No. 812,146. PATENTED FEB. 6, 1906.

G. B. MELLINGER.

METHOD OF PRODUCING TUBES.

APPLICATION FILED JAN. 28, 1905.

4 SHEETS—SHEET 1.

Fig. 1.

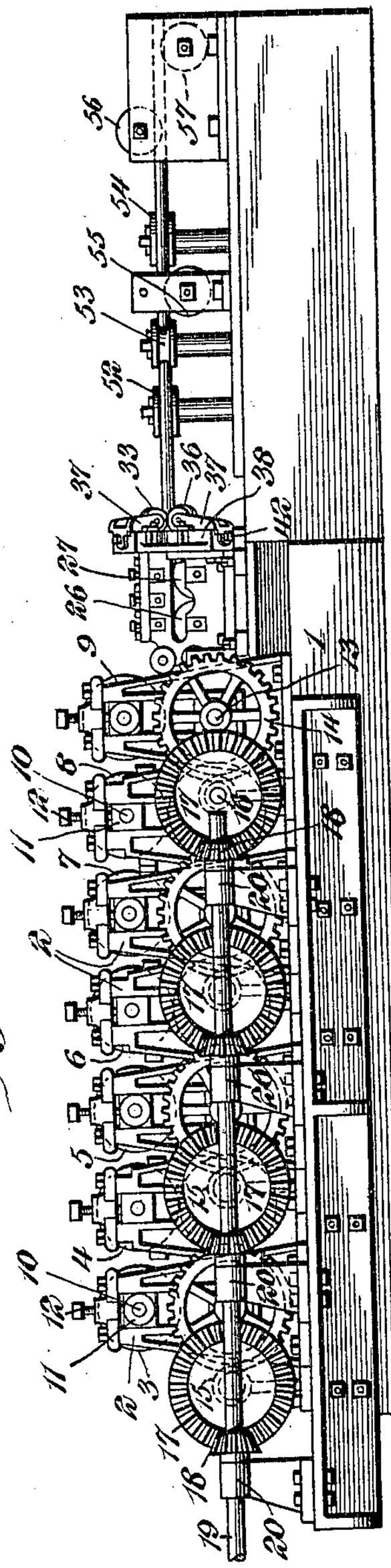
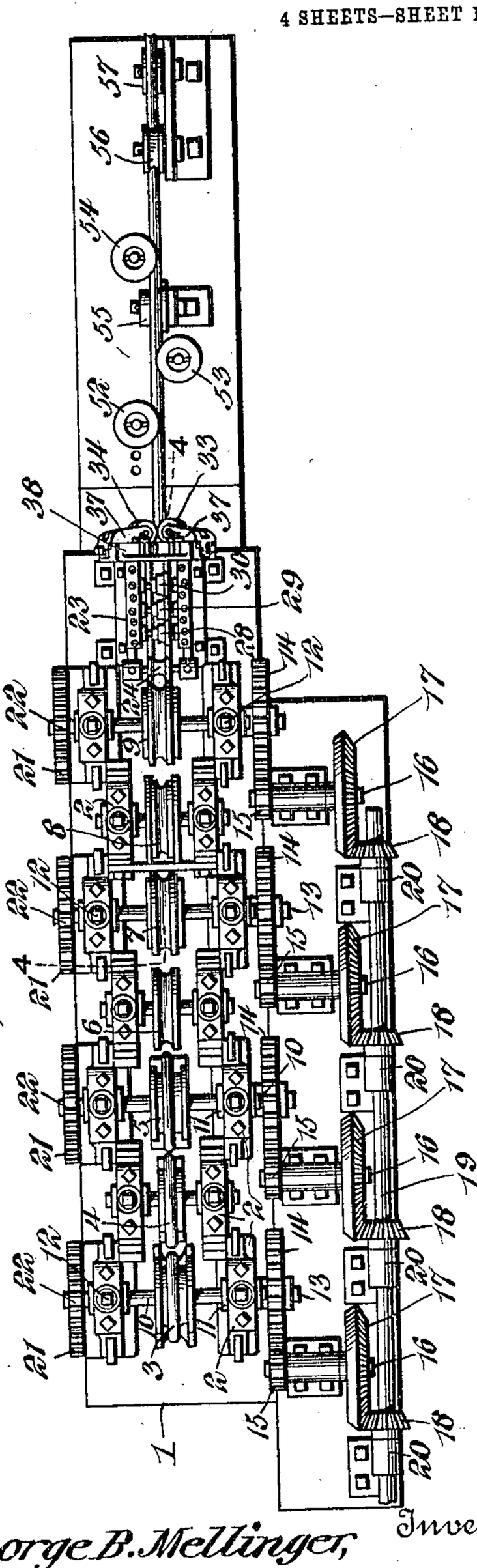


Fig. 3.



