O. BRIEDE.

PROCESS FOR ROLLING OUT HOLLOW BILLETS TO FORM SEAMLESS TUBES.

APPLICATION FILED APR. 20, 1907.

969,333. Patented Sept. 6, 1910.

4 SHEETS—SHEET 1.

FIG. 1.

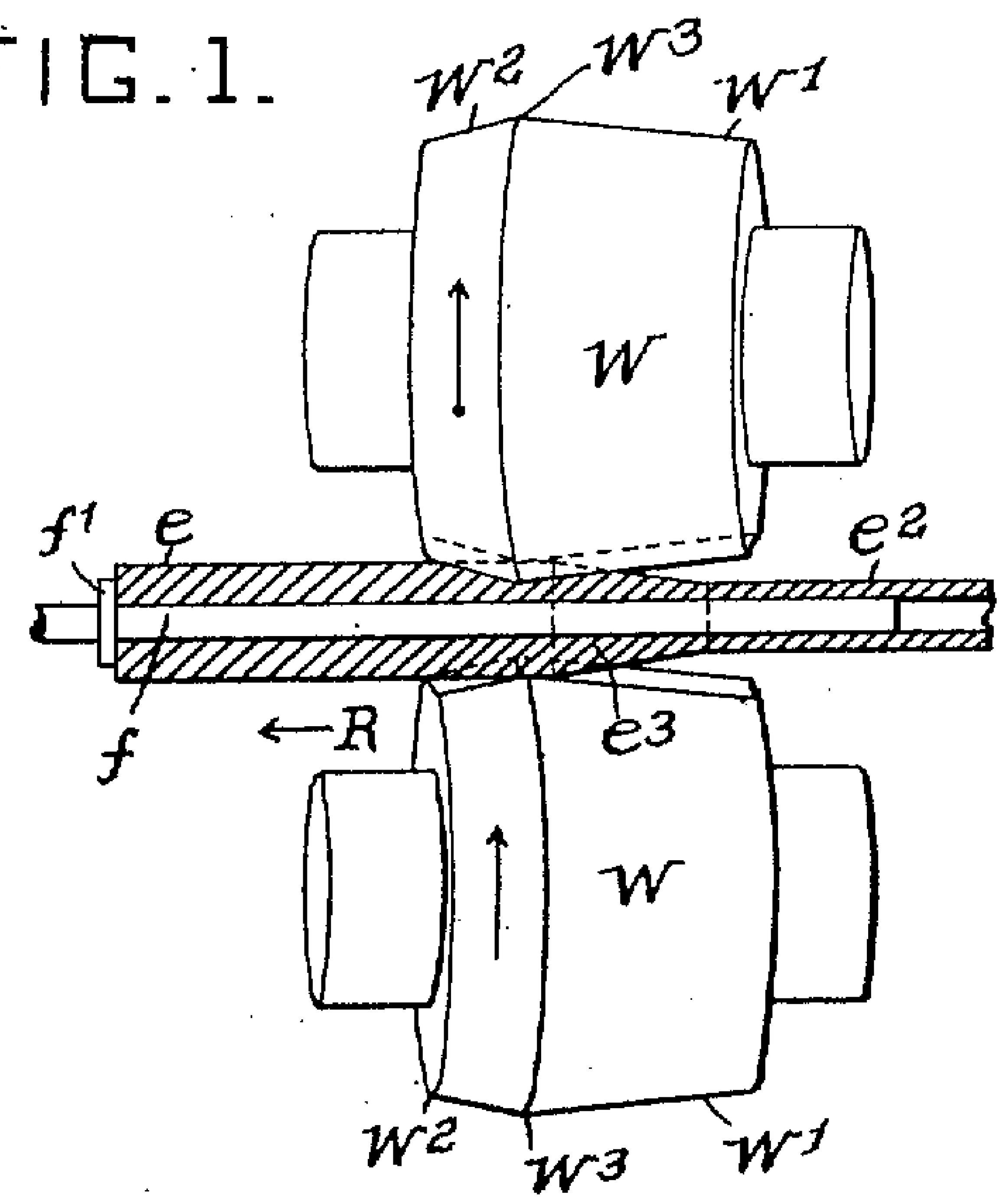

FIG. 2.

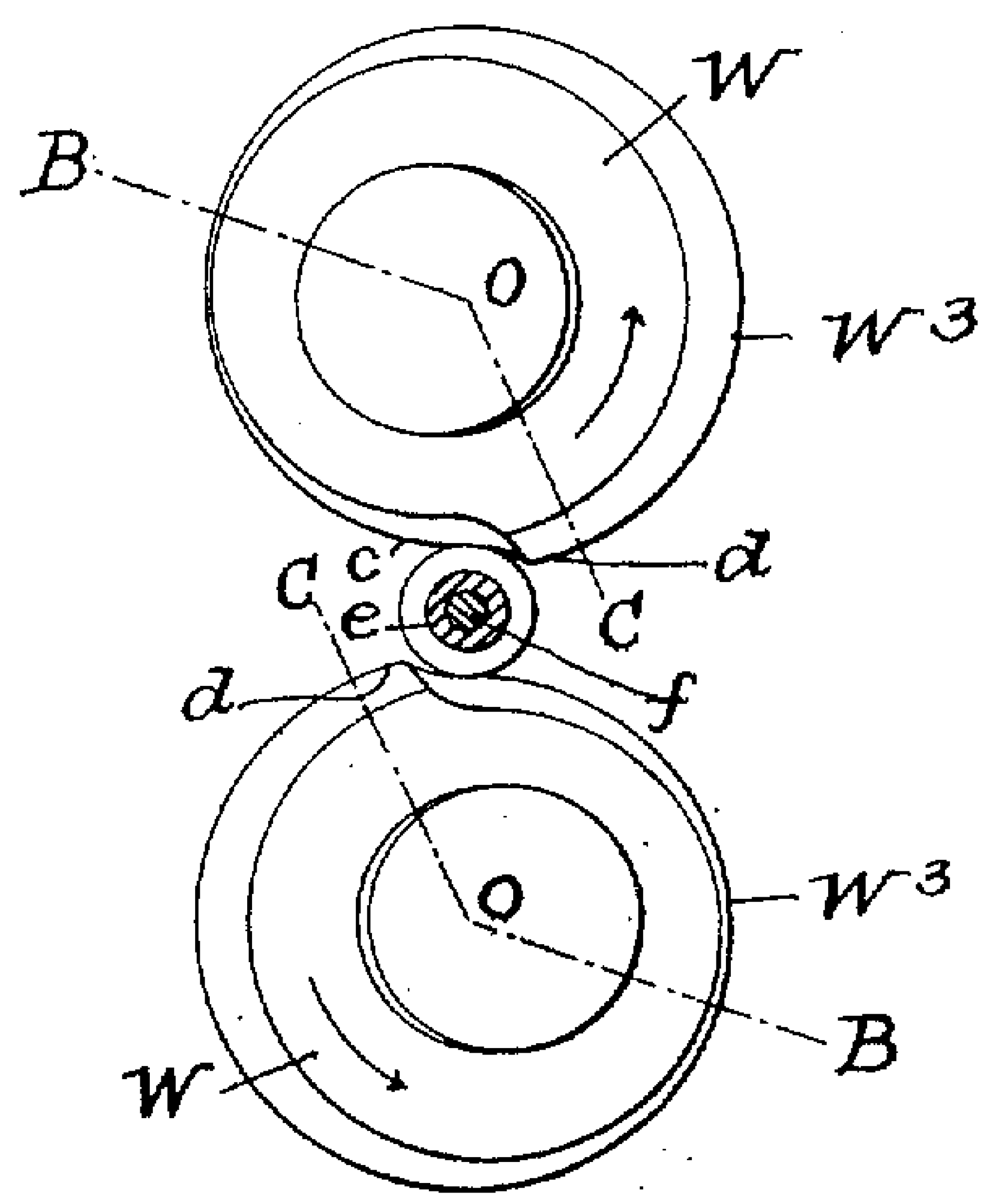

FIG. 3.

