(No Model.) 3 Sheets—Sheet 1

R. C. STIEFEL.

MECHANISM FOR EXPANDING OR ENLARGING METALLIC TUBES.

No. 605,027. Patented May 31, 1898.

Fig. 1.

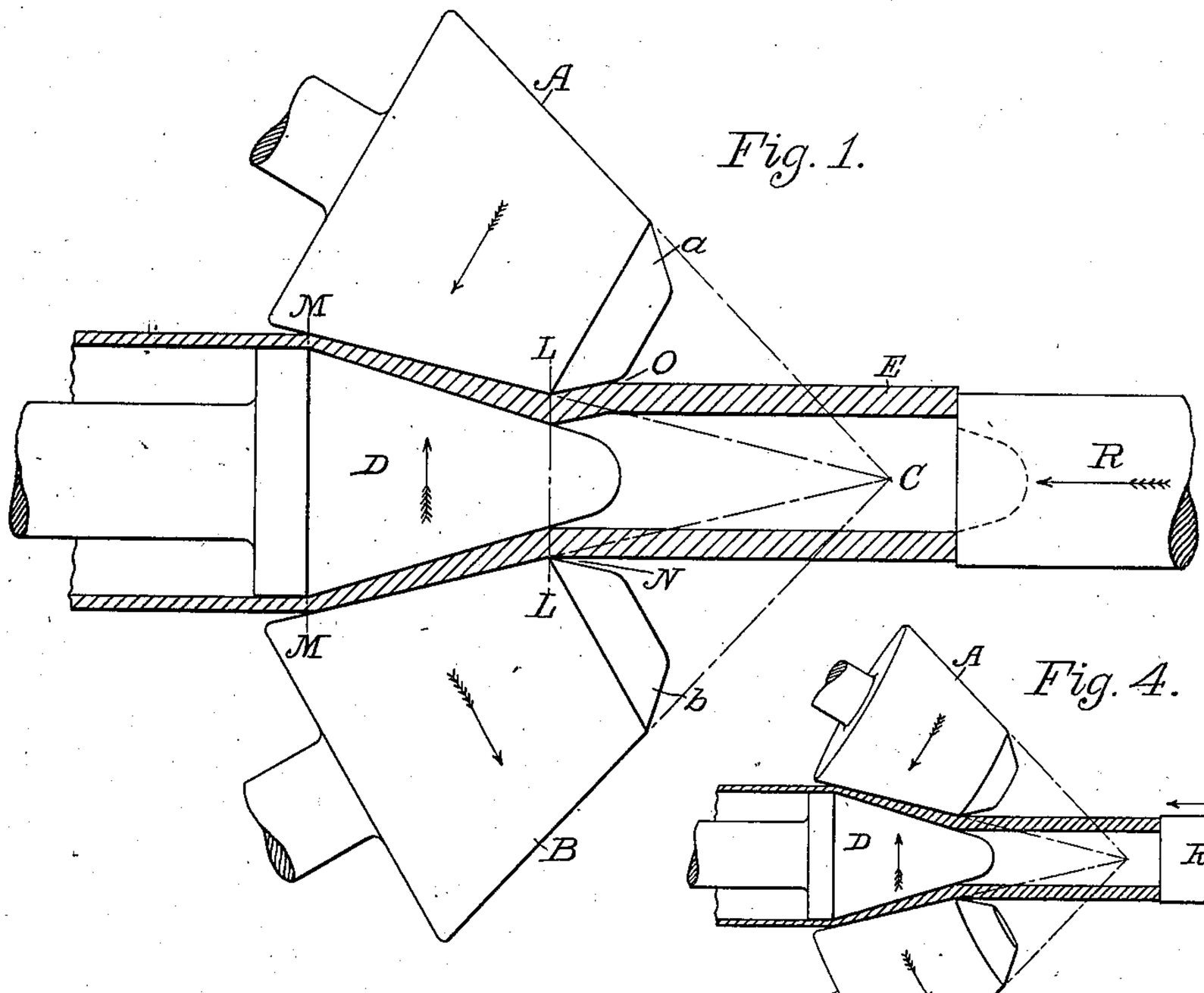


Fig. 4.

