No. 627,455. Patented June 20, 1899.

L. D. DAVIS.

MACHINE FOR AND PROCESS OF SHAPING AND STRETCHING METALLIC INGOTS.

(Application filed Jan. 31, 1898.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

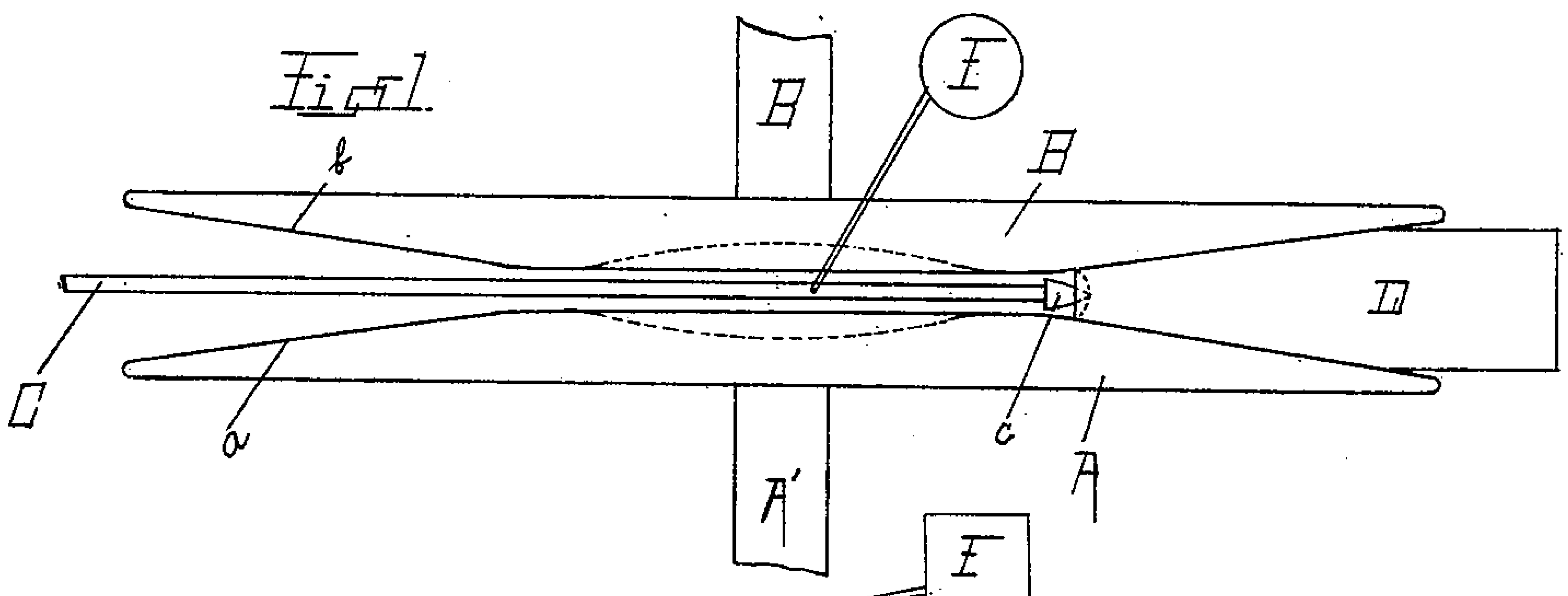
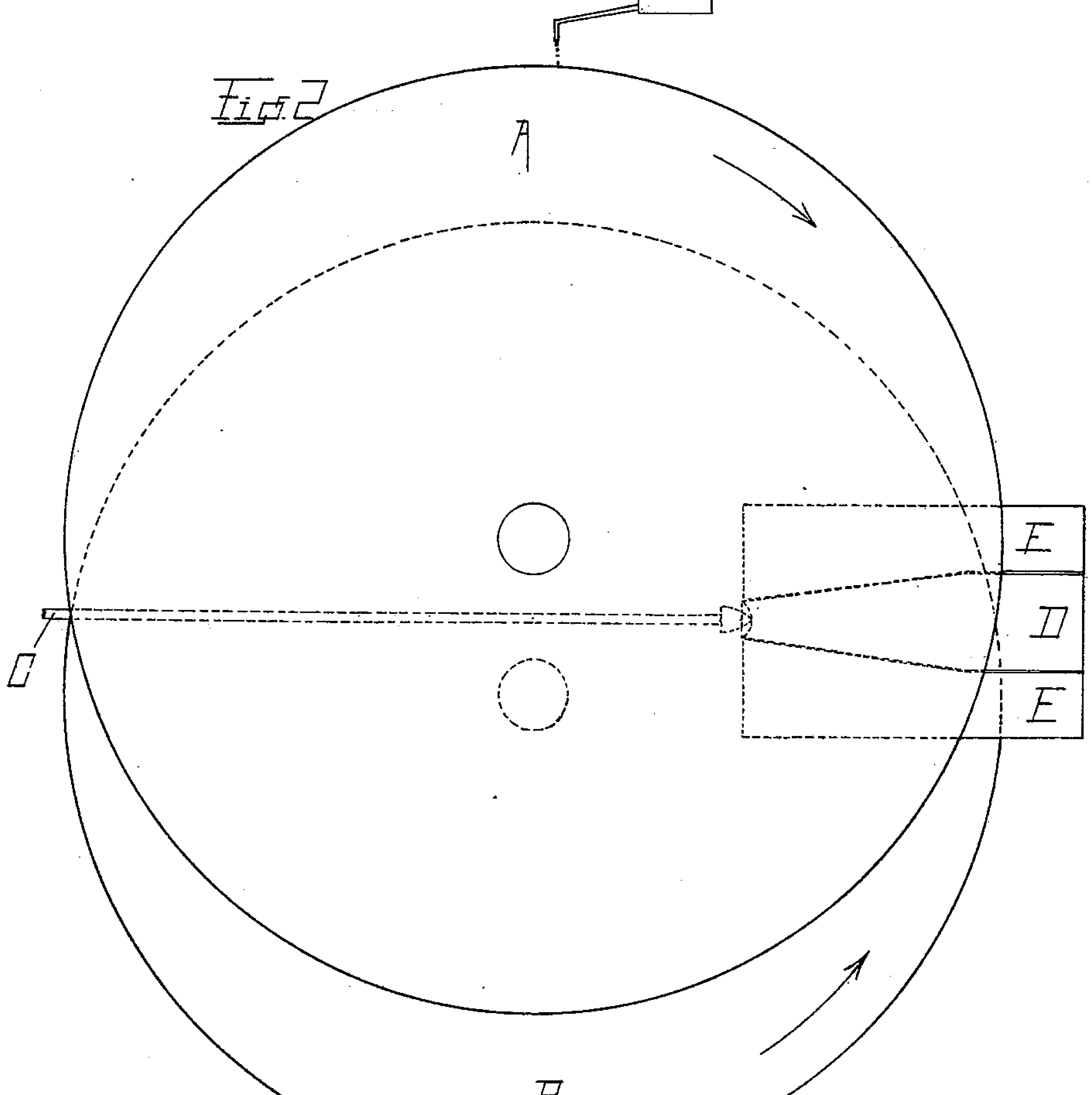


