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METHODS OF GRINDING OR POLISHING ELONGATED ROTATIONAL BODIES

Filed Sept. 10, 1962 3 Sheets-Sheet 1

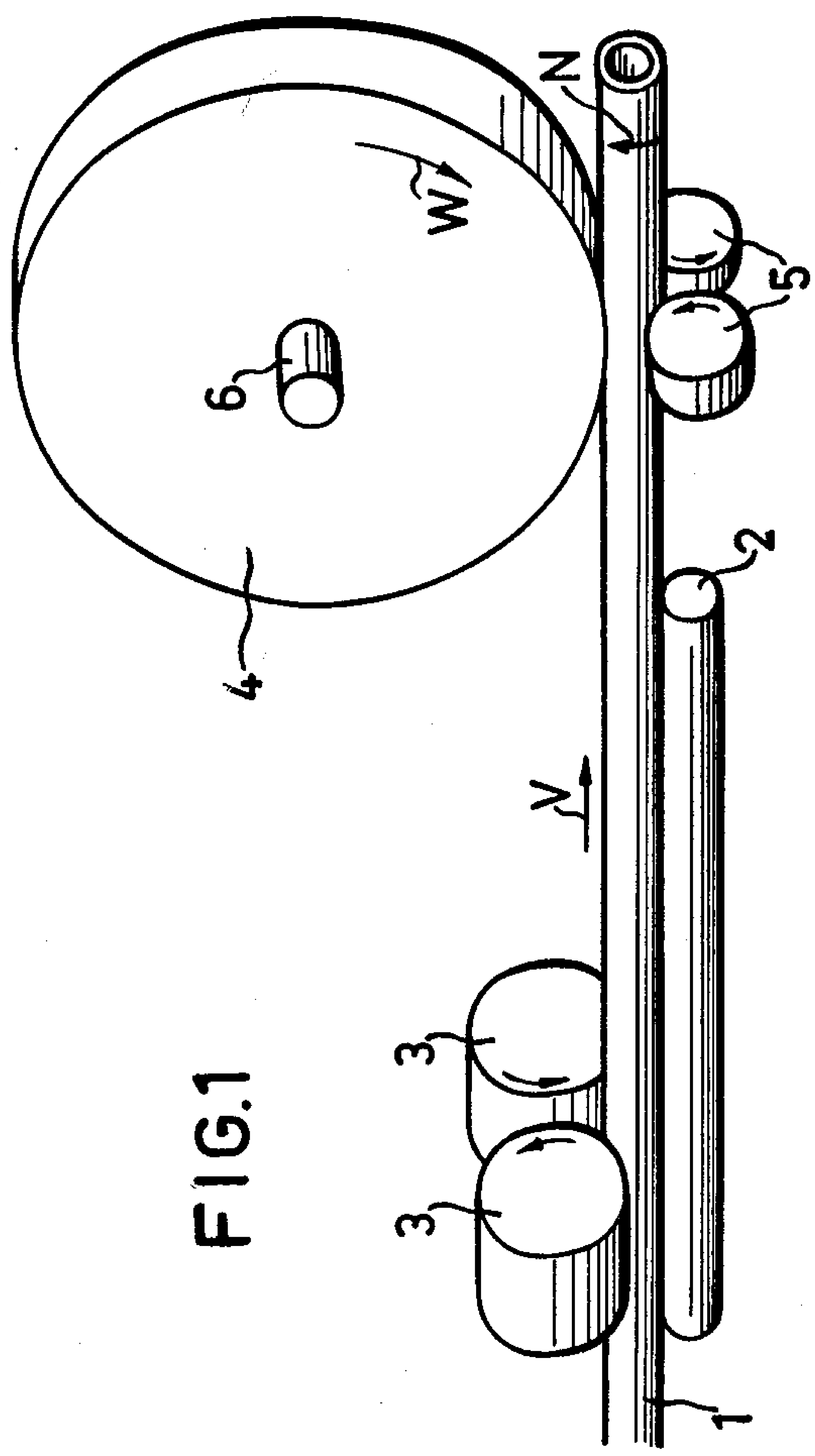

FIG.1

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