Fig. 2

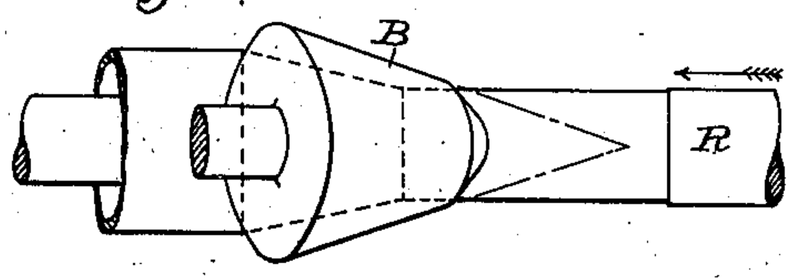
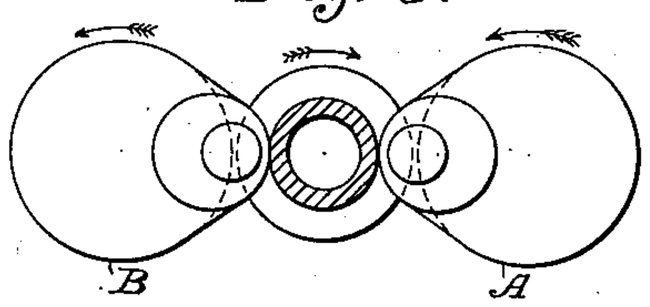


Fig. 3.



Witnesses.

L. G. Hopper.

Geo Wilbians

Inventor.

Ralph C. Stiefel.

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his Attorney.

(No Model.) 3 Sheets—Sheet 2.

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Fig. 5.

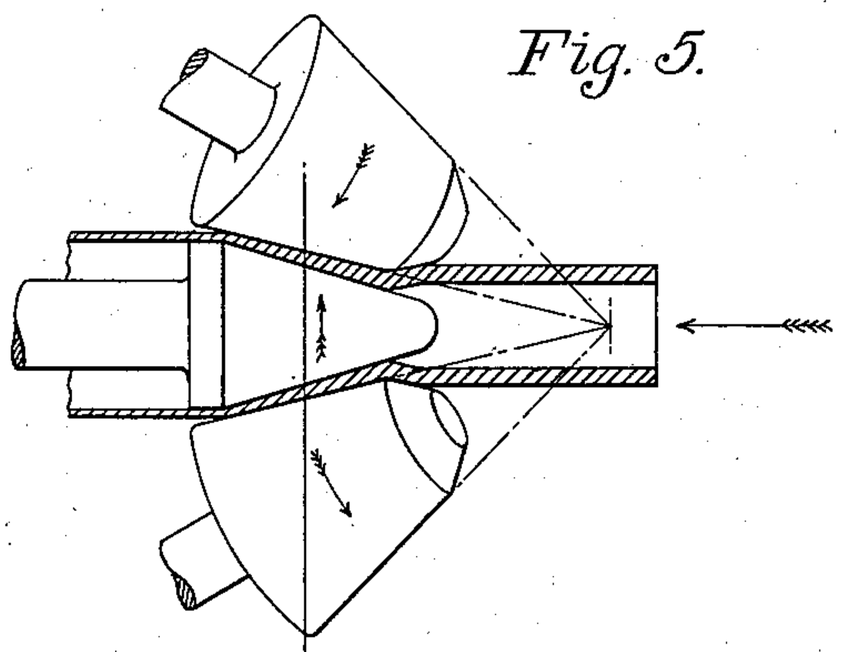


Fig. 6.

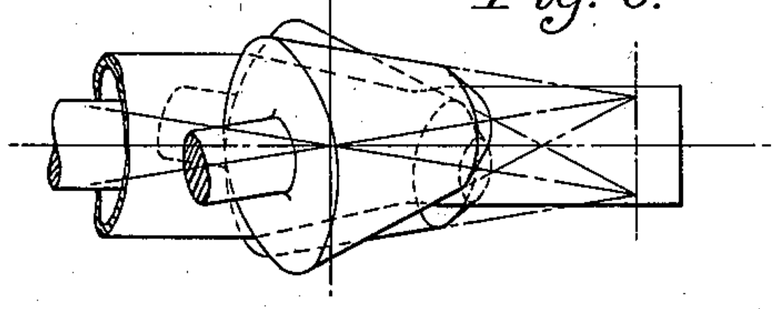


Fig. 7.

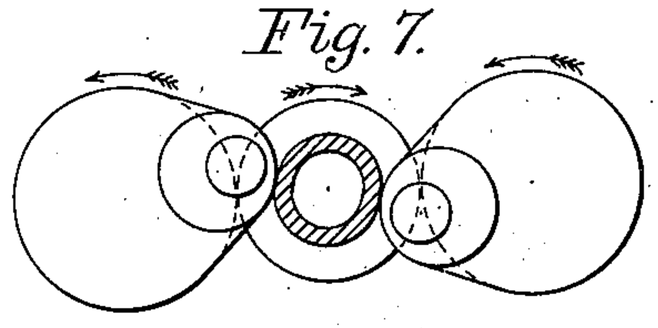


Fig. 8.