Fig. 2



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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Fig. 3.

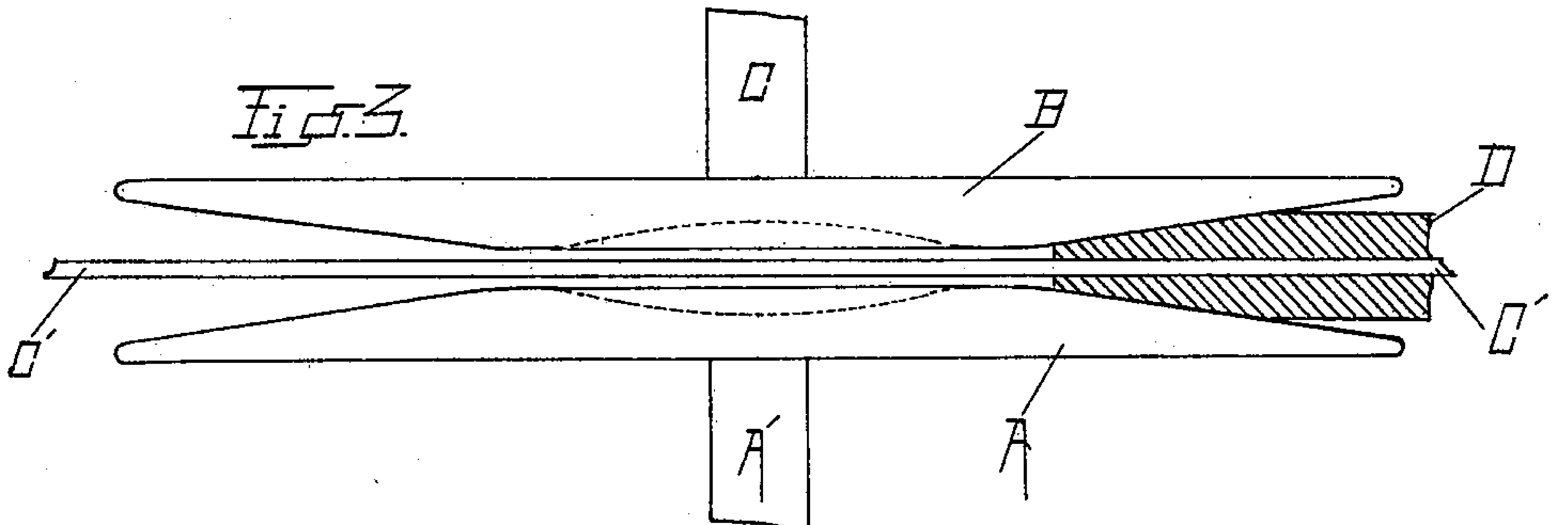
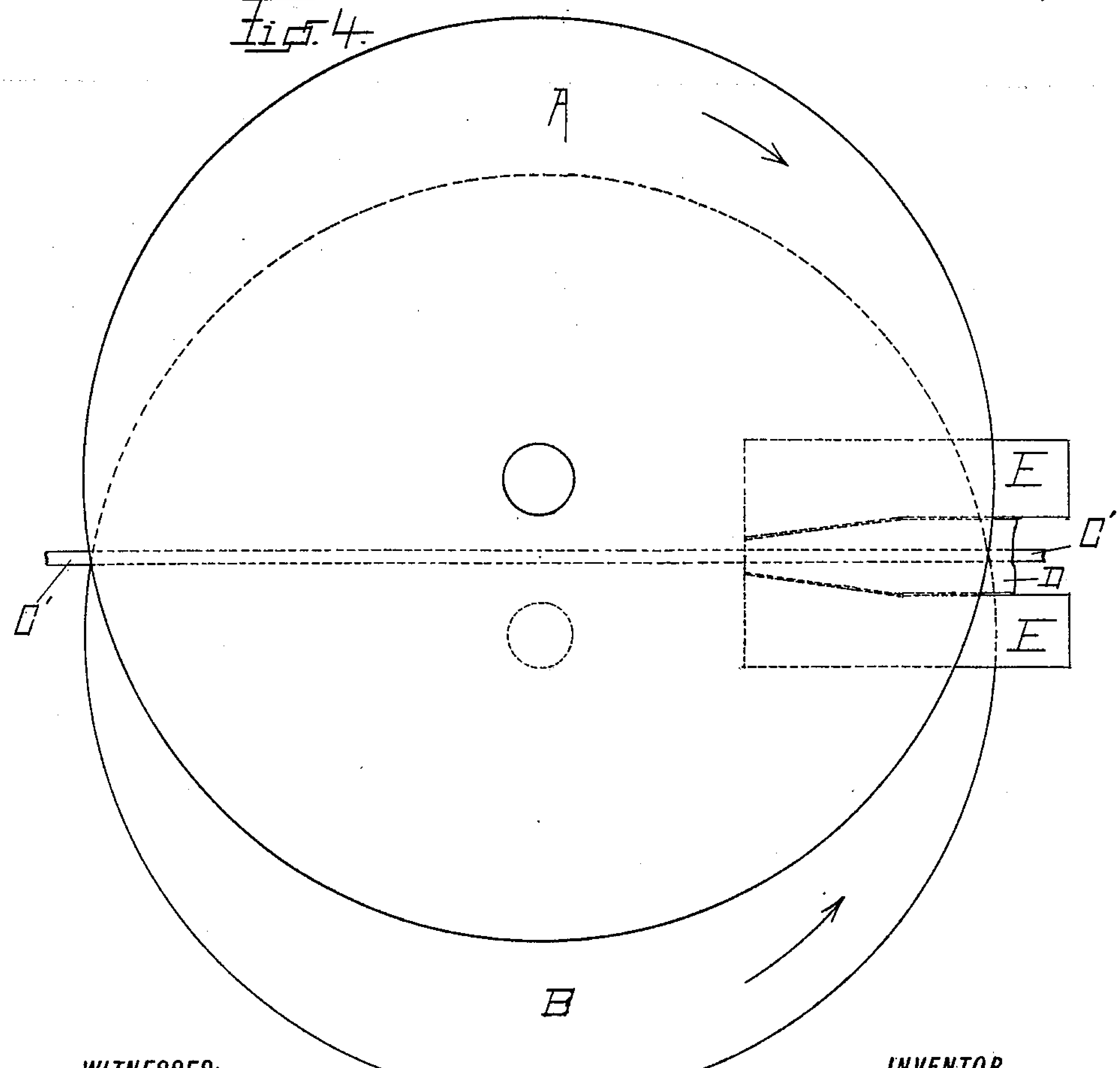