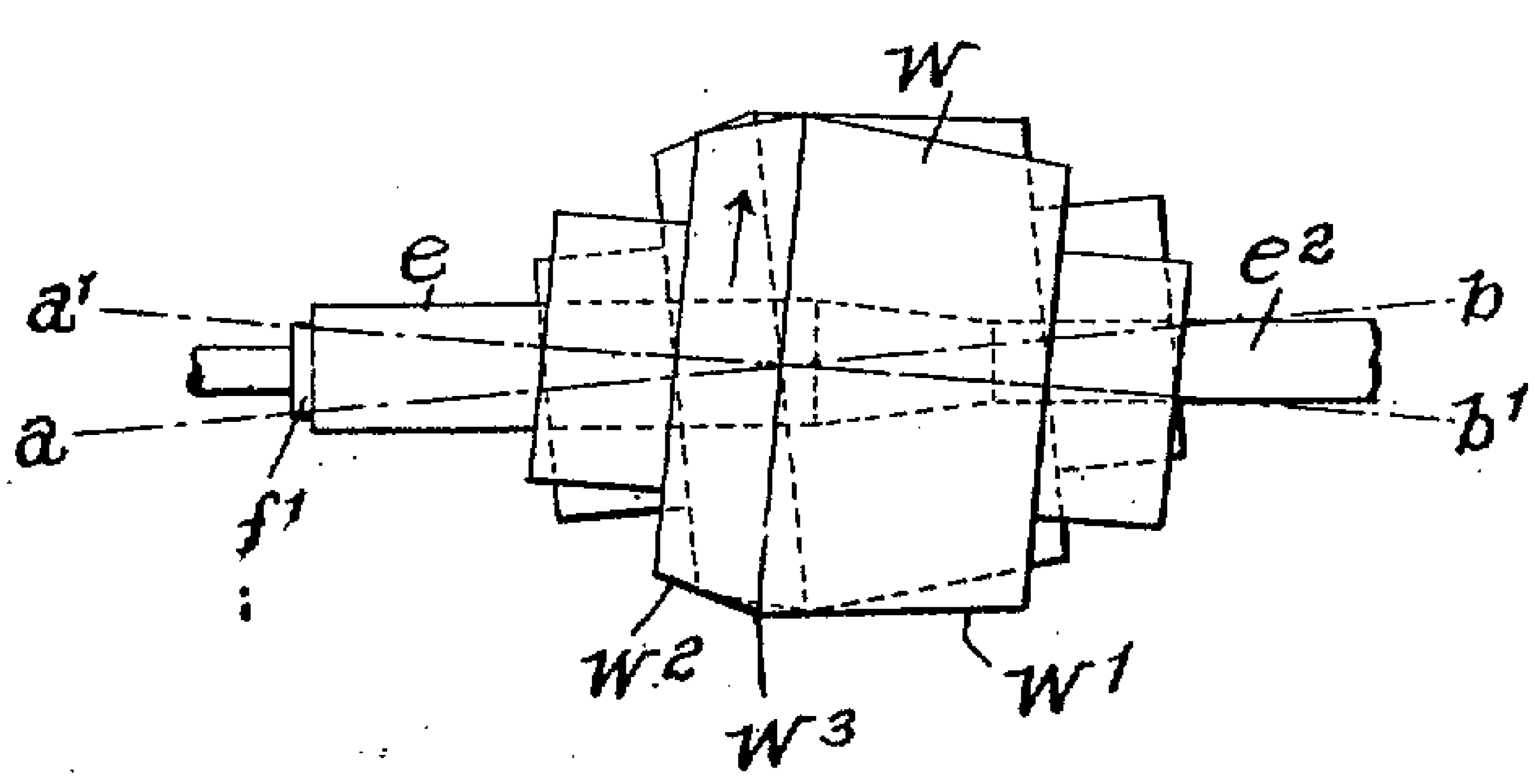

FIG. 4.

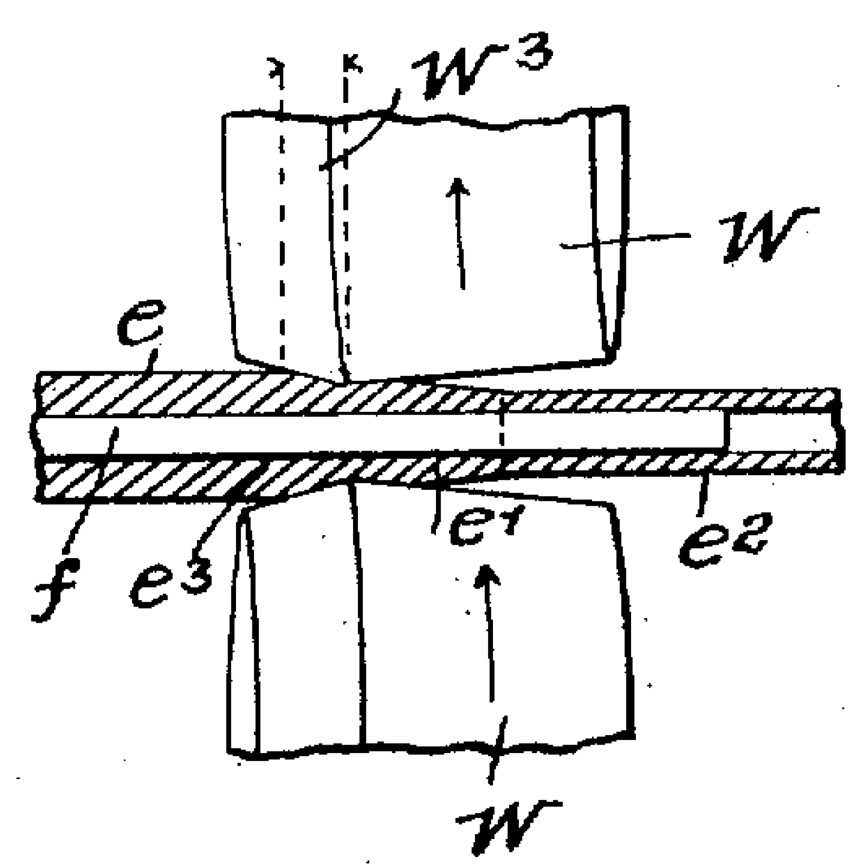

FIG. 5.

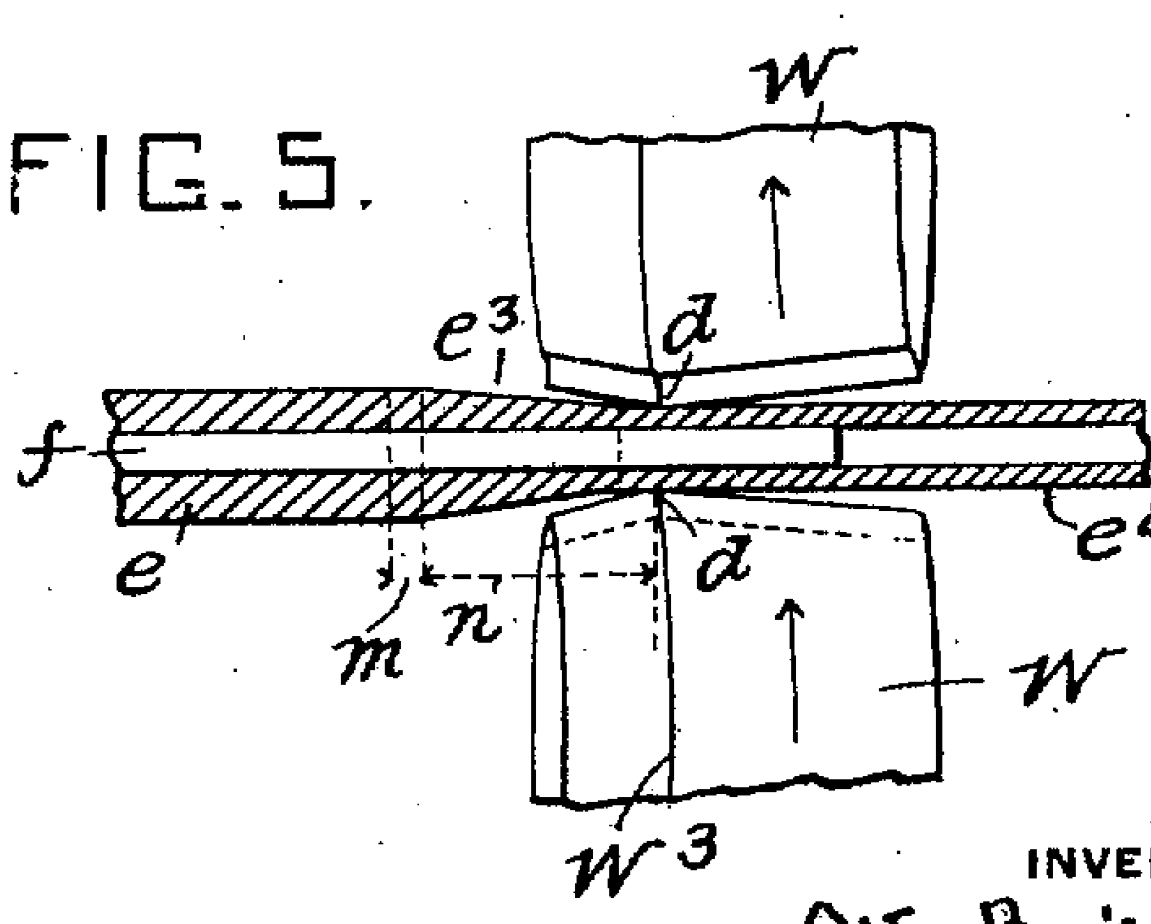

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FIG. 6.

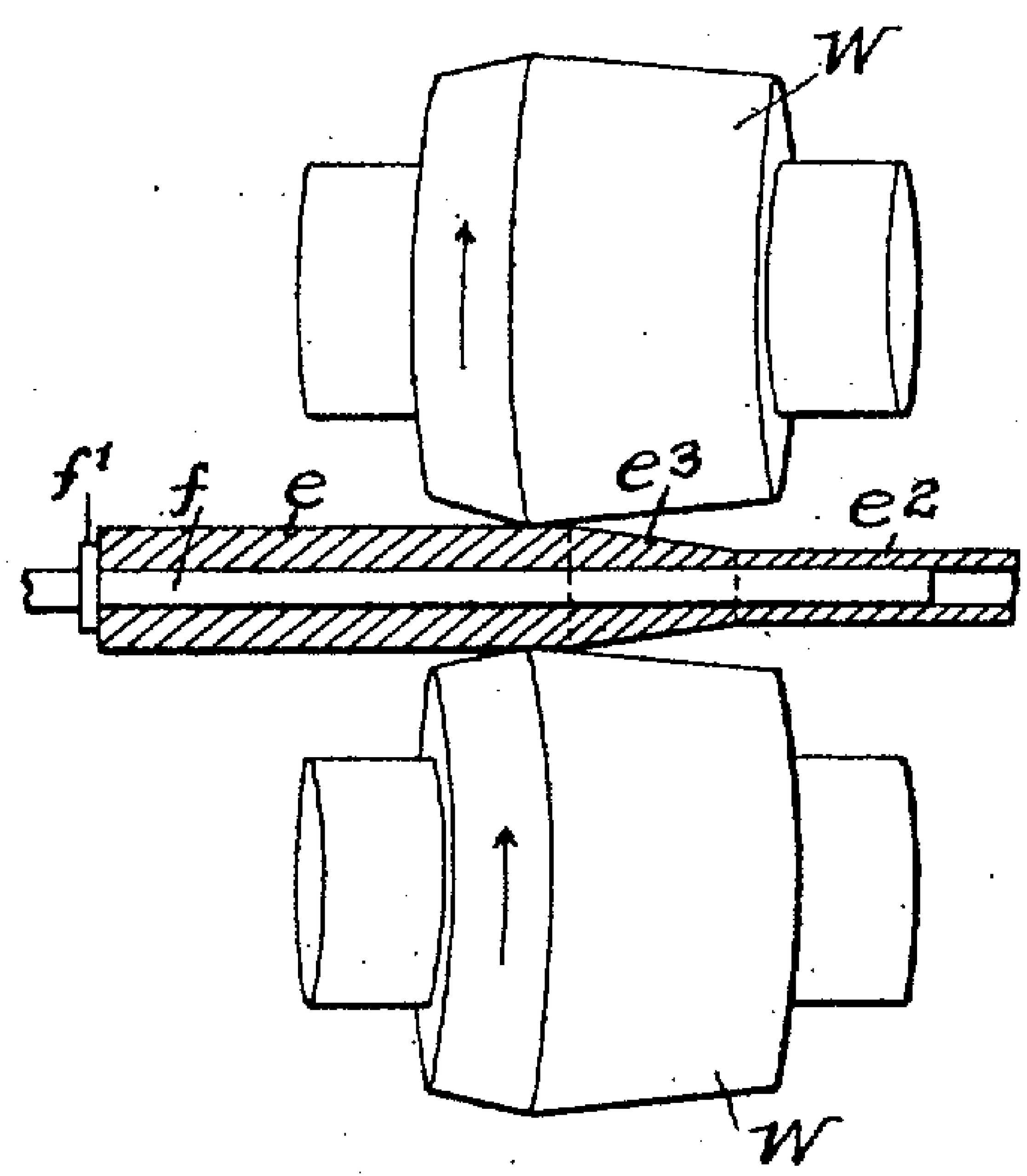


FIG. 7.