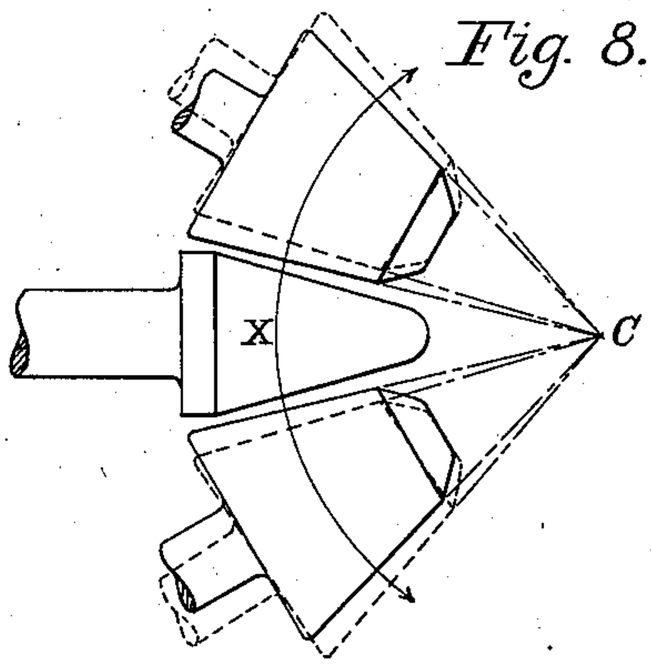


Fig. 9.

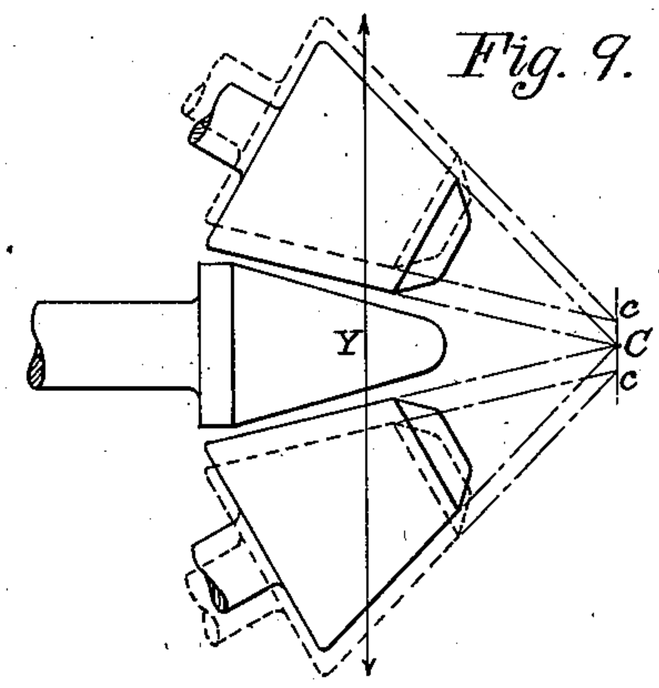
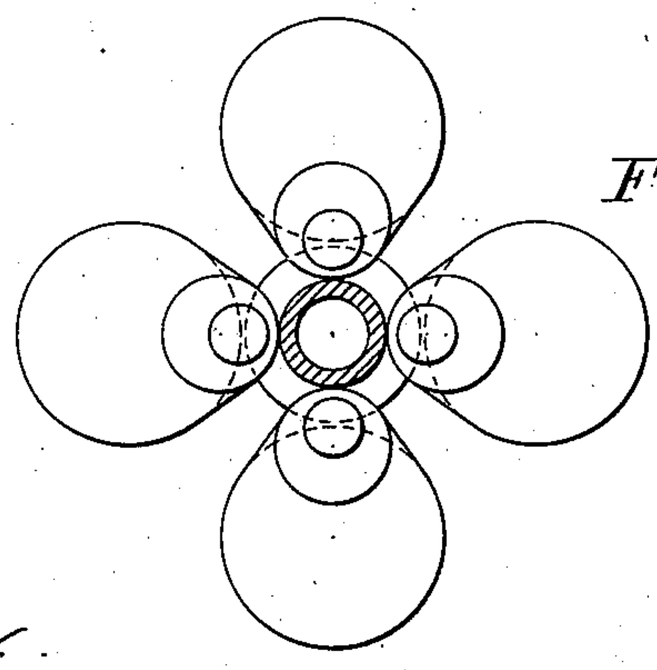


Fig. 10.



Witnesses.
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his Attorney.

(No Model.) 3 Sheets—Sheet 3.

R. C. STIEFEL.

MECHANISM FOR EXPANDING OR ENLARGING METALLIC TUBES.

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Fig. 11.