Fig. 4.



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(No Model.) 4 Sheets—Sheet 3.

Fig. 5.

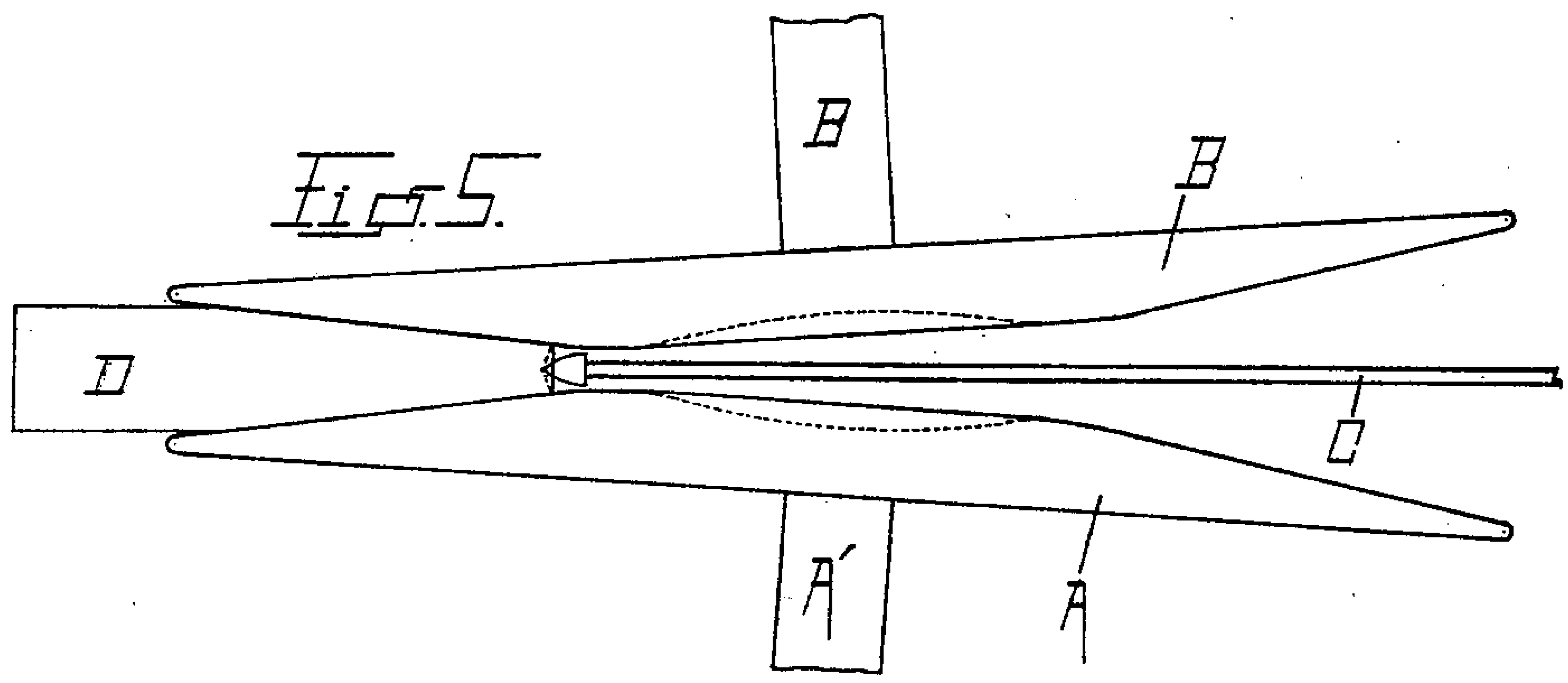

Fig. 6.