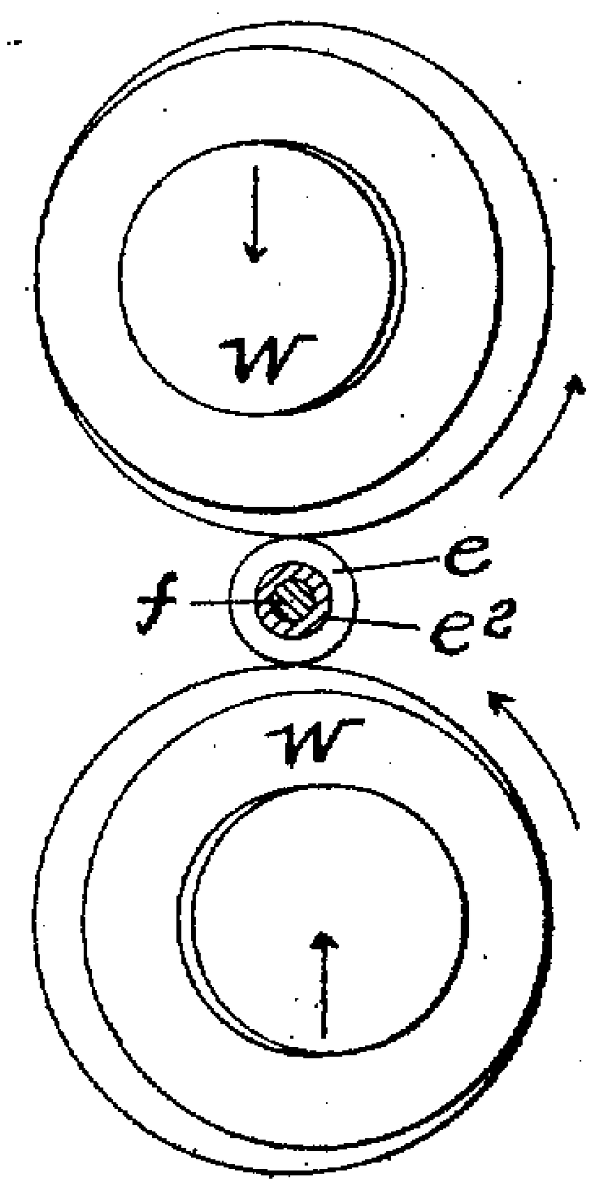


FIG. 8.

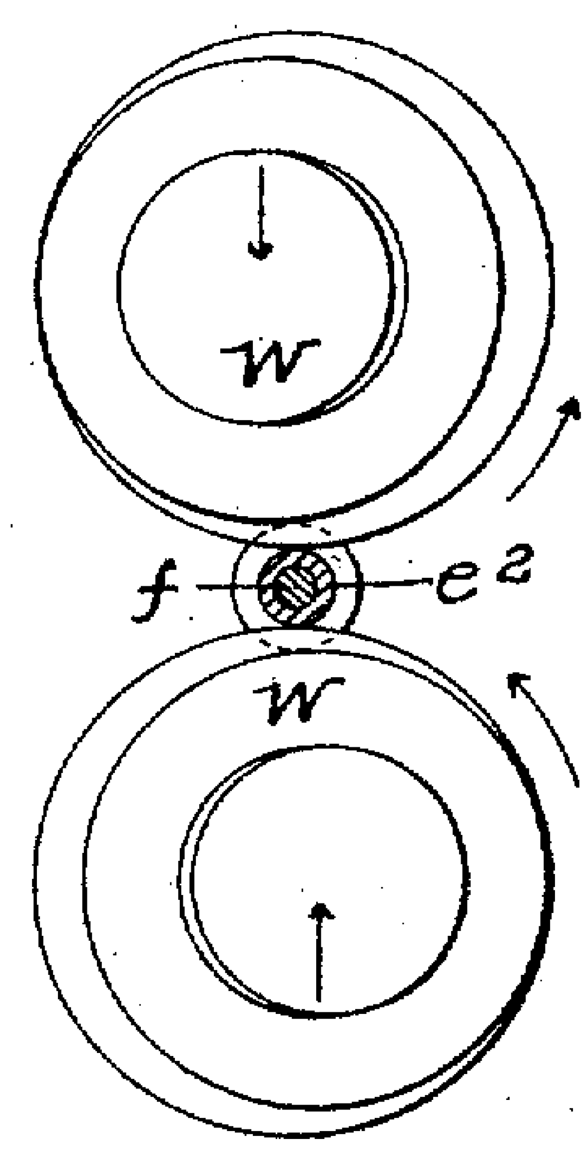


FIG. 9.

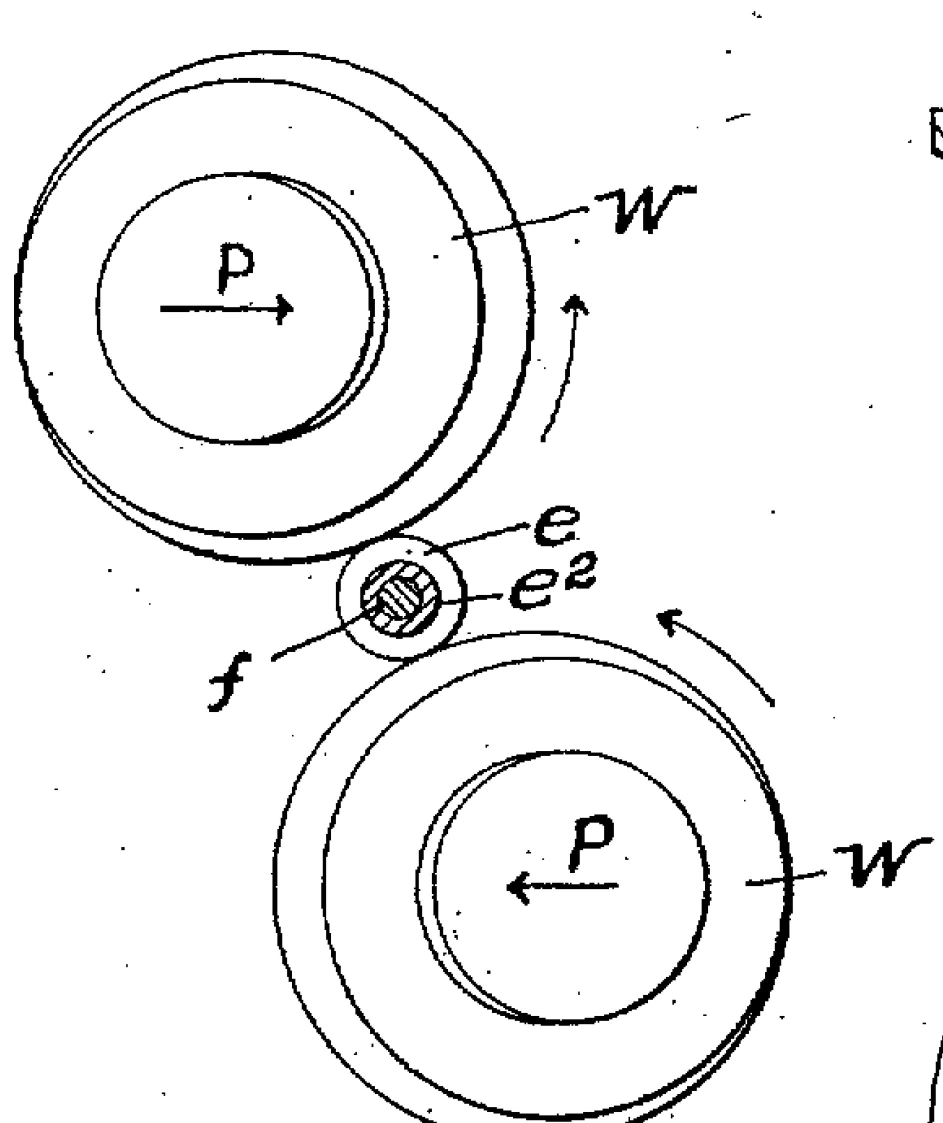


FIG. 10.