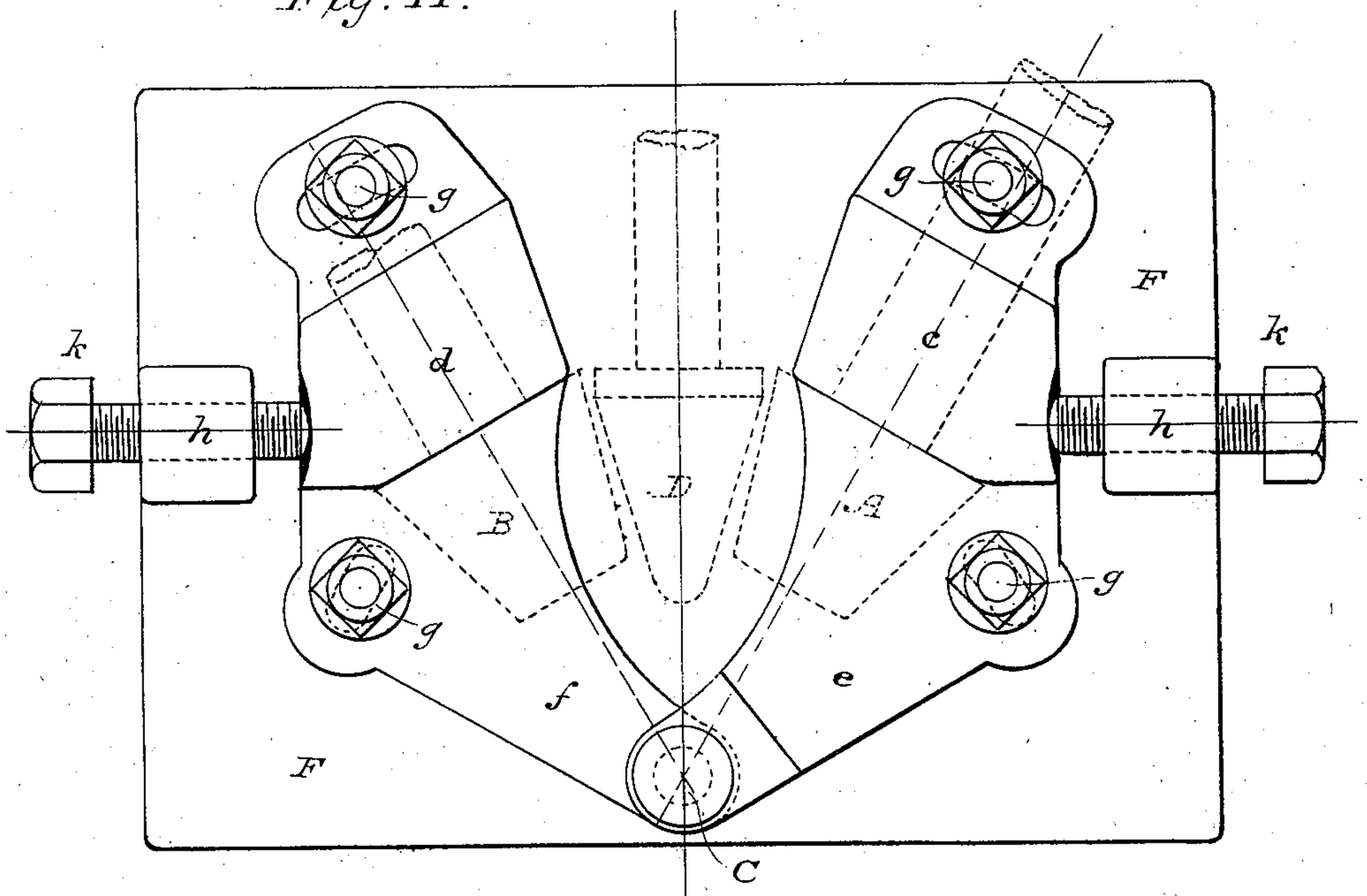
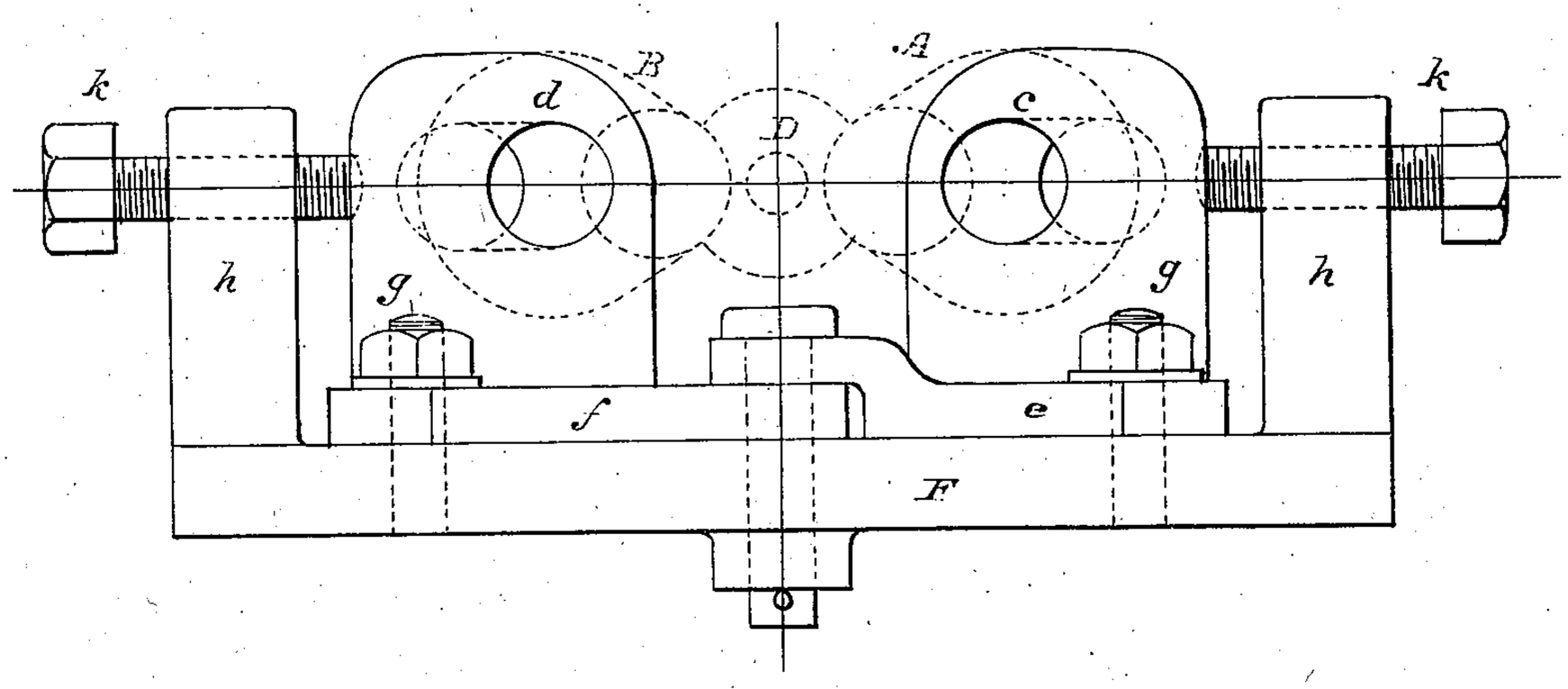