FIG.2

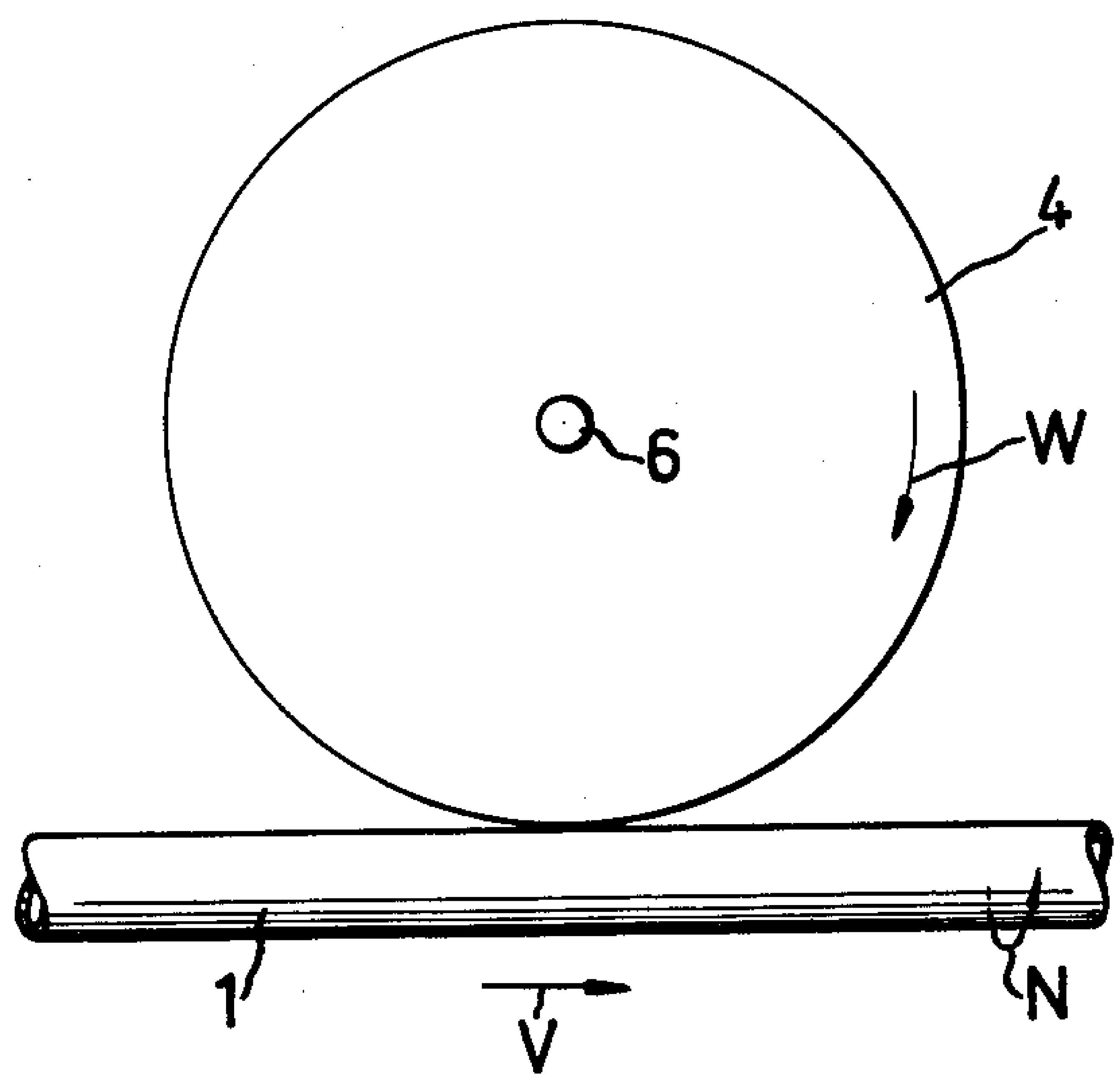
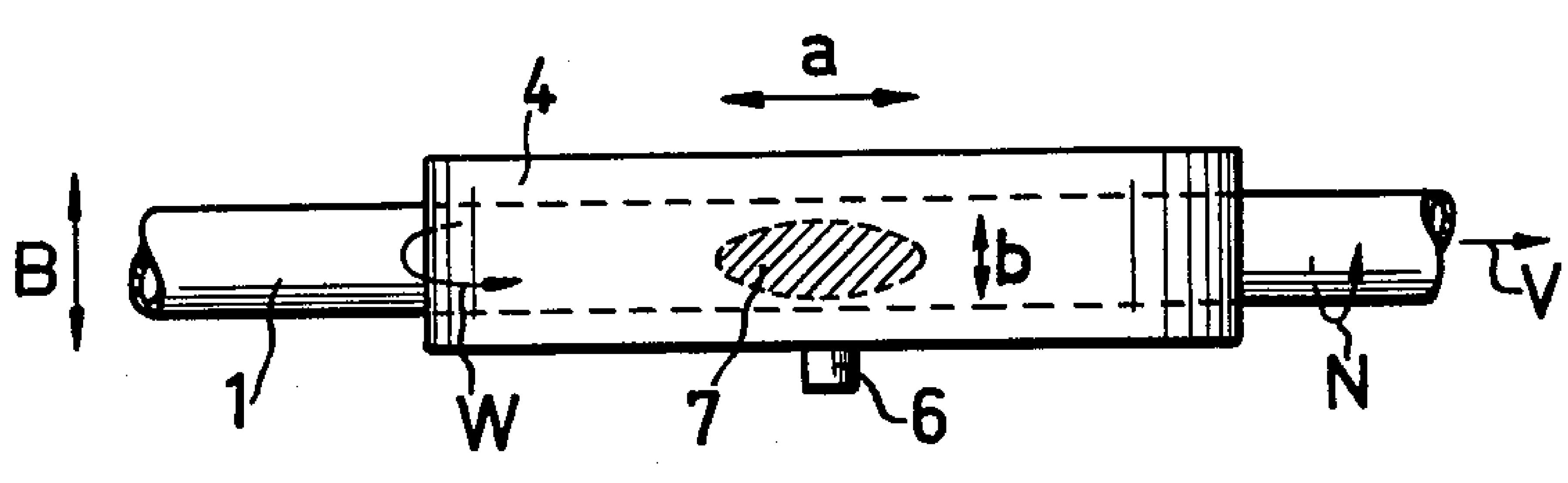