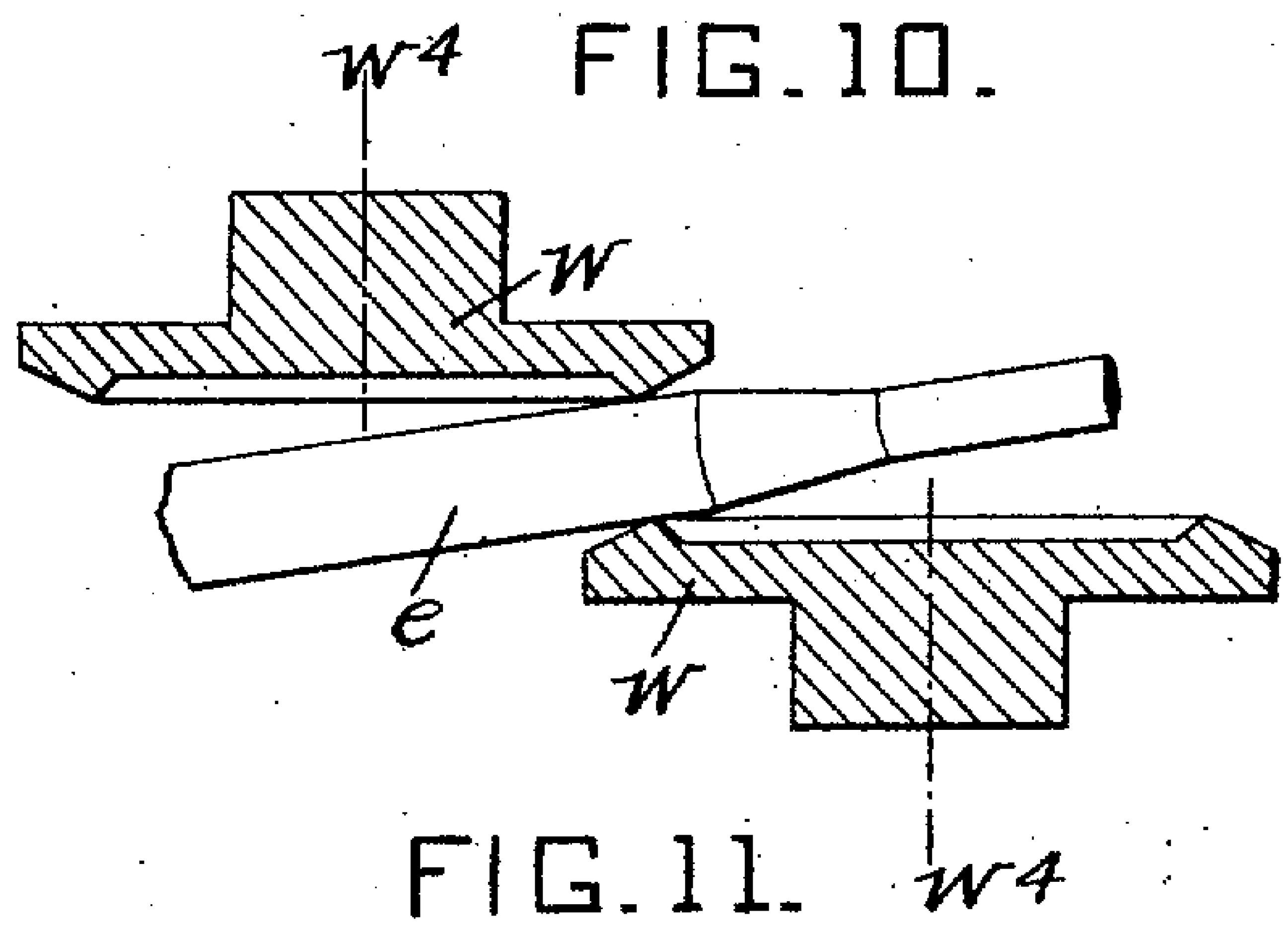
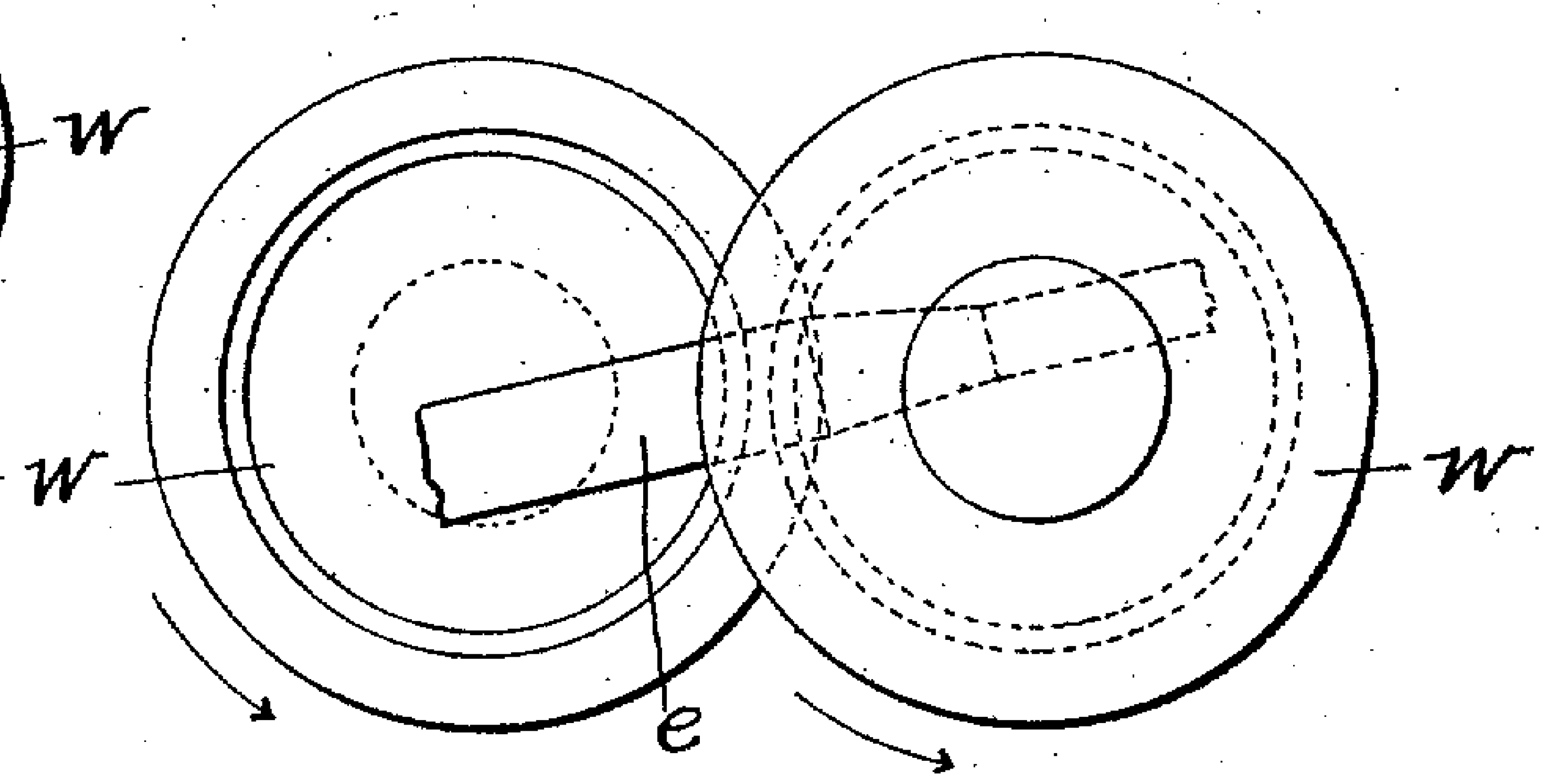


FIG. 11.



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4 SHEETS—SHEET 3.

FIG. 12.

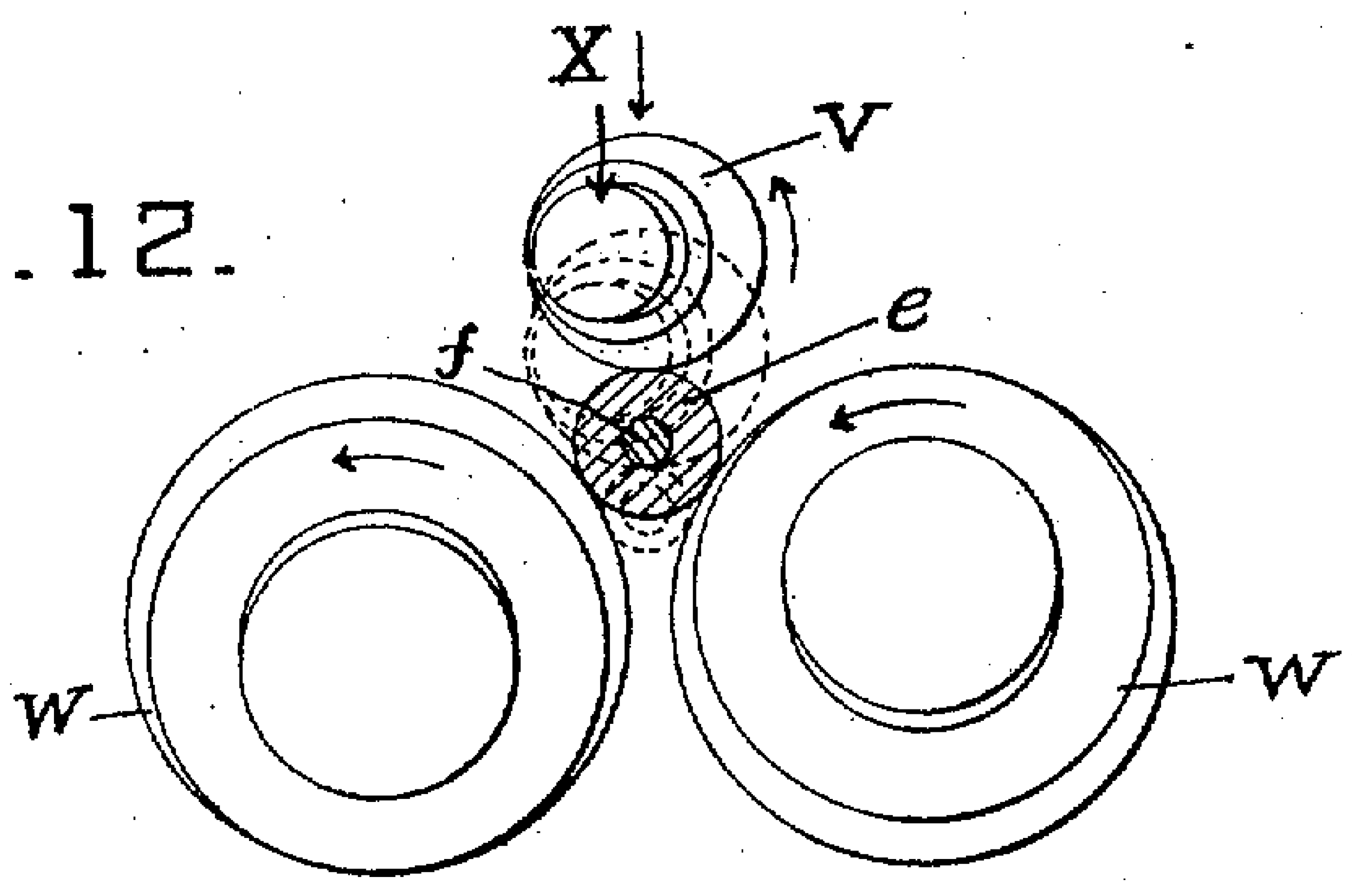


FIG. 13.