Fig. 12.



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UNITED STATES PATENT OFFICE.

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MECHANISM FOR EXPANDING OR ENLARGING METALLIC TUBES.

SPECIFICATION forming part of Letters Patent No. 605,027, dated May 31, 1898.

Application filed May 24, 1897. Serial No. 637,970. (No model.)

To all whom it may concern:

Be it known that I, RALPH C. STIEFEL, a citizen of the Republic of Switzerland, residing at Ellwood City, in the county of Lawrence and State of Pennsylvania, have invented certain new and useful Improvements in Mechanism for Expanding or Enlarging Metallic Tubes, of which the following is a specification, that will enable those skilled in the art to which my invention pertains to make and use the same.

My invention relates to enlarging or expanding metallic tubes or tubular structures. Its objects are to increase the diameters of such structures and to reduce the thickness of their walls by passing them endwise between rolling bodies in the general direction of the axes of the rolls and over an expanding-mandrel lying in the pass between them, the compressing action of the rolls and the mandrel on the walls of the tubes being such as to gradually reduce their thickness and correspondingly increase the diameter of the tube without materially increasing its length and without twisting or disturbing the longitudinal arrangement of the fibers of the metal and also without there being any circumferential slip between the surfaces of the tubes and the faces of the rolls and the mandrel with which they come into contact. The manner in which this is accomplished and the details of the apparatus for doing it will be readily understood from the following description, read in connection with the accompanying drawings. These drawings show my invention by diagrammatic figures which are intended principally to illustrate the shapes of the rolls, the piercing-mandrel, &c., and their relative positions, no attempt being made to show the framework or housings by which the parts are carried or the means for driving the several moving parts of the mechanism, as such matters are well understood by those familiar with this class of machinery and can be readily supplied by skilful mechanics without departing from the spirit of my invention as set forth in the claims at the end of this specification.

Figure 1 is a plan or top view illustrating the preferred shapes and one form of the relative arrangement of the several parts of a mechanism which constitutes a part of my invention and with which the objects thereof may be attained. This figure is made on a larger scale than the other figures of the drawings. Fig. 2 is a side elevation, and Fig. 3 an end view, of the same on a reduced scale. Fig. 4 illustrates a slight modification in the relative disposition of the rolls. Figs. 5, 6, and 7 are respectively a plan view, a side elevation, and an end view of a modification of my invention. Figs. 8 and 9 are diagrammatic views illustrating the effects of different methods of adjusting the rolls to adapt them within certain limits to varying sizes of work. Fig. 10 is an end view illustrating four rolls grouped about a common pass instead of two, as shown in the preceding figures, it being within the scope of my invention to use either two rolls or as many more than two as may be desirable and as can conveniently be grouped about a common pass to effect the purposes of my invention. Figs. 11 and 12 illustrate one method of mounting the rolls so that they may be adjusted toward or away from each other to vary the width of the pass.