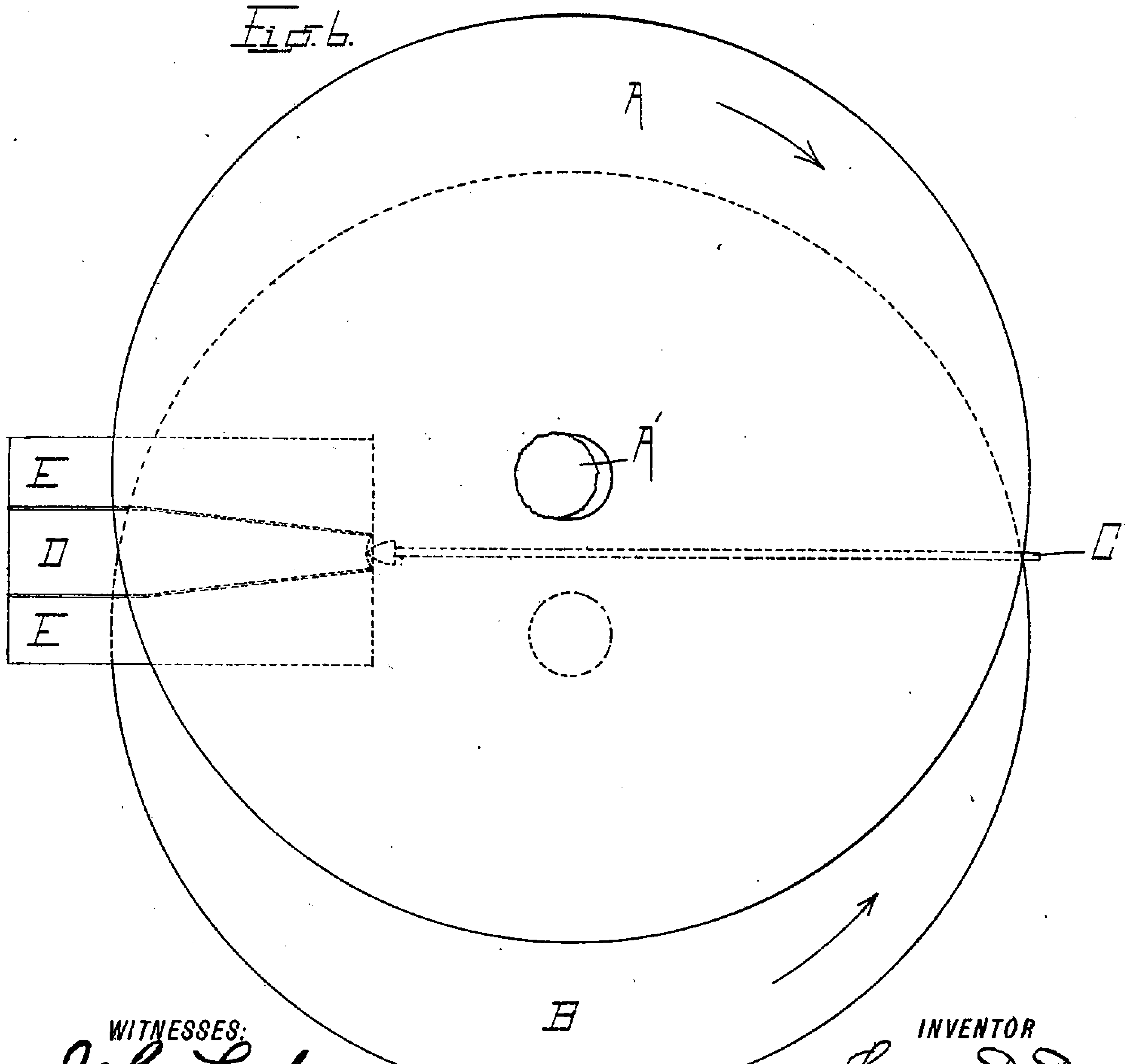

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Fig. 7.