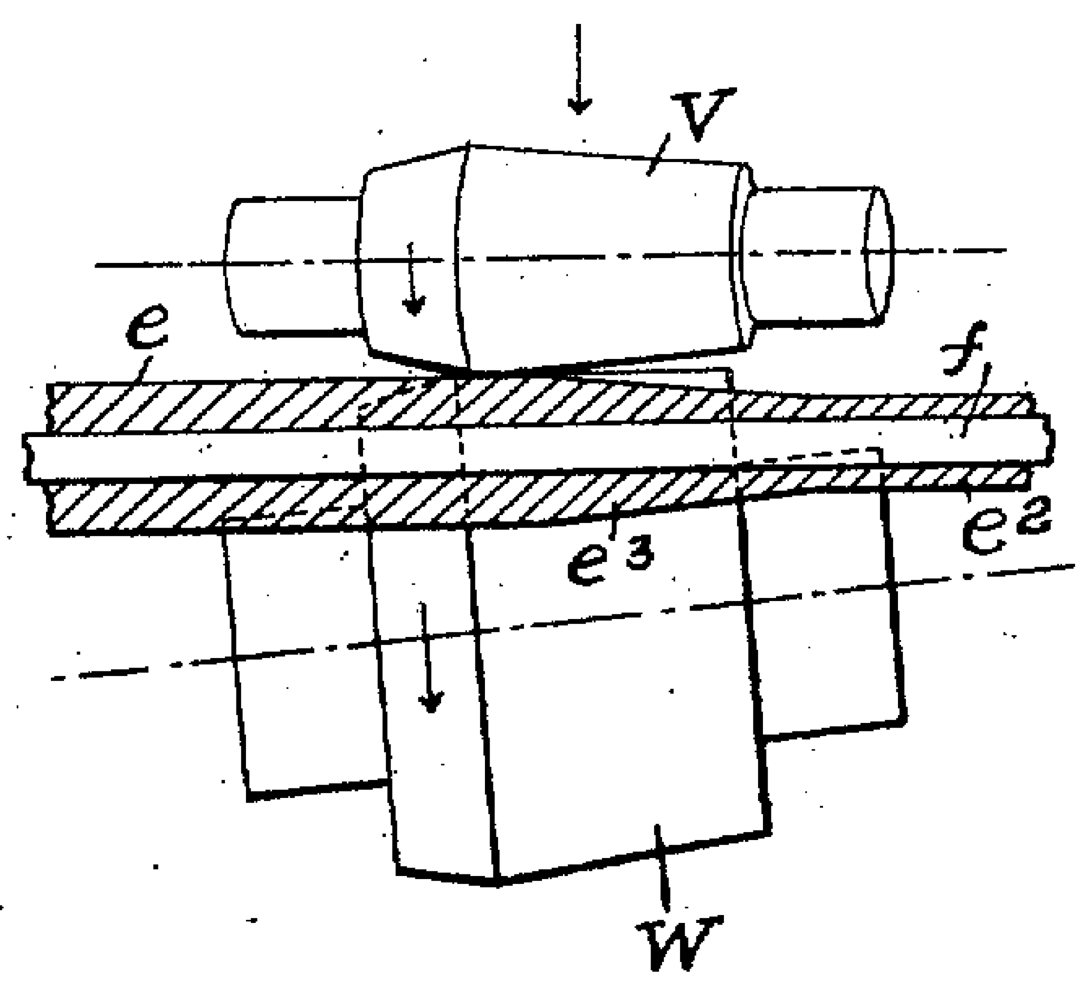


FIG. 14.

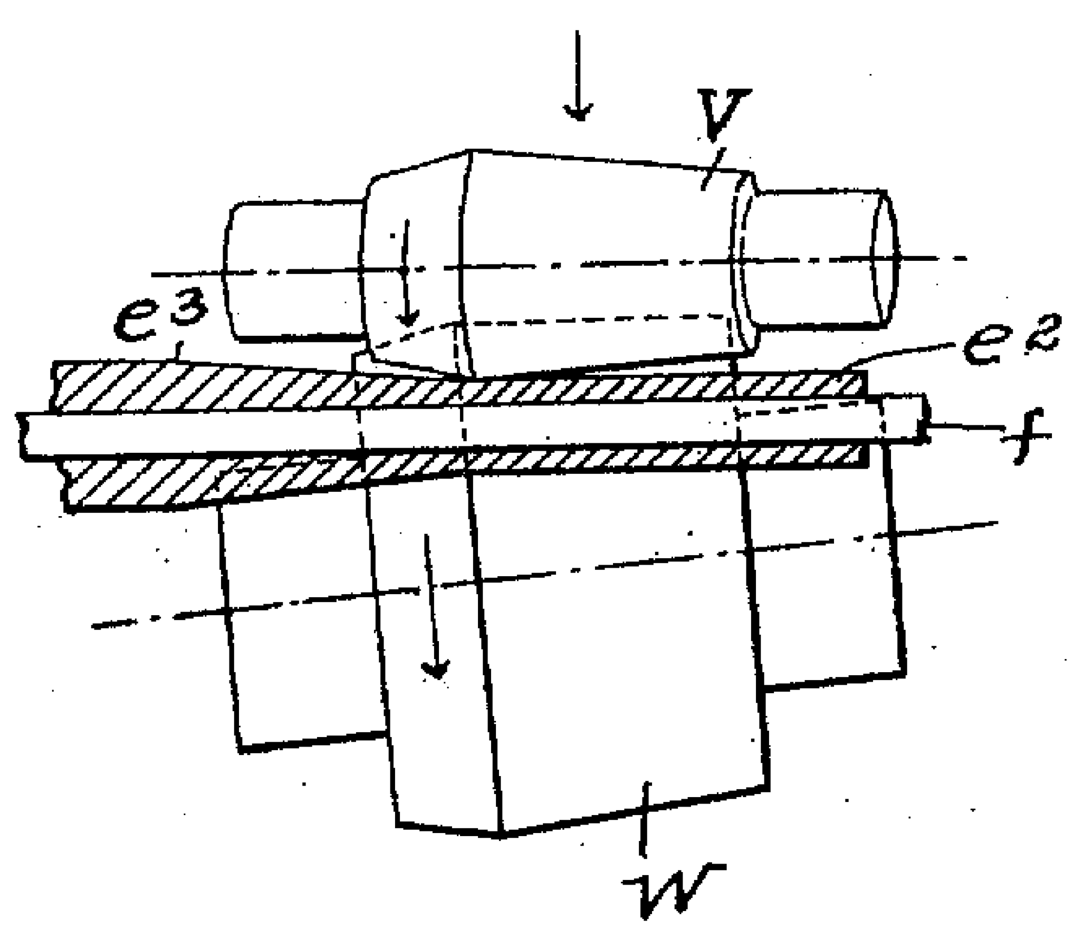


FIG. 15.