At this time I prefer to use two rolls only, as illustrated in the leading figures of the drawings, and for convenience shall confine my description to this construction.

In Figs. 1, 2, and 3 I show two rolls A and B located on opposite sides of a pass, with their axes lying in the same horizontal plane as the axis of the pass. These rolls revolve in the same direction and may be driven in any suitable manner. They are conical throughout their main working portions, terminating at their smaller ends in sections *a* and *b*, the faces of which are more inclined to the axes than are those of the main portions of the rolls, and these faces as they recede from the main portions of the rolls are slightly curved or rounded in toward the axes of the rolls. The rolls are so shaped and arranged that their axes and the line of their main working surfaces all converge toward and intersect the axial line of the pass at a common point C. The sides of the pass at its entrance end between the surfaces of the small ends *a* and *b* of the rolls converge slightly, the pass diminishing in width until it reaches the line L, which crosses the narrowest part of the

pass and intersects the smaller ends of the main conical portions of the rolls. From this line the sides of the pass diverge rapidly and its width increases toward its exit end. Within the pass between the rolls is located the conical head D of an expanding-mandrel, which is free to rotate, and the shape and location of which are important features and are to be governed by the shape of the pass and the work to be performed upon the mandrel.

In Fig. 1 it will be observed that the first bite or compression upon the walls of the tubular billet between the faces of the rolls and the mandrel takes place at the line L, which crosses the pass at its narrowest point, and that the mandrel is so shaped that its first contact with the interior of the tube takes place on this line. As the mandrel-head recedes from this line toward the exit end of the pass its sides diverge at greater angles than do the sides of the pass, so that at the line M, drawn across the largest part of the mandrel and at the point where the finished tube passes away from contact with the rolls, the spaces in the pass between the faces of the rolls and the head of the mandrel are less in width than they are at the line L. In other words, this space at the line L is equal in width to the thickness of the walls of the tubular blank to be operated upon, while at the line M it is equal in width to the reduced thickness of the walls of the finished tubular product of the machine.

The angles of divergence of the sides of the pass and of the sides of the conical mandrel and their relations to each other and the consequent length of the grip of the rolls and mandrel on the work between them may be varied as found desirable to adapt them to the work to be performed, the differences in materials to be operated upon and the amount of expansion of the tube or reduction in thickness of its walls being important factors in determining the relative angles and length of the pass and of the conical head.

With soft and ductile metals that would flow easily the pass might be short and its angles quite abrupt, while with harder and more brittle metals that would not yield readily to the operation the pass would have to be longer and its angles easier to avoid the danger of fracturing the material being worked by an assault upon it more rapid and vigorous than it could yield to.

In the arrangement of the parts shown in Figs. 1, 2, and 3 the hollow billet E is forced endwise into the pass and over the head of the mandrel by a hydraulic ram R or other suitable mechanical appliance, the abutting end of which may revolve with the billet, if desired. The rolls in these figures merely revolve the billet by contact therewith and compress its walls against the head of the mandrel, so that as it advances the thickness of its wall is progressively reduced and its diameters progressively increased until the maximum effects are reached at the largest diameter of the mandrel-head. With this arrangement of the parts the tubular billet is subjected to two forces: first, the endwise thrust of the ram R, which forces it into the pass and against the mandrel D, and, second, the lateral compression of the rolls, which reduce the thickness of its wall and increase its diameter, so that it is flowed or expanded around the conical head of the mandrel and passes therefrom in thin tubular form.

It will be observed that owing to the diverging sides of the pass that portion of the billet within the grip of the rolls and mandrel is smaller in diameter at its entrance than it is at the exit end of the pass. Now if the rolls were cylindrical or of uniform diameter they would of necessity impart a higher speed of rotation to the smaller diameter of that portion of the billet within their grip than to the portion having the larger diameter, which would result in a twisting of the fiber of the billet or a tendency to fracture it.

With my conical rolls arranged as shown there is absolutely no twist imparted by the rolls to the billet or tubular structure in process of formation and no slip between the contacting surfaces of the rolls and the said tubular structure, for while the diverging sides of the pass cause a gradual enlargement of the diameter of the tubular structure it will be observed that the diameters of the rolls increase progressively in the same ratio as the diameters of the tubular structure increase, the smaller diameters of the structure being gripped by the small diameters of the rolls, while the larger diameters of the structure are gripped by proportionately larger diameters of the rolls, so that an absolutely uniform speed of rotation is imparted by the rolls to every portion of the tubular structure within their grip. I regard this as a very important feature of my invention, and it is the result of converging the axes of both rolls and the lines of their working surfaces to a common point on the axial line of the pass. So far as I am aware this has never been done before, and I know of no device with rolls having a tapering or diverging pass between them in which there is not some twist imparted to the billet or some circumferential slip between the billet and the working faces of the rolls, or both.