Witnesses

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4 SHEETS—SHEET 2.

Fig. 2.

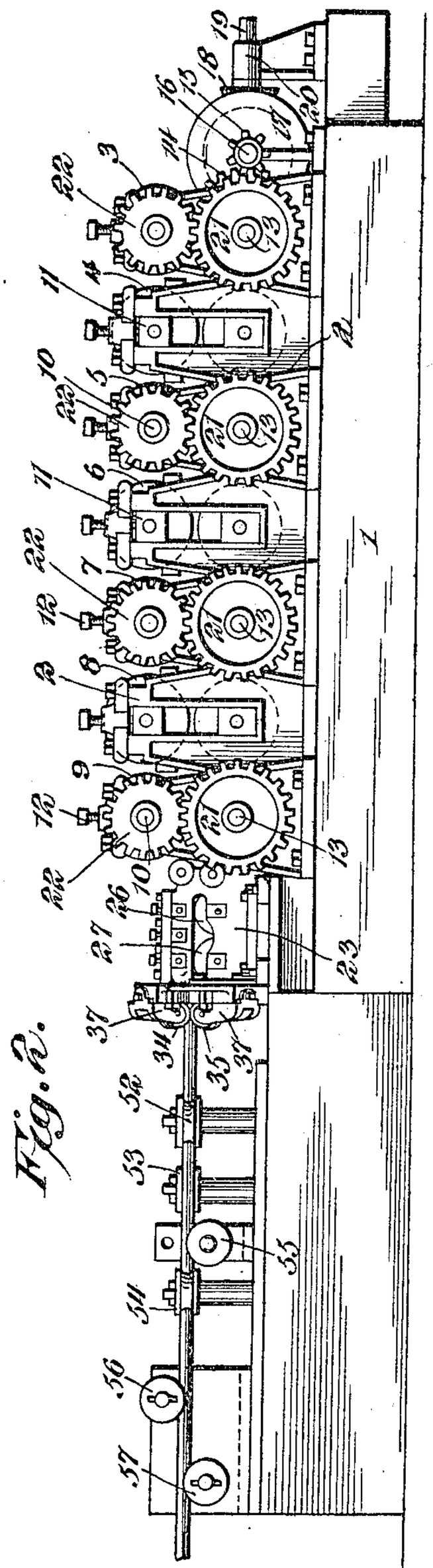
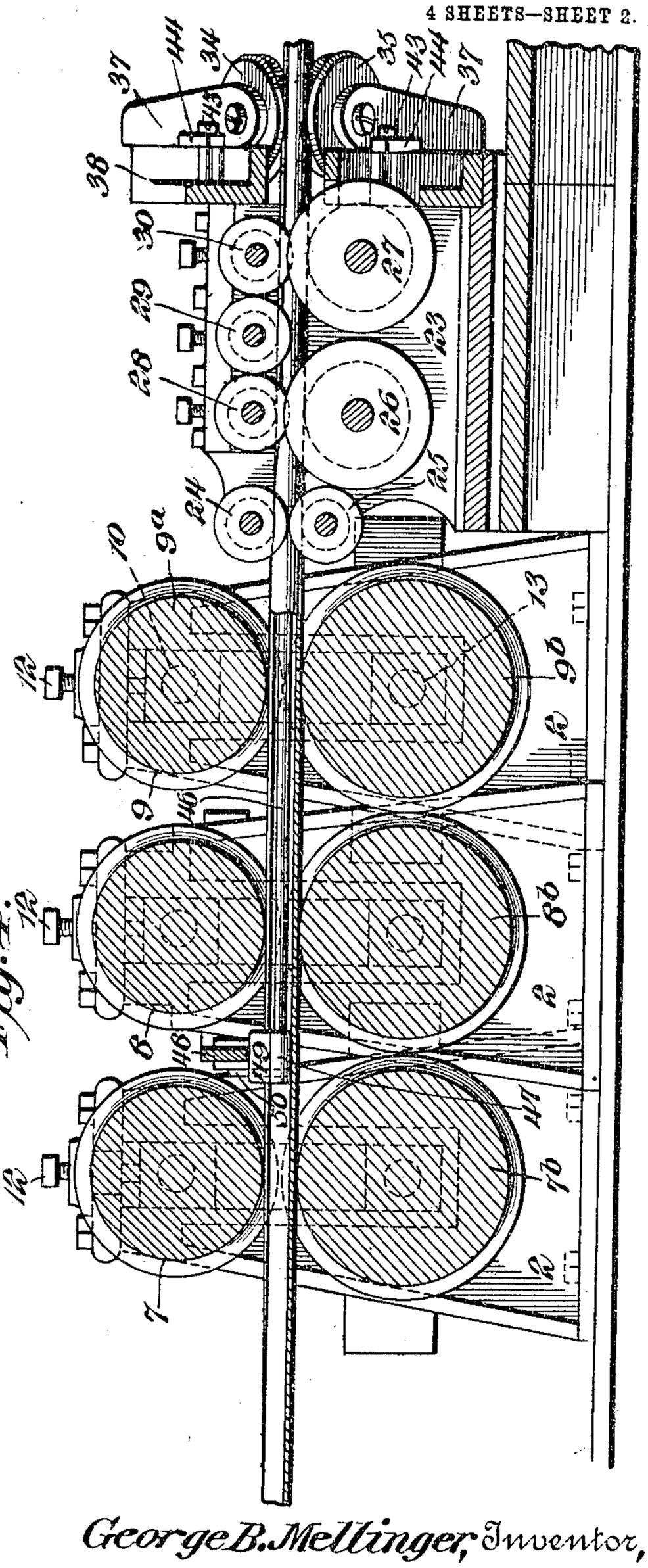


Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 6.

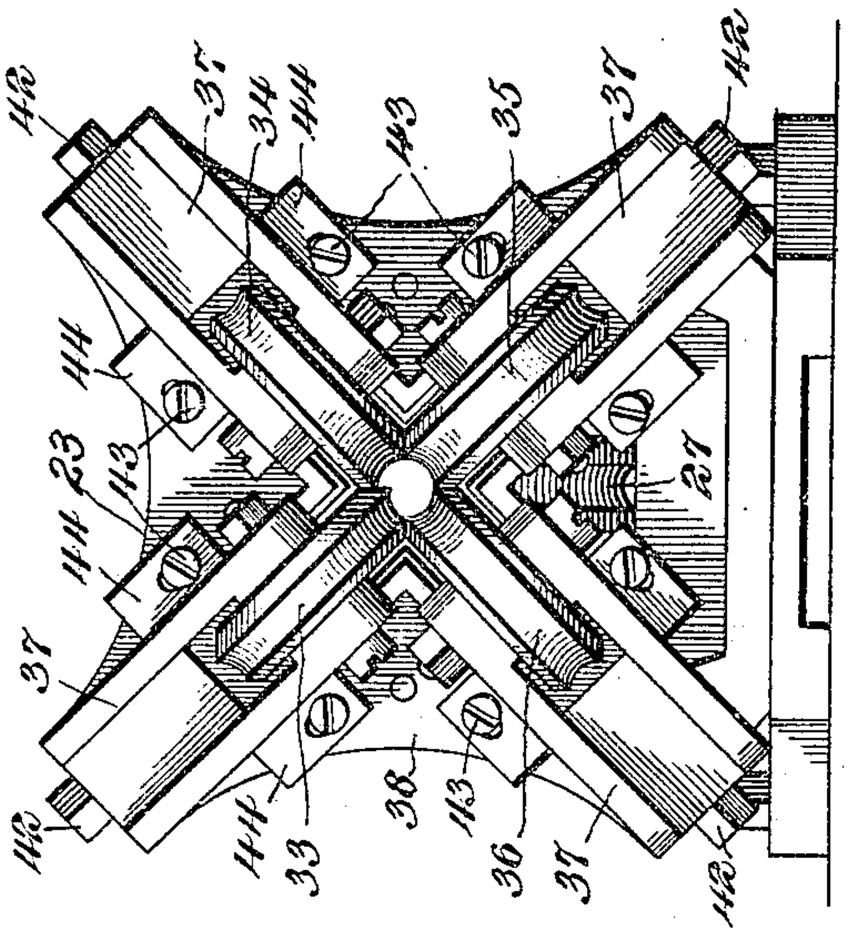

Fig. 5.