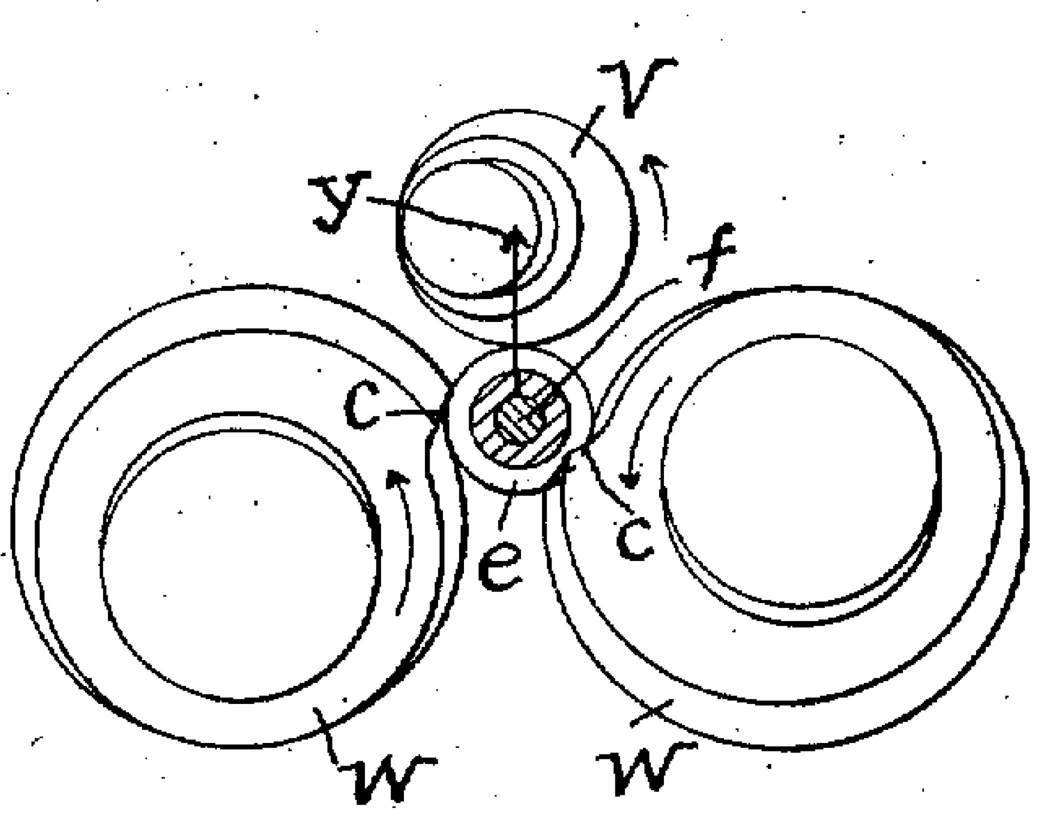
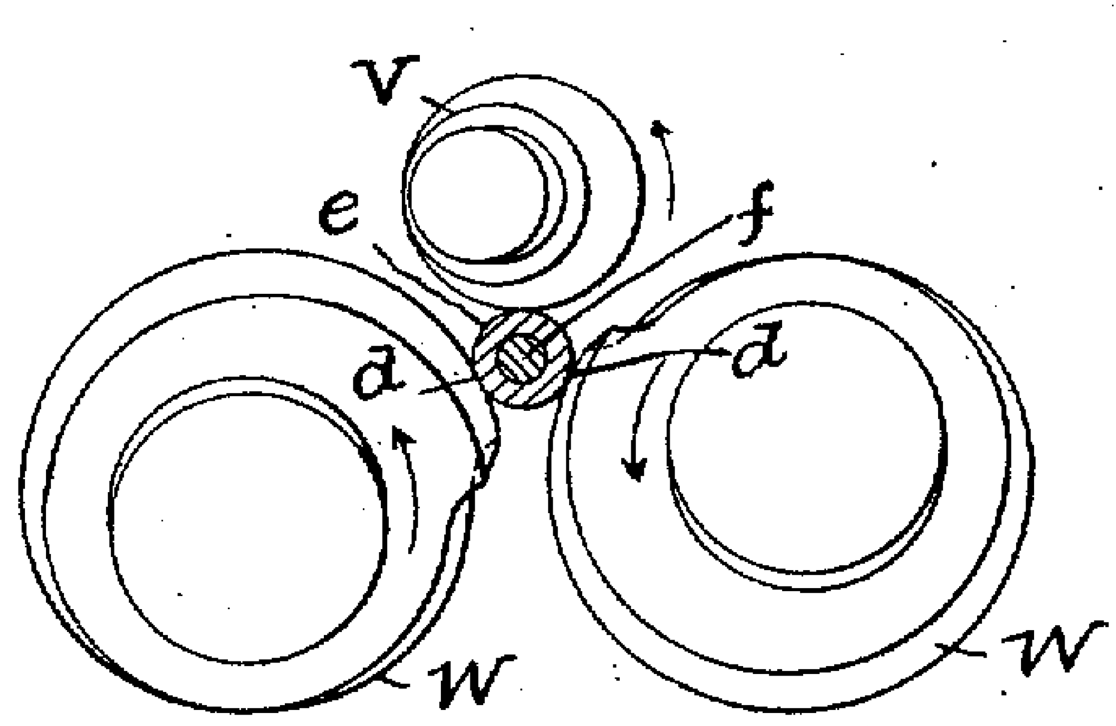


FIG. 16.



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4 SHEETS—SHEET 4.

FIG. 17.

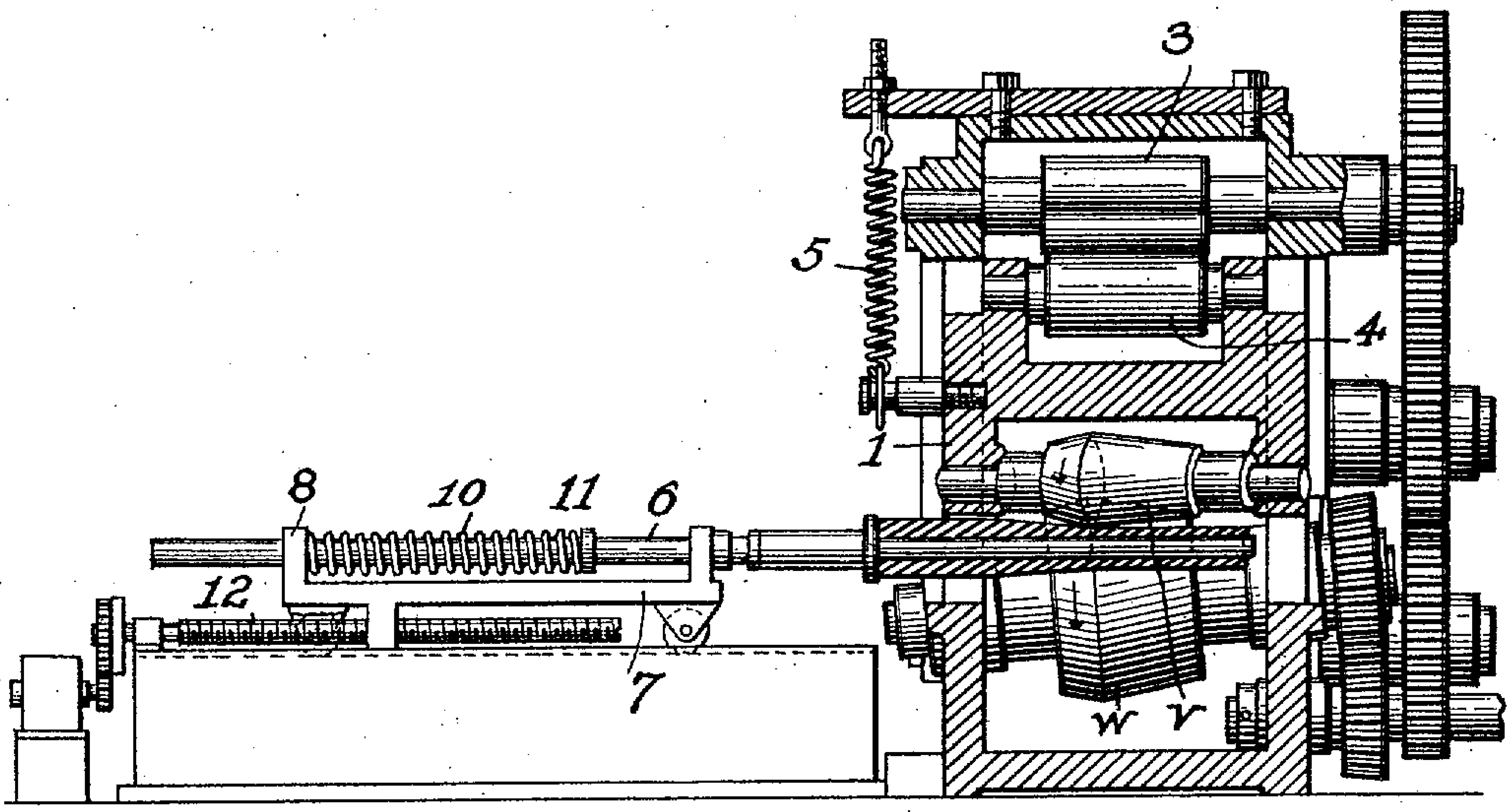
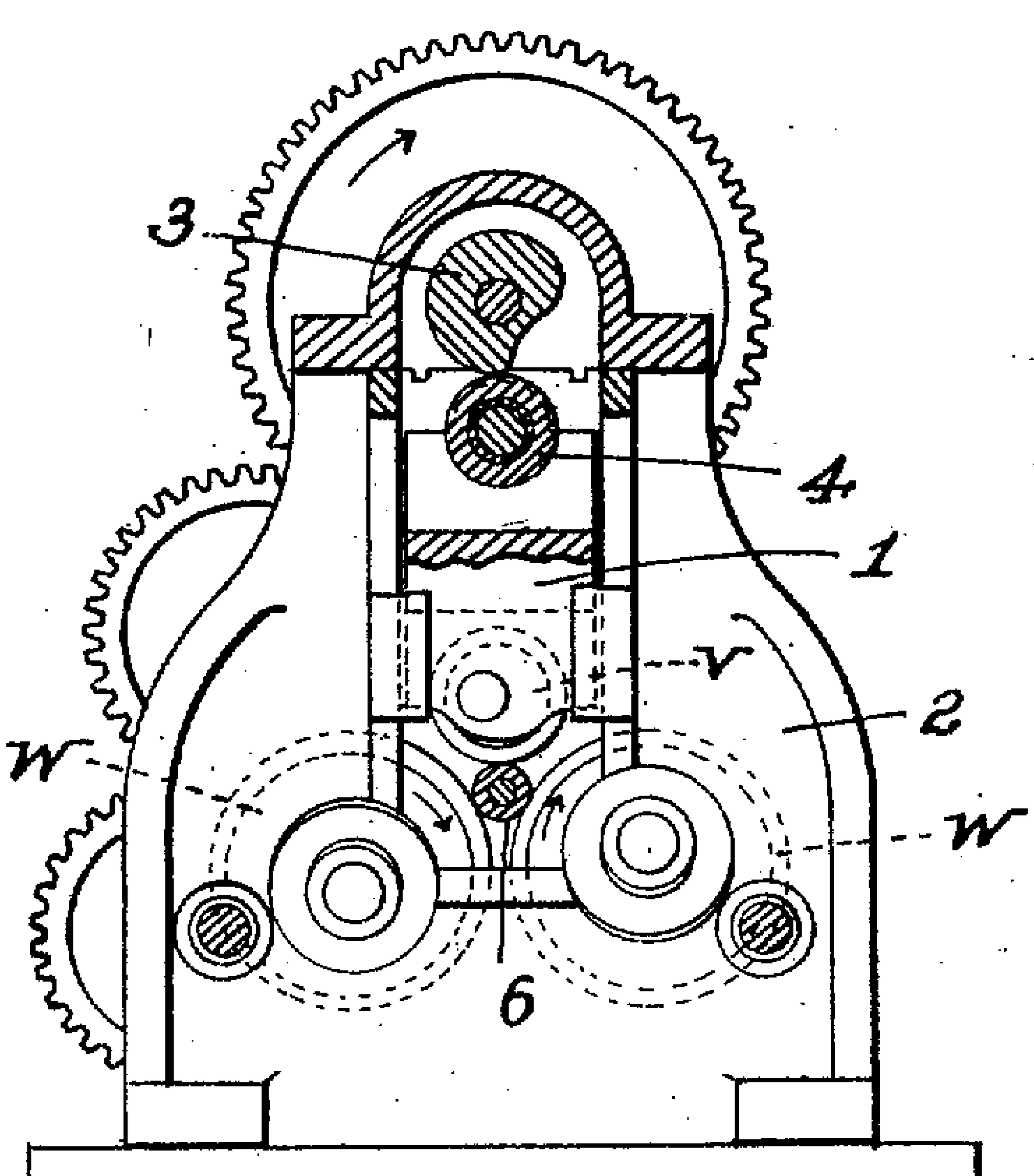


FIG. 18.