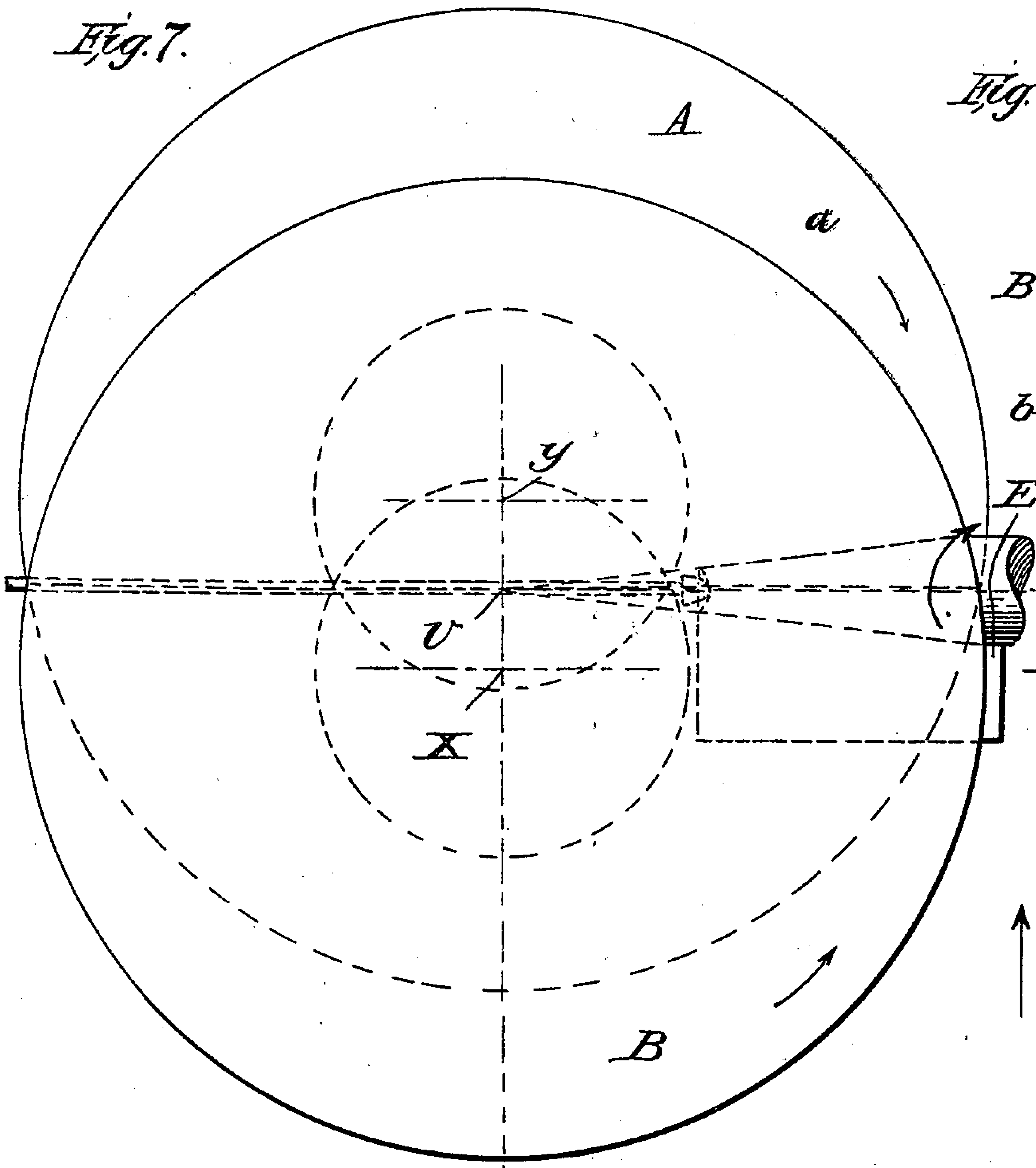


Fig. 8.

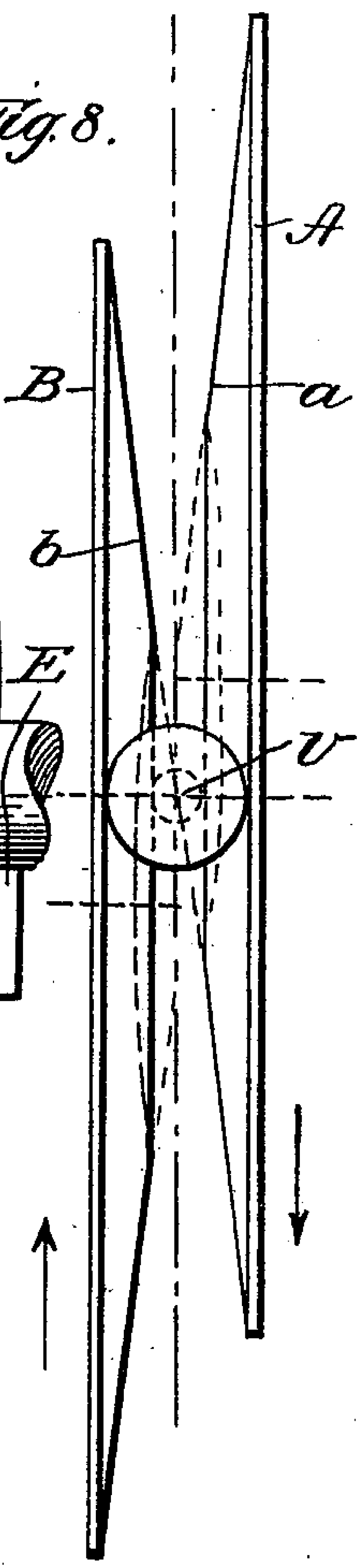
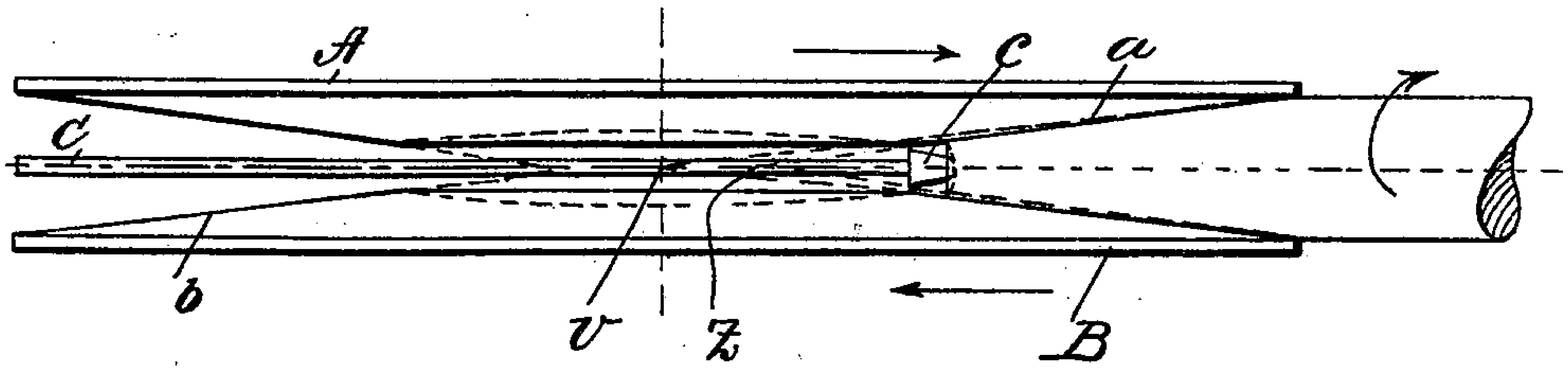


Fig. 9.



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UNITED STATES PATENT OFFICE.

LEONARD D. DAVIS, OF ERIE, PENNSYLVANIA.

MACHINE FOR AND PROCESS OF SHAPING AND STRETCHING METALLIC INGOTS.

SPECIFICATION forming part of Letters Patent No. 627,455, dated June 20, 1899.

Application filed January 31, 1898. Serial No. 668,564. (No model.)