While I have in the preceding description of the operation of the mechanism shown in Figs. 1, 2, and 3 stated that the rolls would pass the tubular structure without slipping upon its surface, I had reference particularly to circumferential slip and not to the endwise slip of the billet as it is being pushed through the pass by the ram R. In order to overcome this endwise slip of the billet on the contacting surfaces of the rolls, I may slightly incline the axes of my rolls, as shown in Fig. 4, so that the rolls themselves will have a slight tendency to feed the billet forward. This inclination should be just enough to

make the forward-feeding tendency of the rolls equal to the speed of the feed imparted to the billet by the ram. With this construction there is absolutely no slip of any kind between the rolls and the billet. In it, however, the axes of the rolls and the lines of their working surfaces do not converge at a common point on the axis of the pass, the axis and sides of one roll converging at a point in line with but above the axis of the pass, while the axis of the other roll and its sides converge upon a point in line with but below the axis of the pass, the two points lying in a common line which intersects the axial line of the pass at a right angle.

In connection with my rolls and mandrel any suitable guides may be employed to hold the work in its proper position in the pass. In some instances I deem it preferable that the surfaces of these guides against which the work rests should conform to the longitudinal contour or outline of the sides of the tubular structure being worked, so that the structure may be supported at every portion of its length within the grip of the rolls. The guides may be stationary, so that the work will slip upon them as it revolves, or roller-guides may be used that will revolve with the work, or otherwise, as found desirable.

In Figs. 8 and 9 are illustrated the effects of certain adjustments of the rolls toward or away from each other to permit, within certain limits, of variations of the sizes of work they may produce.

I consider it better to adjust the rolls toward or away from each other circumferentially by swinging them around a common center C, as shown by the line X in Fig. 8, so that their axes and the lines of their working faces will converge upon this center C in every position to which the rolls may be adjusted. Mechanism admitting of this adjustment of the rolls is illustrated more in detail in Figs. 11 and 12, in which the rolls A B and their driving-shafts (shown by dotted lines) are mounted in suitable bearings *c d*, rising from swinging plates *e f*, pivoted at C in the vertical plane of the axis of the pass to a main base-plate F. These plates rest upon the top of the base-plate and are free to swing around the pivotal center C, except when clamped to the plate by the clamping stud-bolts *g*. Suitable blocks or pillars *h*, rising from the surface of the base-plate, carry adjusting-screws *k k*, which force the roll-carrying plates toward each other and with the clamping-bolts resist their tendency to separate when work is being performed in the pass between them. The mandrel-head D is also shown by dotted lines in these figures. Theoretically this is the best method of adjustment; but within certain limits the rolls might be adjusted laterally or at a right angle to the axis of the pass in the direction of the line Y, Fig. 9, and although the intersecting points *c c* of their converging axes and working surfaces would not intersect a common point C on the axis of the pass the rolls would still work with a certain degree of efficiency and success in effecting the purposes of my invention.

In Figs. 5, 6, and 7 I illustrate a modification of my invention in which the axes of the rolls are oppositely inclined relatively to the axis of the pass, so that the rolls themselves will cause the endwise movement of the billet without the aid of a hydraulic ram or other mechanical appliance to force the billet into the pass and upon the head of the expanding-mandrel. In this construction while the axes and lines of the faces of the rolls do not intersect a common point on the axis of the pass they do intersect a common line passing through the axis of the pass, but above and below said axis, respectively, as hereinbefore set forth in the description of Fig. 4. In the construction shown in Fig. 4, however, the axes of the rolls were only inclined enough to render the rolls passive in their effect upon the endwise movement of the billet—that is to say, they neither assisted nor resisted this movement; but in the construction shown in Figs. 5, 6, and 7 the inclination of the rolls is such as to make them active promotors of this endwise movement of the billet, thereby enabling me to dispense with other agencies for this purpose. When the rolls are thus oppositely inclined, a horizontal line drawn transversely across the axis of the pass at mid-length of the contact of the rolls on the billet should intersect the axes of the two rolls, as shown by the line Z, Figs. 5 and 6.

With the exception of the inclination of the axes of the rolls the general shapes of the parts and their relative positions are substantially like those described in connection with Figs. 1, 2, and 3.

With the axis of the rolls inclined for the purpose of securing endwise feed of the billet without the aid of a ram or other outside means the small ends *a* and *b* of the rolls have an important function which is not essential in the construction where a ram is used to feed the billet.