FIG.3



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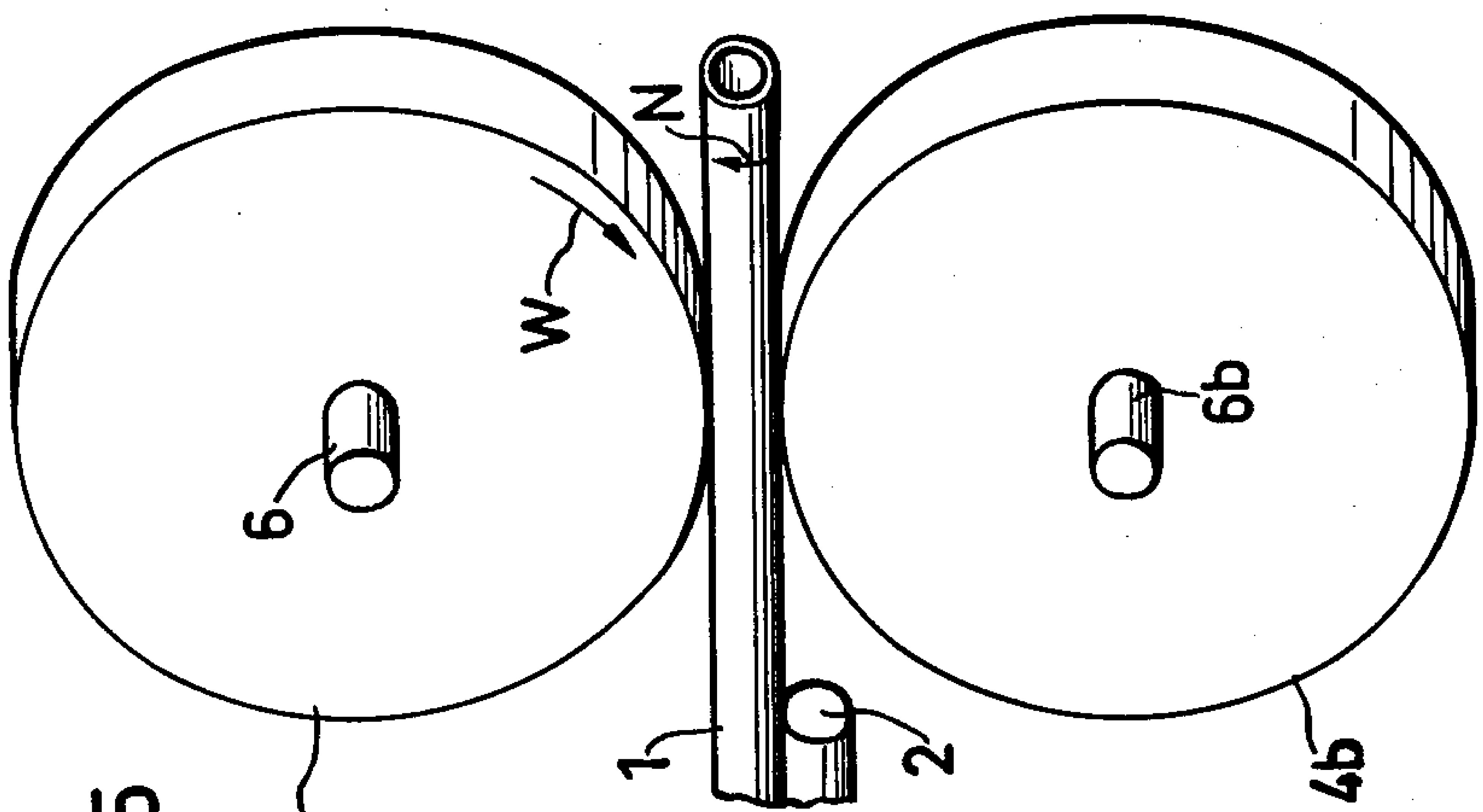