To all whom it may concern:

Be it known that I, LEONARD D. DAVIS, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented certain new and useful Improvements in Machines for and Processes of Shaping and Stretching Metallic Ingots; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a machine for and a process of shaping metallic ingots; and it consists of certain improvements therein, as will be hereinafter fully described, and pointed out in the claims.

The machine is illustrated in the accompanying drawings, as follows:

Figure 1 shows a plan view of the device arranged to pierce and stretch the billet. Fig. 2 shows a side elevation of the same. Fig. 3 is a plan view of the machine arranged to stretch a pierced ingot or tube. Fig. 4 is a side elevation of the same. Fig. 5 shows an alternative construction of the device arranged to pierce and stretch a billet. Fig. 6 shows a side elevation of the same. Figs. 7, 8, and 9 show diagrammatical views, a side elevation, an end elevation, and a plan view, respectively.

The machine comprises two disks A and B, having working surfaces *a* and *b* and mounted on axles A′ and B′, respectively. The disks are so positioned relatively to each other that the working surfaces *a* and *b* are opposingly faced. The disk A, as shown, has its axis above the line of travel of the ingot and the disk B its axis below said line. The disks rotate in the directions indicated by the arrows, which are, as may be noted, in opposite directions. The piercing-mandrel C, with the usual tip *c*, is placed in the line of travel of the ingot if the machine is designed to pierce and stretch the ingot, and the continuous mandrel C′ is placed in the line of travel of the billet where the machine is designed simply to stretch a pierced ingot or tube. The guides E E are also provided to control the movement of the ingot between the disks.

As is well known in this art, it is desirable to give not only to the ingot a rotative movement through the action of the working surfaces of the disks upon it, but also through the same agency to give the billet an end thrust, which forces it in the line of its travel. This has been accomplished in various ways, most generally by passing the ingot by the contacting surfaces from the centers of the disks toward their outer periphery. The principal disadvantage incident to this method of working the ingot lies in the fact that there is greater rotative travel of the disks at points nearer the outer periphery than at those nearer the centers of the disks, so that the billet cannot be reduced in diameter in the direction of its feed and be given at the same time an equal rotative movement throughout the length of its contact, so that, as a result, where the billet is reduced in diameter the ingot is subjected to a severe twist, which makes it impracticable, except perhaps with some peculiar metals. Disks have also been arranged so that in their operation the billet was passed through them from the outer peripheries by the working surfaces toward the centers of the disks; but these, as well as the other devices of this kind with which I am familiar, lack the advantages which are found in my machine and do not affect the process which is present in the operation of my machine. With my machine, one of the disks being placed above the other, with the line of travel of the ingot midway between the axes of the disks, the ingot is given by reason of the passage of the working surfaces of the disks by and in contact with the ingot both a rotative and longitudinal movement toward the centers of the disks. This rotative movement and compression at diametrically opposite points operate upon the fibers of the ingot in such a way as to produce or tend to produce an opening through the center of the ingot. This tendency is aided by a piercing-mandrel, as C, where piercing is desired as part of the operation. It is desirable where the ingot is much reduced in transverse area that there be as little twisting of the ingot as possible, because where the reduction is considerable a very slight twisting as the work goes along cumulates into a very severe strain before the complete reduction is accomplished. This twisting of the ingot is obviated in my machine as follows: Observing Figs. 7, 8, and 9, it will be seen that the disks are beveled so that the line of the surfaces of the disks continued intersect each other when observed in plan view, Fig. 9, (see also Figs. 1, 3, and 5,) at a point Z, which point as it appears in Fig. 9 is at a distance from the line of the axes of the disks equal to one-half the distance between said axes as they appear at Y and X in Fig. 7. Again observing this bevel as it appears in Fig. 8, it will be seen that if the disks were added to in the direction of each other until they came together, as indicated by the dash-lines, the lower edge of the flat central part of the upper disk would contact the upper edge of the flat central part of the lower disk at a point V, so that a continuation of the upper line indicating the bevel of the lower disk coincides with the lower line indicating the bevel of the upper disk. It will further be noted that the axis of the billet passes through this point V. The disks so added to would have a movement at the point V exactly in line with the axis of the billet, so that if the billet were continued, as indicated by the dash-lines in Figs. 7 and 9, to the point V it would give to the billet at that point longitudinal movement only, so that this point may be called, so far as rotative-producing movement is concerned, the "zero-point." Beginning, therefore, with this zero-point as a basis and giving to the billet at its first contact with the surface of the disks any diameter desired, or, in other words, shaping the disks so as to bring their outer peripheries any distance apart, it is manifest that if there is no intermediate contact of the billet between the point V and the outer peripheries of the disks there will be no conflict as to the rotative-producing effect upon the billet. Having the point of zero rotation at Z and the point of maximum rotation at the outer edge of the disk in order to give equal rotation to all parts of the interposed billet, it is only necessary to give to the bevel between the points Z and the outer periphery a shape which will give a diameter to the billet at each point of contact in proper proportion to the diameter of the billet at the outer edges of the disks to compensate for the difference in rotative-producing effect of the disks at the several points of contact. It is not practical to illustrate the exact contour of the surfaces of the disks on drawings of a scale shown. In the drawings, therefore, the elements of the cones forming the disks are shown as straight. It will be found that this will make the billet at the inner edge of the working surface too small. If, therefore, the initial shape is as shown, the inner portions should be cut or ground out to give to the interposed billet a slightly larger size at these points. The disks may be formed of more nearly correct shape in the first instance by making the intersection of the surfaces of the disks with a horizontal plane, including the axis of the billet, straight lines. The shape of disks to give substantially exactly equal rotation to the billet can be made, however. This can be done by a series of approximation starting with any bevel having its line pass from the outer periphery to the point Z, getting the line of contact of an interposed billet, and finding the rotative-producing effect of the disks at several points along said line; then changing the shape of the disks to give a form to the billet that will satisfy the rotative-producing effect of the newly-formed disks at the several points; then getting the new line of contact produced by the billet so justified, and repeating this operation until the disks assume a shape which will have a rotative-producing effect at the several points along the line of contact of an interposed billet to give to the interposed billet substantially equal rotation throughout its length of contact. As the billet passes through machines of this class and is reduced in transverse area by radial pressure the reduction in transverse area must be compensated for by elongation of the billet. With my machine arranged as described this elongation of the billet is effected both by the radial pressure and a differential pull upon the billet at different points along its contact with the working surfaces of the disks. This effect may be explained as follows: The longitudinal producing effect of the disks upon the billet is due to the passage of the disks by and in contact with the billet at an angle less than a right angle to the axis of the billet, or, in other words, the lines of travel on the disks pass the billet on a slant and this passage produces both a rotative and longitudinal movement. Where the line of contact of the billet with the disks is in the same horizontal plane with the axis of the billet, the longitudinal producing effect of all parts of the working surfaces of the disks is the same. This is due to the fact that while the slant of the movement of the disks nearer the outer periphery is less than at points nearer the centers of the disks the greater travel at the outer periphery exactly compensates for this difference in the direction of travel. In my machine the line of contact of the disks with the billet is not included in a horizontal plane including the axis of the billet, but is represented by a line which more nearly approaches the radial lines which are in planes parallel to the horizontal plane including the axis of the billet at points nearer the outer periphery than at points nearer the center, or, in other words, on the disk A, as shown in Fig. 8, the line of contact slants upwardly toward the outer periphery of the disk and the line of contact on the disk B passes downwardly as it approaches the outer periphery. This being so, the lines of travel of the disks by the billet at points near the outer periphery of the disks approach more nearly to a movement at a right angle to the axis of the billet than would be the case were the line of contact included in the same horizontal plane with the axis of the billet, and as the line of contact more nearly approaches the horizontal plane including the axis of the billet at points near the center of the disks a greater longitudinal producing movement or end thrust is effected by those parts of the disks near the center than by those parts near the outer periphery. The result is that every point of contact on the disks' surface tends to hold the ingot against the pull of the disks at the next succeeding point nearer the center of the disks, so that throughout the whole length of the working contact of the disks there is a longitudinal pull upon the ingot and a longitudinal resistance to this pull which tends to produce a stretching action in the ingot, and as a stretching of the ingot tends to reduce the transverse area of the billet and a radial pressure on the ingot sufficient to reduce its transverse area also tends to lengthen it it will be seen that the forces working upon the ingot work in harmony. It will also be noted in this connection that with my machine the billet is engaged at a series of transversely-opposing points (in the machine shown two points) and is simultaneously pulled at all these points, so that the billet is engaged and stretched bodily as well as locally.