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UNITED STATES PATENT OFFICE.

OTTO BRIEDE, OF BENRATH, NEAR DUSSELDORF, GERMANY.

PROCESS FOR ROLLING OUT HOLLOW BILLETS TO FORM SEAMLESS TUBES.

969,333. Specification of Letters Patent. **Patented Sept. 6, 1910.**

Application filed April 20, 1907. Serial No. 369,337.

To all whom it may concern:

Be it known that I, OTTO BRIEDE, residing at Benrath, near Dusseldorf, Province of the Rhine, German Empire, a subject of the German Emperor, have invented or discovered certain new and useful Improvements in Processes for Rolling Out Hollow Billets to Form Seamless Tubes, of which improvements the following is a specification.

In the known processes for stretching out seamless tubes by rolls obliquely disposed, the billet to be stretched out was operated on by the rolls in a continuous helix, the billet thus being screwed through the rolls. The pitch of the helix produced by the rolls on the billet, determines the forward movement of the billet during one revolution of the rolls, the rolling path operative for stretching the billet therefore was equal to the length of the helix produced on the billet. Oblique rolling is very simple with regard to the arrangement and operation of the mill, but there are defects due to the fact that the material is detrimentally affected by loosening it, so that a large hollow billet cannot be transformed into a reliable tube.

In the new process, oblique rolls for transforming hollow billets into seamless tubes are used and the novelty of this process consists in the fact that the billet is operated on by the rolls step by step or intermittingly, thus causing the work-piece while being reduced to move stepwise. In the known oblique rolling, the billet is gradually screwed into and through the rolls and is gradually reduced in diameter, but in my new process, the manner of operation is reversed and the billet is screwed off or out from the rolls and therefore it is required to impart to the oblique rolls a rotation opposite the known oblique rolls. The work piece is intermittingly pushed between the rolls and only such part as projects between the rolls is stretched, the work-piece being moved or screwed backward. After this part of the work-piece is stretched or reduced, another portion of the work-piece is fed in. Such forward feed is of course larger than the foregoing backward movement, as not only the part already reduced but a further part to be reduced, is now to be introduced between the rolls. It will be observed therefore that the work-piece is continuously given a small to- and fro-motion the forward movement being the greater, thus producing a step-by-step feed motion. To enable the billets to be introduced between the oblique rolls, it is necessary that the construction of the mill should be changed from that usual in mills having oblique rolls. It is required that the rolling surfaces must periodically depart one from the other to allow the billet to enter between them, then to approach and rotate simultaneously while the reduction takes place. Again if fixedly mounted oblique rolls are used one or several recesses should be formed in their circumference, the recesses being adapted to permit of the introduction of the billet, when two recesses are opposite. The surfaces of these rolls must be eccentrically shaped with reference to their axis in order to penetrate gradually into the work piece when rotation takes place, thus providing the latter with a tapering part as the work piece by the rotating oblique rolls, is displaced axially.

In the drawings a convenient rolling mill for carrying out the process is diagrammatically illustrated and may be regarded only as an example, other shapes and arrangements of the roll being within the scope of my improvement.

Figure 1 shows a side view; Fig. 2 is a front view; Fig. 3 a view in plan; Figs. 4 and 5 show successive reducing positions of the rolls shown in Fig. 1; Figs. 6 and 7 represent another form of elevation and a front view of an oblique rolling mill respectively for carrying out my new process; Fig. 8 illustrates the rolls at the end of a reducing operation; Fig. 9 shows a modified manner of advancing the rolls; Figs. 10 and 11 represent modified rolling mills in a diagrammatical manner. Figs. 12–16 show further modifications as examples of constructing rolling mills for carrying out my new process. Fig. 17 is a view partly in elevation and partly in section of a machine embodying my improvements, showing means for moving the rolls as described for feeding the billet, and Fig. 18 is a front elevation of the same, the housings of the upper part being broken away.

The rolls w except in the modification shown in Figs. 10 and 11 are obliquely mounted in the known manner and have their axes $a\ b$ and $a'\ b'$ at an angle to each other. The generating line of the operative surfaces forms a broken lineation, each roll forming a double cone constituted by the surfaces w' and w^2. The rolls may be so mounted that their peripheral surfaces are eccentric to their axes of rotation, such eccentricity gradually increasing from the lowest point c to the highest point d. If the points c of the rolls are opposite the billet e to be operated on can be placed between the rolls by suitable mechanism. If the rolls are then rotated in the direction of the arrows, the space left between the rolls and occupied by the work piece or billet, will be gradually diminished, thus causing the surfaces of the rolls to gradually reduce and elongate the work piece, the edge w^3 producing a helix because the rolls are obliquely arranged and cause a movement of the billet in the direction of the arrow R. Figs. 4 and 5 show positions of the rolls and reduction effected during one revolution of the rolls, in Fig. 4 the rolls having moved far enough to bring the radii O. B. of Fig. 2 into line with each other. The figure shows a part e^3 already worked by the rolls and having a conical shape and a material-wave e' between the portions w' of the rolls formed by the pressing in of the edge w^3. This wave is moved along and reduced by the portions w' in further rotating of the rolls toward the finished tube e^2. Fig. 5 shows the rolls in position according to which the radii O C, that is the parts d are opposite. Fig. 5 represents the edge w^3 having reached the finished diameter of the part e^2 and a cone e^3, formed between the finished and unreduced portion e of the billet. As is well known in step-by-step rolling each roll may be formed with a cylindrical portion which produces smooth finished surfaces.

In the Figs. 6 and 7 is illustrated in side and front elevation a rolling mill for carrying out the new process, the roll surfaces being concentric with their axes of rotation. In the beginning of the reducing operations, the rolls have the position shown in the Figs. 6 and 7, and during the rotation, one or both are moved radially toward the work-piece, causing thereby a stretching in the same manner as described with regard to Fig. 1. When the edge w^3 has obtained the finished diameter of the part e^2, the rolls occupy the position shown in Fig. 8. Of course the rolls can be advanced to the work-piece by another method as for example they can be displaced in the direction of the arrows on parallel lines (see Fig. 9), the lines of movement being parallel with the tangents to the circumference of the work-piece. In place of rotating rolls, rolls can be used which reverse their direction, the rolls having either eccentrically shaped mantle-surfaces or are circular in cross section and are moved toward and from the work-piece, as shown in Figs. 7–9. It may not be necessary to use a complete rolling body, but sector-shaped recesses of the rolls can be employed, as already known. By enlarging more and more the diameter, the limit is a mill which consists of two straight planes only, which may be shaped wedge-like, equivalent with the eccentric shape of the rolls of Fig. 2 and the rotating bodies of Fig. 7, or which may be parallel. In the latter case, besides the to- and fro-motion in their longitudinal direction, the plates must move in their cross direction thus advancing toward the work-piece and departing therefrom after the reduction. The plates may have a roof- or similar-shaped cross-section.

The manner of operation of the different mills used is essentially the same with regard to the stretching or reduction of the work-piece. It may be sufficient therefore to consider more detailed the rolling mill shown in Figs. 1–5. When passing from the initial into the end-position *i. e.* from the position shown in Fig. 1 into that shown in Fig. 5, the work-piece e is moved from the righthand to the lefthand side for a length equal to the cone e^3. This longitudinal movement of the work-piece is denoted by n in Fig. 5. After the rolls return into the position shown in Figs. 1 and 2, the advance of the work-piece takes place, the inward movement being equal to the length n plus a certain length m (Fig. 5) equal to the length of that portion of the billet to be stretched out by the following attack of the rolls. The movement to the righthand side in the direction of stretching out, is larger than the movement to the lefthand side, that is the work-piece is reduced by a step-by-step motion through the rolls. That part of the work-piece subjected to the stretching out process, is displaced to the right, sliding off from the mandrel f carrying the work piece. Therefore a mandrel of a length equal to the length of the finished work-piece is not required, but a short mandrel will be sufficient, projecting between the rolls a sufficient distance to support the portion attacked by the rolls. It will be observed therefrom that mandrels can be short, and furthermore it will be favorably attacked as continuously reciprocating between the rolls for the length n m, and it will further be observed that a relatively long and constantly renewing part of the mandrel is between the rolls. This action takes place at least if, as illustrated in the drawings, the mandrel f holds the work-piece by means of a collar f' or the like, and the advance is effected by the mandrel. Of course the mandrel can be fixedly mounted and the work-piece then is gradually pushed along the mandrel in any suitable manner. Whereas, as indicated above, in the known oblique rolling works, the rolling path is equal to the length of the helix described by the rolls on the work piece, the rolling path is considerably increased in the present case. The magnitude of the rolling path for each revolution of the rolls or in each stretching out, depends directly on the proportion of the diameter of the work-piece to that of the rolls or the length of the acting rolling surface. In selecting the feed, that is the rate m, larger or smaller, the rolling path is rendered correspondingly smaller or larger for the whole working piece, as the entire rolling path is equal to the single rolling paths added one to the other when the single sections n are stretched out.