Where a ram is used, the relation of the outside diameter of the billet to the width of the entrance or narrowest part of the pass is not a matter of great importance. If the billet is slightly larger in diameter than the width of the rolls at the line L, the surfaces *a* and *b* of the rolls will merely rub against and burnish the outside of the billet before it enters the pass and by lightly compressing the sides of the billet spring it to a slight oval form. While these effects are not injurious, they are neither sought nor specially avoided with a ram feed, and the outer diameter of the billet may be exactly equal to or even slightly smaller than the width of the pass at the line L and enter the pass without coming in contact with the surfaces *a* and *b*, as shown at N, Fig. 1, without detriment to the efficiency of the apparatus. When, however, the ram is dispensed with and the rolls inclined to produce the forward feed, it is very

essential that the first end of the billet should be gripped by the rolls before it encounters the mandrel and that this grip should be sufficiently powerful to overcome the resistance of the first contact of the billet with the sloping sides of the mandrel. When this construction is used, therefore, it is essential that the outside diameter of the billet should slightly exceed the width of the pass at the line L, so that it is fairly gripped, as indicated at O, Fig. 1, by the surfaces *a b*, which rotate and give the billet its forward impulse before it encounters the mandrel. This may cause the billet to be sprung into a slight oval form before it encounters the mandrel; but I do not regard this as injurious or objectionable. It is, in fact, an effect that is being produced throughout the entire length of the tubular structure that is within the field of operation of the rolls and mandrel. The rolls pressing the sides of the structure against the mandrel expand it and cause it to assume a slight oval form, so that while the tube is tightly pressed at its sides by the rolls against the mandrel its oval form insures absolute freedom from contact of the inside of the tube with the top and bottom sides of the mandrel. As a result of this there is no sliding friction of the inside of the tube upon the head of the mandrel except at the immediate sides where it is in the pinch between the rolls and the mandrel, and as this point is constantly changing with the revolution of the mandrel and billet to bring new portions of the latter into operation the sliding contact of the billet upon the mandrel is a spiral rather than an endwise slip.

Having thus described my invention, what I claim as new and useful, and desire to secure by Letters Patent, is—

1. The combination of conical rolling bodies disposed to form a pass between them the sides of which converge toward the entrance end, the diameters of the rolling bodies diminishing progressively in the same direction and in the same ratio as the width of the pass with a mandrel located in said pass, substantially as set forth.

2. The combination of conical rolls disposed to form a pass between them, the sides of which converge toward its entrance end, a mandrel located in said pass the working surfaces of which converge toward the entrance end more rapidly than do the sides of the pass, the diameters of the rolls diminishing progressively in the same direction and in the same ratio as the width of the pass, substantially as set forth.

3. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass the working surfaces of which converge toward the entrance end more rapidly than do the sides of the pass, the axes of the opposed rolls and the lines of their working faces substantially converging in a common point on the axial line of the pass substantially as set forth.

4. The combination of conical rolling bodies disposed to form a pass between them, the sides of which converge toward its entrance end, a conical mandrel located in said pass, the working surfaces of which converge toward the entrance end more rapidly than do the sides of the pass, the axes of the opposed rolling bodies intersecting the plane of the pass and diverging therefrom and means for forcing hollow billets or blanks endwise into the pass and against the mandrel, substantially as set forth.

5. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass the working surfaces of which converge toward the entrance end more rapidly than do the sides of the pass, the axes of the opposed rolls intersecting the plane of the pass and diverging therefrom, and means for forcing hollow billets or blanks endwise into the pass and against the mandrel substantially as set forth.

6. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass the working surfaces of which converge toward the entrance end more rapidly than do the sides of the pass, the diameters of the rolls diminishing in the same ratio as the width of the pass diminishes, with means for forcing hollow billets or blanks endwise into the pass and against the mandrel substantially as set forth.

7. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass, the axes of the opposed rolls and the lines of their working surfaces converging toward a common point on the axial line of the pass, the rolls being adjustable toward or away from each other by swinging about an axis passing through the said common point and at right angles to a common plane of the axes of the roll and of the pass substantially as set forth.

8. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass, the axes of the opposed rolls and the lines of their working surfaces converging toward points on a common line drawn through the axis of the pass at a right angle to a plane through the axis of the pass and through the straight line which intersects the center of the pass at a right angle and also the axes of the rolls, the rolls being adjustable toward or away from each other by swinging about an axis on said common line as set forth.

9. The combination of conical rolls disposed to form a pass between them the sides of which converge toward its entrance end, a conical mandrel located in said pass the working sur-

faces of which converge toward the entrance end more rapidly than do the sides of the pass, the axes of the opposed rolls being oppositely inclined relatively to the plane of the pass and their axes and the lines of their main working surfaces converging toward points on a common line drawn through the axis of the pass at a right angle to its said plane, with the additional surfaces *a*, and *b*, on the small ends of the rolls outside of the narrowest part of the pass substantially as and for the purpose set forth.

In testimony whereof I affix my signature, in the presence of two witnesses, at Ellwood City, Pennsylvania, April 23, 1897.

RALPH C. STIEFEL.

Witnesses:
SAML. A. ROELOFS,
GEO. WILLIAMS.