FIG.5

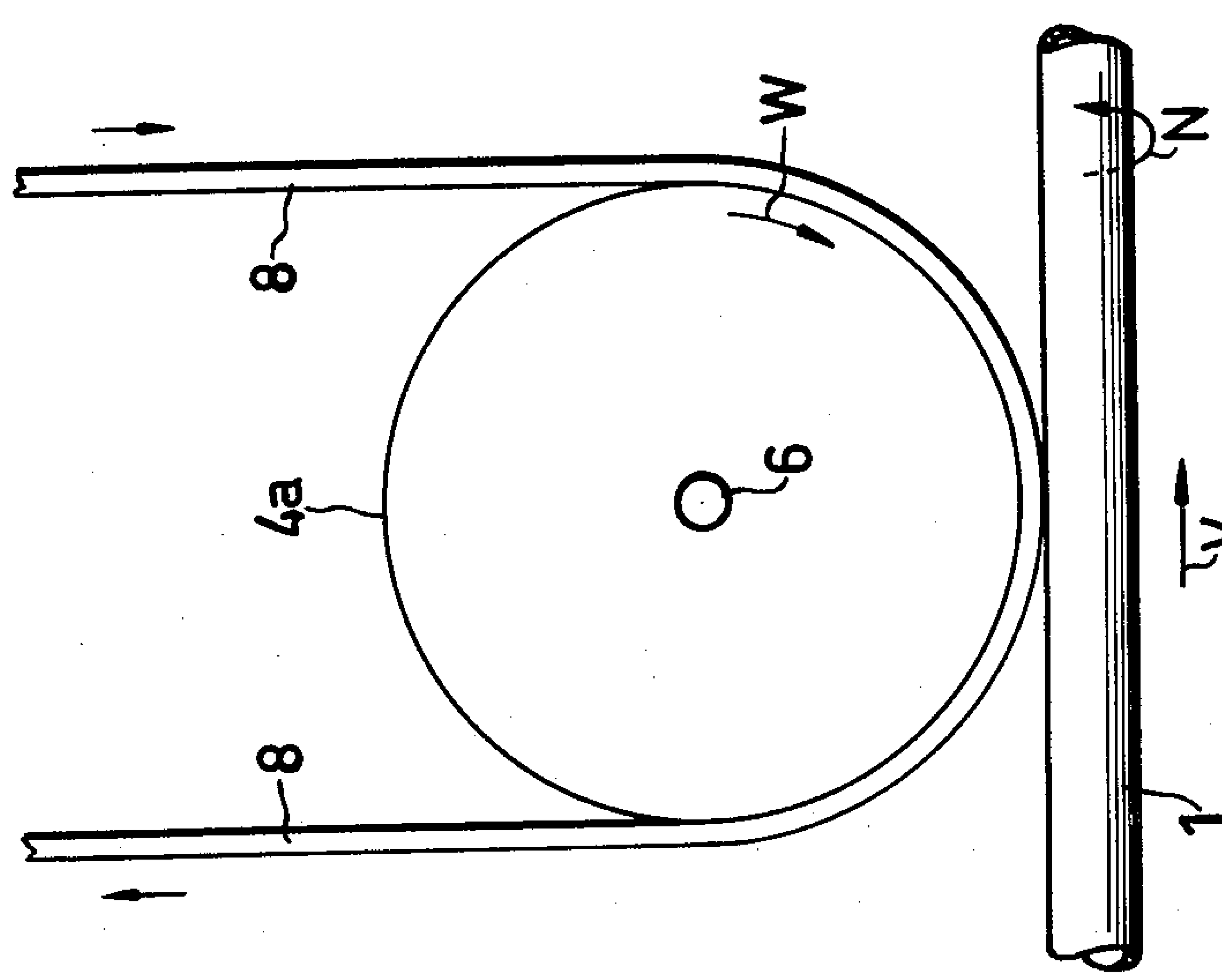

FIG.4

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METHODS OF GRINDING OR POLISHING ELONGATED ROTATIONAL BODIES

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2 Claims. (Cl. 51—289)

The present invention relates to a method of grinding or polishing elongated rotational bodies which, while being rotated about their longitudinal axis, are advanced in engagement with a movable grinding or polishing member, each part of which is caused to move substantially parallel to the longitudinal axis of said body at a speed considerably superior to that by which the body is advanced.

The chief object of this invention is achieving, so far as possible, and in a simple, nonexpensive way, a smooth and even surface of an elongated rotational body by grinding and/or polishing.

This object, as well as others, is accomplished by the method according to the present invention in which each part of said grinding or polishing unit in momentary engagement with the body has had a speed component imparted to it, which is substantially perpendicular to the longitudinal axis of said body and which, with regard to its magnitude and direction, is in substantial agreement with the circumferential speed of said body caused by its rotary motion, and in which each part of the grinding or polishing unit, while in momentary engagement with said body, is caused to work the latter along a path which is longer than the distance that said body is advanced during each revolution about its longitudinal axis.

Further objects and advantages of the invention will become more fully apparent from the following description and the accompanying drawings illustrating preferred embodiments of the invention, and in which:

FIG. 1 is a perspective view showing how to work a tube by utilizing the method according to the invention, as well as elements directly co-operating with the tube in a machine intended for carrying out this method;

FIG. 2 is a side view of a grinding or polishing apparatus in the form of a polishing disc, by the aid of which the surface of an elongated rotational body, in the form of a tube, may be treated; and

FIG. 3 is a plan view corresponding to FIG. 2.

FIG. 4 illustrates an alternative embodiment in the same way as FIG. 2.

FIG. 5 illustrates a modification of the embodiment according to FIG. 1.