In the usual oblique-rolling process there occurs always a considerable loosening of the material which may result in the destruction of the latter. In the present method this can be entirely avoided by employing rolls which, as shown in Fig. 1, enter into the material with one edge, w^3, in a cutting fashion, which rolls, therefore, consist of double cones causing on both sides of the edge w^3 twisting tendencies, because the radii of the rolls and of the billet are different at different points in the line of contact between rolls and billet. Hence the well known twisting effects occur also in this case, but as the effect of the surface w' is opposite that of the surface w^2, they remain without any influence upon the billet, and there will occur rather a harmless partial gliding between the surfaces of the rolls and the billet.

The length n of the cone shaped portion e^3 reduced on each revolution of the rolls in the construction shown in Figs. 1 to 9 depends, as will be understood, on the diameter of the rolls, the diameter of the work-piece and the angle of inclination of the rolls toward the axis of the work-piece. The reduction of the part e^3 is due to the helix-like moving of the rolls around the work-piece equal to the length n, thus obtaining a long cone e^3 if the radius of the roll is large in relation to the radius of the work-piece. The cross section of the hollow billet e is transformed gradually into the finished tube e^2, the reduction being followed by a smoothing operation effected by the respective parts of the rolls.

The advance of the work piece is effected in any suitable manner and can be so controlled that shocks and considerable strain due to inertia will not occur.

The new process is of course not limited to the rolls above described and illustrated in the drawings, but other rolls, more especially such as have been used for the so-called oblique rolling, are suitable for use. It is required only that the rolls attack the work-piece in a helix, the arrangement of the rolls being varied in accordance with the manner of using the same. Figs. 10 and 11 for example show a rolling mill having the rolls w with their axes w^4 parallel. These rolls can be constructed in their acting parts either as above described or they can be arranged and constructed so that the rolls will move toward the work-piece. When the work-piece e, as shown in Fig. 11, is passed through such rolls, it is caused to move at an angle to the plane passing through the axes of the rolls, so that the attack of the rolls takes place in a helix. A further modification is obtained by the work-piece being operated upon by rolls of different diameters. In the usual oblique rolling three and four rolls are arranged around the work-piece, in order to avoid distorting the same and producing an oval shape during the rolling. When arranging more than two rollers around the work piece the diameter of the rolls, of course, is limited, as the rolls must be of such diameter as will permit of their approaching each other sufficiently to effect the desired reduction. Now it is desirable in the step-by-step rolling to employ rolls of a most possible great diameter as the length of each attack of the rolls depends directly on the diameter, viz. on the circumference of the rolls. It is preferred to use three rolls, one of which has a small diameter when compared with the other rolls, the smaller the third roll, the larger can be both the other rolls. In using such rolls an extremely simple rolling mill is obtained. The production of the cone like wave of metal to be stretched out to the finished tube body, is effected in this case by a movement of the third or small roll toward the large rolls. Of course the large rolls can be made eccentrically or can be provided with spiral-shaped surfaces. Or one or both the large rolls, being circular can be made movable. Also the third small roll, and one of the large rolls may be movable relative to the axis of the work piece. When two or more of the rolls are movable, all move in radial lines toward and from the axis of the work piece. All these modifications in the structure and arrangement of the rolling work are evident, and in all cases the work-pieces should be supported so as to move laterally, when the roll or rolls are moved relative to each other.

Fig. 12 shows a front view of a rolling mill having three rolls. There are two large rolls w and a third small roll v. Between the rolls, the work piece e is arranged on the mandrel f. The large rolls are fixedly mounted and provided with concentric peripheries in the same manner as shown in Figs. 6–9. For reducing the work piece the small roll v is to be moved in the direction of the arrow x. The rolls are mounted so as to operate helically on the work pieces, as heretofore described. The Figs. 13 and 14 show in a side view the formation of the cone e^3 between the parts e and e^2, one roll

w being removed, and Fig. 13 showing the initial position, and Fig. 14 the final position of the rolls and billet. It will readily be understood that by keeping the roll v small, the rolls w can be of large diameters, thereby avoiding the forcing of the work piece to an oval shape, due to the work piece being attacked always at three points. It may be mentioned that the work-piece is forced laterally from the mandrel at points between the rolls, but this action is desirable, as the work piece is prevented from being rolled tight on the mandrel. The length of the rolling path is independent of the diameter of the rolls when the construction shown in Figs. 12 to 16 is used, as the rolls w can be revolved as much as desired, for the rate of the attack of the rolls depends only on the speed of approaching the roll v toward the rolls w. If the roll v, as illustrated in Fig. 12, is caused to ascend slowly the cone e^3 lying between the parts e' and e^2 will be very slender, and the pressure, to which the mandrel is subjected is comparatively small.

Figs. 15 and 16 show a modified construction carried out by rolls having spiral-shaped surfaces. Fig. 15 is a front view showing the rolls in the initial position. The work piece c bears against the parts c of the surfaces of the rolls w and against the roll v, the latter being fixedly mounted in this case. By rotating the rolls in the direction of the arrow, the work piece is gradually rolled down, till it bears against the part d (Fig. 16) of the rolls w. The work-piece e together with the mandrel f move in the direction of the arrow y during the production and reduction of the cone e^3, whereas in the arrangement of rolls according to Figs. 12 to 14, the work-piece displaces in the direction of the arrow x. For permitting such movement of the work piece, a carrier of a convenient structure must be provided.

In the foregoing, it is stated, that the work piece is screwed out from the rolls by causing the rolls to attack the billet helically, and to move their operative portions forward till the diameter of the finished work-piece is reached. My method is similar to the known oblique rolling with regard to the movement of the work piece relatively to the rolls, but it differs therefrom by the intermitting or step by step working and in the fact, that the tapering part, joining the billet to be reduced with the part of the finished portion, is not produced along the whole work-piece in a single working stage, but in displacing step-wise this tapering part.

The process permits of the employment of existing oblique rolling mills and it is required only that the latter are subjected to a simple modification as regards rolls and the work-piece-carrier. This work-piece-carrier is constructed similar to those employed in step-by-step rolling, the mandrel-carrier being mounted on a slide, advanced slowly and continuously or intermittingly for the length of each attack of the rolls on the work-piece. The work-piece is carried by a slide movable longitudinally, and is held normally in position by a spring as usual in step-by-step rolling mills, the spring being compressed by the work-piece, when shifted by the rolls, and being moved to normal position by the spring, when the work-piece is released from the rolls. The rolls can now again attack the work-piece, due to the slide being fed forward, at a new spot. Of course, it is possible to positively control the work-piece by any convenient device for the purpose of reciprocating the work-piece stepwise.

It will be readily understood by those skilled in the art that in the arrangement of rolls illustrated in Figs. 1 to 5, inclusive, and Figs. 15 and 16, where the rolls are provided with eccentric reducing faces, said rolls may be mounted in stationary housings, it being unnecessary in such arrangement that the rolls be shifted toward and from each other where the mill is constructed so that one of the rolls, as v, is moved toward and from the rolls w, the former is mounted in the carrier 1 arranged to move vertically in the housings 2 of the mill. While this carrier 1 may be shifted up and down by any suitable means, it is preferred to employ a cam 3 for that purpose, a friction roller 4 mounted in the carrier being held in contact with the cam by a spring 5. The billet holder or mandrel is attached to a bar 6 mounted on a slide or carriage 7 provided with upwardly projecting arms 8, through which the bar is free to move back and forth. The bar with the mandrel is normally pulled toward the rolls tending to pull the billet in between the latter by a spring 10 surrounding the bar and bearing at its ends against one of the arms 8 and a collar 11 secured to the bar. The slide or carriage 7 is shifted toward the rolls by means of a screw 12. As will be clearly seen by reference to Figs. 17 and 18 the rolls have their axes inclined to each other.

I claim herein as my invention:

1. The method herein described which consists in successively segregating portions of the metal of a billet, and reducing such segregated portions to the desired dimensions by pressure applied transversely of and progressively around the billet, and in a direction at an angle less than a right angle to the axis of the billet.

2. The method herein described which consists in subjecting a billet to a step by step reducing pressure applied by surfaces

moving in planes at an angle less than a right angle to the axis of the billet.

3. The method herein described which consists in successively reducing portions of a billet to finished dimensions by subjecting successive portions step by step to a rolling pressure applied by surfaces moving at an angle less than a right angle to the axis of the billet.

4. The method herein described which consists in subjecting successive portions of a billet to reducing faces helically disposed with reference to a billet whereby the billet is moved longitudinally during reduction, and shifting the billet longitudinally intermediate of successive reductions in a direction opposite that in which the billet is moved during reduction.

5. In a mill for reducing billets, the combination of reducing surfaces, means for moving such surfaces at an angle less than a right angle to the direction of feed of the billet, said surfaces being adapted while operating on the billet to move toward and from each other and means for intermittingly feeding the billet between such surfaces.

6. In a mill for reducing billets, the combination of rolls having operative faces adapted to operate on successive portions of the billet in a direction at an angle less than a right angle to the direction of feed and means for intermittingly feeding the billet between such operating faces.

7. In a mill for reducing billets the combination of rolls having their axes at an angle to each other and having eccentric reducing portions and means for intermittingly feeding the billet between the rolls in a direction at an angle to the plane of rotation of the rolls.

8. In a mill for reducing billets the combination of rolls having the operative faces adapted to operate helically on the billet whereby the billet is shifted longitudinally in opposition to the feed during reduction and feed mechanism having a resilient member for advancing the billet after each reduction.

9. In a mill for reducing billets the combination of rolls having operative faces adapted to act helically on successive portions of the billet and means for causing the operative face of one of said rolls to move toward the other roll or rolls during such reduction.

10. In a mill for reducing billets the combination of a plurality of rolls adapted to act helically on successive portions of the billet, means for causing the operative face of one of said rolls to move toward and from the others, and means for intermittingly feeding the billet between the rolls.

11. The method of reducing billets, which consists in intermittingly feeding the billet between rolls, helically reducing successive portions of the billet by such rolls and during such reduction moving the billet in reverse a distance less than the preceding feed.

In testimony whereof, I have hereunto set my hand.

OTTO BRIEDE.

Witnesses:
M. ENGELS,
FRANK HEPENBRUCH.