It will be noted that as the line of contact on the disk A in my machine passes upwardly from a line included in a horizontal plane including the line of the axis of the billet a greater amount of the travel of the disks at the outer periphery is absorbed by a rotative movement of the ingot than would be the case were the line of contact in the horizontal plane including the axis of the billet. This greater rotative-producing effect by reason of this deflection of the contact-line is of course to be compensated for by the method hereinbefore described, or, in other words, the diameters of the ingot at the several points effected by the shape of the disks are to be proportioned to the rotative-producing effect of the disks at said points rather than the actual rotative movement of the disks. By reason of this arrangement of the disks, whereby their rotative action upon the billet is so compensated, a much longer working surface of the disks can be presented to the ingot, and hence a more gradual reduction may be had, because where the variation in rotative-producing action of the different portions of the disks are not so compensated by the change in the circumference of the ingot the twist produced in the ingot becomes so great as to make such a length of contact impracticable, and the reduction must in consequence be very abrupt. For this reason my machine is peculiarly designed for reducing and stretching tubes already pierced, as shown in Figs. 3 and 4. With disks having their axes parallel this stretching action of the disks is present through quite a variation in the shapes of the disks—that is, the point Z may be brought nearer the lines of the axes than shown in Fig. 9 without eliminating this effect. In Figs. 5 and 6 the disks are shown with their axes at a slight angle to each other. This arrangement allows a greater width of passage at the back side of the disk, so that a free passage for the shaped ingot is provided. As the angle of the axis is increased, however, or the disks are changed from a position wherein their axes are parallel the shapes of the disks as to bevel which will give a stretching action to the billet become more limited, and as the point Z is carried nearer to the line of the axis the stretching effect is lost and may become entirely neutralized, and in fact such a bevel may be given to the disks set at an angle to each other as to have an upsetting effect upon the billet in its passage between them.

Where the axes of the disk are parallel, as shown in Figs. 1 and 2, it may be desirable to provide a drip device for cooling a tube or ingot as it passes the center of the disk and before it reaches the opening or pass at the back side of the disks. The disks are preferably hollowed out or dished at the center to allow a space in which the ingot may cool, and while it is desirable to use the trip device, which not only cools the ingot, but gives to its surface a polish, the ingot may be allowed to cool in the space created by the hollow of the disks sufficiently without said device to readily pass through the opening at the back side of the disks.

From the description heretofore given of the machine it will be observed that I utilize a process of stretching and shaping ingots whether they are initially solid and pierced by the machine or are of tubular form and are simply shaped by the machine. The features of this process comprise subjecting the billet to a rotative swaging action so graduated and directed as to shape the billet without twisting it. This process I consider an important step in the art when used with ingots which are initially substantially homogeneous; but it is particularly advantageous with ingots having a pronounced fiber. In fact I believe this process to be the only successful one for treating the latter. The operation of the machine also includes a process wherein there is a rotative engagement opposing another rotative engagement, said engagements being arranged to effect in themselves the swaging of the ingot. It also describes a process wherein the nature of this engagement is so varied without breaking its continuity as to effect both the swaging and the stretching of the ingot. It also includes the important minor feature of varying the diameter of the ingot by rotative swaging effected by pressure so graduated and directed as to maintain in it substantially straight fibers, or, in other words, in a manner which obviates the twisting of the ingot.