Referring particularly to FIG. 1, an elongated rotational body in the form of a tube **1** resting on a rotary roller **2**, is rotated by means of two rollers **3**, in the direction of the arrow N at a circumferential speed of N meters/sec. which corresponds to the rate of *n* revolutions per second. These rollers **3** are slightly skewed, so that they impart by means of their rotary motion, a longitudinal motion to the tube, which is thus advanced to the right at a rate of V meters per second, as indicated by the arrow V in FIG. 1. During the rotary and forward motions of the tube **1**, its surface is worked by a grinding or polishing member shown in FIGS. 1–3 and 5 of the drawings in the form of a polishing disc **4**, but which might just as well be e.g. an abrasive belt **8** which is held firmly pressed against the tube **1** by a contact disc **4***a* corresponding to the polishing disc **4** as shown in FIG. 4. The tube **1** is supported by the rotary rollers **5** located opposite to the grinding or polishing member. For the sake of simplicity, the term "grinding member" will be used in the following description as a general designation for the abrasive belt unit with appurtenant contact disc, polishing discs, grinding discs and similar tools used for surface treatment.

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According to the invention, a motion is imparted to the grinding member, that is the polishing disc **4** or the combination of contact disc **4***a* and belt **8** respectively, in such a manner that those patrs of it that are in instantaneous engagement with the workpiece **1**, are made to move substantially parallel to its longitudinal direction, at a speed of W m./sec., when working its surface, as is indicated by the arrow W in the figures. Consequently the grinding member **4** in FIG. 1 is rotated on the axis **6** at a rate corresponding to circumferential speed of W m./sec.

Owing to the elasticity, among other things, of the grinding member (i.e. the elasticity of the polishing disc or contact disc respectively), the contact between the elongated rotational body, i.e. the tube **1**, and the grinding member is not confined to a point but forms, in the example shown, a substantially elliptic contact area, designated with **7** in FIG. 3 and having a length of *a* meters and a width of *b* meters. The shape and size of the contact area above all depend on

The hardness of the grinding member, which affects both *a* and *b*;

The magnitude of the grinding pressure applied, which also affects both *a* and *b*;

The diameter of the grinding member, which affects *b*; and

The diameter of the workpiece, which affects *b*.

A hard grinding member naturally gives a smaller contact area than does a soft one, using one and the same pressure. The shape of the grinding image obtained will be affected by the hardness of the grinding member so that a hard contact disc will produce an image **7** having a more pointed appearance than a softer contact disc of equal diameter. Correspondingly, heavy working pressure produces larger contact area than reduced working pressure, hardness of grinding member being identical. The amount of working pressure to be applied on the workpiece depends on many factors, such as the condition of the workpiece, the grain of the abrasive belt, the quantity of material to be removed, the hardness of the contact disc, etc.

The diameter of the grinding member (or that of the contact disc respectively) will affect the size of the grinding image in about the same way as will the hardness of the contact disc.

The larger the grinding member, the larger the grinding image produced, and vice versa the use of smaller grinding members will of course affect the grinding pattern in the opposite way.

The number of revolutions of the contact disc will influence the result of the grinding operation in such a way, among others, that its hardness shall increase with the number of revolutions. The circumferential speed W giving the best possible belt ecenomy should be chosen. Concerning the nature of the face (whether plain or serrated face of the contact disc), the condition here is the one applicable in flat finishing: A plain disc face produces a somewhat smoother surface, with less removal of material, however, but a serrated one gives a coarser surface but achieves a larger amount of material removed.

In order to ensure treatment of the entire tube surface, and not only of a helical path of it, it is essential that the advancement of the tube for each revolution should be shorter than the length of the area **7**. In other words, the contact area **7** which is obtained at a certain tube angle, must necessarily overlap the corresponding surface obtained during the preceeding revolution (with respect to the rotation of the tube). The above condition may be expressed by the following formula:

$$a \geqq \frac{V}{n}$$

giving the following number of revolutions to be imparted to the tube:

$$n \geqq \frac{V}{a}$$

The diameter of the tube **1** (or the workpiece) will affect the dimensions of the grinding image or the contact area **7** in such a way that a larger diameter of the tube **1** will give a greater value of *b* than will a smaller diameter, and vice versa if other conditions remain identical.

