections between said ring and the heels of said elements respectively, whereby said elements are caused to have similar, simultaneous movement.

12. A polishing machine embodying therein a plurality of supports symmetrically grouped about a common axis, means whereby said supports are rotated, a plurality of polishing elements respectively pivotally mounted upon one of said supports, each of said polishing elements having a flat extended polishing surface presented toward the axis of rotation of said supports, a weighted extension carried by and operative upon each element, whereby rotation of said supports at high speed will cause each of said elements to have rotative movement about its support and cause said flat extended polishing surface to move toward the axis of rotation of said support, means whereby each of said weighted extensions may be adjusted toward or from the support for the element carrying it, to regulate the pressure developed by said element, each of said elements having a heel extending radially of its support, a ring concentric with the axis of rotation of said supports, and pivotal connections between said ring and the heels of said elements respectively, whereby said elements are caused to have similar, simultaneous movement.

13. A polishing machine embodying therein a plurality of supporting rods symmetrically grouped about a common axis, means whereby said rods are rotated, a plurality of polishing units arranged to act successively upon the material being polished each consisting of a plurality of polishing elements, each of said elements having a substantially flat, smooth, extended surface presented towards the axis of rotation of said elements respectively pivotally mounted upon one of said rods, and a weighted extension carried by and operative upon each element, whereby rotation of said rods about a common axis and at high speed, will cause each of said elements to have rotative movement about its rod, and cause a portion thereof to move toward the axis of rotation of said rods.

14. A polishing machine embodying therein a plurality of supporting rods symmetrically grouped about a common axis, means whereby said rods are rotated, a plurality of polishing units each consisting of a plurality of polishing elements respectively pivotally mounted upon one of said rods, each of said polishing elements having a flat extended surface presented toward the axis of rotation of said rods, a weighted extension carried by and operative upon each element, whereby rotation of said rods about a common axis and at high speed, will cause each of said elements to have rotative movement about its rod, and cause a portion thereof to move toward the axis of rotation of said rods, means whereby each of said weighted extensions may be adjusted toward or from the rod upon which the element carrying it is mounted, to regulate the pressure developed by said element, each of said elements having a heel extending radially of its rod, a ring concentric with the axis of rotation of said rods, and pivotal connections between said ring and the heels

of said elements respectively, whereby said elements are caused to have similar, simultaneous movement.

15. A polishing machine embodying therein a plurality of supporting rods symmetrically grouped about a common axis, means whereby said rods are rotated, a plurality of polishing units each consisting of a plurality of polishing elements respectively pivotally mounted upon one of said rods, each of said polishing elements having a flat extended surface presented toward the axis of rotation of said rods, a weighted extension carried by and operative upon each element, whereby rotation of said rods about a common axis and at high speed, will cause each of said elements to have rotative movement about its rod, and cause a portion thereof to move toward the axis of rotation of said rods, means whereby each of said weighted extensions may be adjusted toward or from the rod upon which the element carrying it is mounted, to regulate the pressure developed by said element, each of said elements having a heel extending radially of its rod, a ring concentric with the axis of rotation of said rods, pivotal connections between said ring and the heels of said elements respectively, whereby said elements are caused to have similar, simultaneous movement, and stay plates reinforcing said rods intermediate the ends thereof and between some of said units, whereby flexure of said rods is prevented.

16. A polishing machine embodying therein oppositely disposed bearing housings, members rotatably mounted in said housings, a plurality of supporting tie rods extending between said members and symmetrically grouped about a common axis, means whereby said rods are rotated, a plurality of polishing units each consisting of a plurality of polishing elements respectively pivotally mounted upon one of said rods, each of said polishing elements having a flat extended surface presented toward the axis of rotation of said rods, a weighted extension carried by and operative upon each element, whereby rotation of said rods about a common axis and at high speed, will cause each of said elements to have rotative movement about its rod, and cause a portion thereof to move toward the axis of rotation of said rods, means whereby each of said weighted extensions may be adjusted toward or from the rod upon which the element carrying it is mounted, to regulate the pressure developed by said element, each of said elements having a heel extending radially of its rod, a ring concentric with the axis of rotation of said rods, pivotal connections between said ring and the heels of said elements respectively, whereby said elements are caused to have similar, simultaneous movement, and stay plates reinforcing said rods intermediate the ends thereof and between some of said units, whereby flexure of said rods is prevented.

In witness whereof I have hereunto affixed my signature this 9th day of January, 1924.

WILLIAM E. COOK.