I do not herein claim specifically the structure shown in Figs. 5 and 6, as a specific claim for said structure is contained in my application filed May 3, 1899, Serial No. 715,394.

What I claim as new is—

1. The art or process of stretching and shaping metallic ingots, which consists in simultaneously imparting a rotary motion to said ingot, stretching said ingot by engaging one part of said ingot at a series of transversely-opposing points and exerting longitudinal pull at said points and engaging and holding another part of said ingot at a series of transversely-opposing points back of the points subjected to the pull sufficiently to effect a resistance to said pull, and swaging said ingot by subjecting that part of the ingot receiving the stretch incident to the pull and resistance to said pull to radial pressure exerted by a rolling contact, whereby the rotating ingot is subjected at one and the same place to a stretching action and non-twisting radial compression.

2. The art or process of stretching and shaping metallic ingots which consists in engaging said ingot at a series of transversely-opposing points, and exerting a longitudinal pull at said points; engaging and holding another part of said ingot at a series of transversely-opposing points back of the points subjected to the pull sufficiently to effect a resistance to said pull; and rotatively swaging said ingot by subjecting that part of the ingot receiving the stretch incident to the pull and resistance to said pull to pressure graduated and directed to maintain or produce straight fibers in said ingot.

3. The art or process of stretching and shaping metallic ingots which consists in engaging said ingot at a series of transversely-opposing points, and exerting a longitudinal pull at said points; engaging and holding another part of said ingot at a series of transversely-opposing points back of the points subjected to the pull sufficiently to effect a resistance to said pull; and rotatively swaging said ingot by subjecting that part of the ingot receiving the stretch incident to the pull and resistance to said pull to pressure graduated and directed to effect a variation in the diameter of the ingot and to maintain or produce straight fibers in said ingot.

4. In a machine for shaping metallic ingots, the combination of two eccentrically-disposed disks provided with working faces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet, and for a feeding of the billet toward the centers of the disks, the faces on said disks being shaped and disposed to each other and the axes of the disks to effect a greater feeding action on the billet at points nearer the centers of the disks than at those nearer the outer peripheries of the disks.

5. In a machine for shaping ingots, the combination of two eccentrically-disposed disks provided with working faces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet, and for a feeding of the billet toward the centers of the disks, the faces on said disks being shaped and disposed to each other and the axes of the disks to contact an interposed billet on lines inclined to approach a plane, parallel to the axes of the disks and including the axis of the billet, in the direction of the centers of the disks.

6. In a machine for shaping ingots, the combination of two eccentrically-disposed disks having parallel axes and provided with working surfaces opposingly faced, and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet; said disks being arranged to rotate in opposite directions, the directions of rotation being such as to produce by contact of the working surfaces rotative movement of the ingot subjected thereto and longitudinal movement thereof by said contacting surfaces in a direction toward the centers of the disks.

7. In a machine for shaping ingots, the combination of two disks provided with working surfaces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet and for a feeding of the billet toward the centers of the disks with the distance between said faces increasing from a point nearer the center to a point nearer the outer periphery in proper proportion to effect approximately a rotative-producing curvilinear travel at each of said points equal to the circumference of an interposed ingot at said points respectively.

8. In a machine for shaping ingots, the combination of two eccentrically-disposed disks provided with working surfaces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet with the distance between said working surfaces increasing from a point nearer the centers of the disks to a point nearer the outer periphery thereof in proper proportion to effect approximately a rotative-producing curvilinear travel at each of said points equal to the circumference of an interposed ingot at said points respectively, said disks being arranged to rotate in opposite directions, the directions of rotation being such as to produce by contact of their working surfaces, a rotative movement of the ingots subjected thereto, and a longitudinal movement of the ingot.

9. In a machine for shaping ingots, the combination of two eccentrically-disposed disks provided with working surfaces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet with the distance between said working surfaces increasing from a point nearer the centers of the disks to a point nearer the outer periphery thereof in proper proportion to effect approximately a rotative-producing curvilinear travel at each of said points equal to the circumference of an interposed ingot at said points respec-

tively, said disks being arranged to rotate in opposite directions the directions of rotation being such as to produce by contact of their working surfaces, a rotative movement of the ingots subjected thereto, and a longitudinal movement of the ingot, by said contacting surfaces in a direction toward the centers of the disks.

10. In a machine for shaping ingots, the combination of two eccentrically-disposed disks provided with working surfaces opposingly faced and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet with the distance between said surfaces increasing from a point nearer the center to a point nearer the outer periphery in proper proportion to the rotative-producing curvilinear travel at each of said points to approximately equal the circumference of an interposed ingot at said points respectively, said disk being arranged to rotate in directions to produce by the contact of said working surfaces, a rotative movement of the ingot subjected thereto and a longitudinal movement of the ingot by said contacting surfaces in a direction toward the centers of the disks; and a mandrel interposed in the line of travel of said ingot.

11. In a machine for shaping ingots, the combination of two disks provided with working surfaces opposingly faced, and arranged to contact an interposed billet at substantially diametrically opposite sides of said billet and for a feeding of the billet toward the centers of the disks with the distance between said faces increased from a point nearer the center to a point nearer the outer periphery, said disks having their axes parallel and being dished at their centers sufficiently to prevent their contact with the ingot at said centers.

12. In a machine for shaping ingots, the combination of two disks provided with working surfaces opposingly faced and for a feeding of the billet toward the centers of said disks with the distance between said faces increasing from a point nearer the center to a point nearer the outer periphery, said disks having their axes parallel and being dished at their centers sufficiently to prevent their contact with the ingot at said centers; a drip device arranged to feed a cooling liquid to the ingot as it passes said central portion of the disks.

In testimony whereof I affix my signature in presence of two witnesses.

LEONARD D. DAVIS.

Witnesses:
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H. C. LORD.