If the tube **1** is advanced at a comparatively high speed, V m./sec., rather long striae will appear on its surface, and on account of its revolving motion, these will be slightly curved, giving the tube a spiral appearance. Even a slight skew of the polishing disc **4**, or contact disc **4***a*, (1° to 3° owing to the rotational speed N of the tube **1** and to its feed speed V) will eliminate the helical path of the grinding pattern.

Because of this skew, the points of the grinding member being in momentary contact with the tube **1**, are imparted a speed component substantially perpendicular to the longitudinal direction of the tube. This speed component is in substantial agreement with the circumferential speed N of the tube, produced by its rotation.

The angle mentioned above (α) between the longitudinal axis of the tube and that direction in which the different points of the surface of the grinding member move, when in contact with the tube **1**, may be calculated with the use of the following formula:

$$\operatorname{tg} \alpha = \frac{N}{W+V}$$

in which the designations have been used as in the foregoing.

In accordance with another feature of the present invention the grinding member is displaced substantially perpendicularly to the longitudinal axis of the rotational body being processed, in order that fresh, unworn abrasive may be constantly brought into engagement with it, as the abrasive on one part of the grinding member gets dulled or used up. This relative displacement between the grinding member and the body being processed, may be carried out intermittently or continuously and be performed by moving either the grinding member or the rotational body laterally, or by a combination of both. This displacement which may be performed, manually or automatically, by means of some means known per se, normally requires a width B (FIG. 3) of the grinding member, several times larger, or at least essentially larger, than the width *b* of the contact area **7**. When the grinding unit is an abrasive belt, the lateral displacement of the belt may be performed continuously at such a rate that the cutting or grinding capacity of the belt is entirely exhausted, as the entire width of the contact area or part of the workpiece has been traversed. This also produces the effect that the depth of the striae of the grinding pattern will gradually decrease as the abrasive grains are worn down, and therefore a smoother surface will be obtained than one normally obtained with the use of the chosen grain size.

If the grinding member is comprised of a polishing disc, the rate of the lateral displacement chosen should be the one that dispenses of take-up adjustments before its entire width has traversed the contact area, or a certain part of the workpiece (for instance all of it).

The choice of the kind of grinding member (type and grain size of the abrasive belt) is determined, as is the feed speed and the number of passes, by the material of the workpiece (whether stainless steel, aluminium, brass and so forth) and by the condition of this material (whether it presents more or less deep scratches etc.).

The number of revolutions of the rotational body is intimately related to the appearance of the grinding pattern, i.e. of the contact area **7**, and therefore indirectly dependent of the applied work pressure and the hardness of the contact disc and the feed speed etc.

While the invention has been particularly shown and described with reference to the preferred embodiments of FIGS. 1–4, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention. For instance, the rollers **5** in FIG. 1 might be replaced by a second grinding member **4***b*, working the surface of the rotational body **1** in an identical way to that of the grinding or polishing disc **4**, and located diametrically opposite to the latter with respect to the workpiece as shown in FIG. 5.

What I claim is:

1. A method of finishing the surface of an elongated rotational body, comprising the steps of advancing said body in the direction of its longitudinal axis and in engagement with an abrasive member while rotating said body on its said axis; moving each part of said abrasive member in momentary contact with said rotational body at a speed which is considerably superior to that by which said body is advanced, and in a direction which is substantially parallel to the longitudinal axis of said rotational body but which has a component which, as to magnitude and direction, is in substantial agreement with the circumferential speed of said body caused by its rotation; and maintaining the momentary engagement between each part of said rotational body and said abrasive member along a path which is longer than the distance that said body is advanced during each revolution about its longitudinal axis.

2. A method as claimed in claim 1 further comprising the step of displacing said abrasive member in its entirety with respect to said rotational body during the surface finishing operation substantially at right angles to the longitudinal axis of said body through a distance substantially superior to the width of the contact area between said member and said body as measured in the direction of displacement of said abrasive member so that fresh parts of said abrasive member which have not been in prior contact with said body are brought into repeated contact with said body.

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