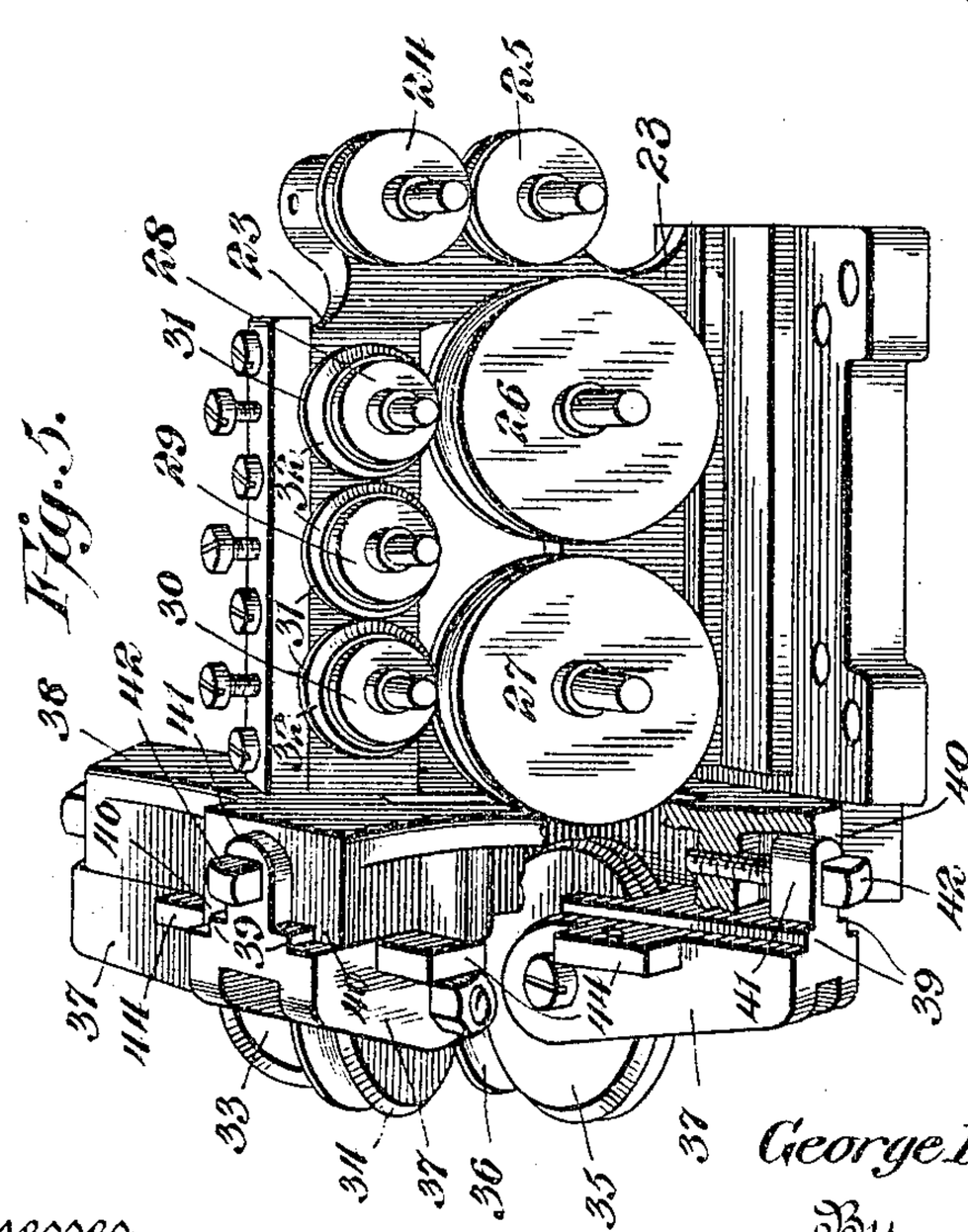

Fig. 7.

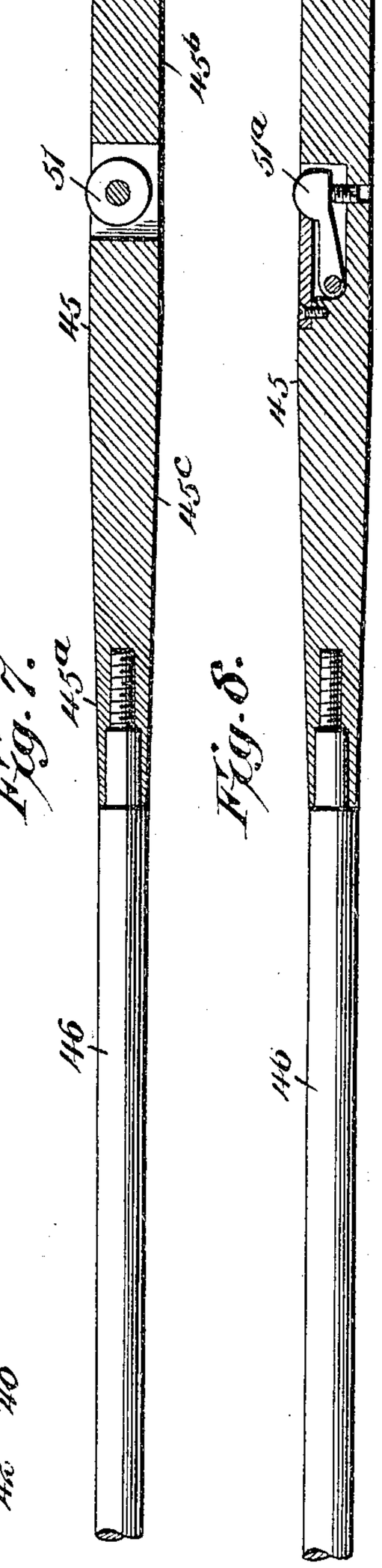

Fig. 8.

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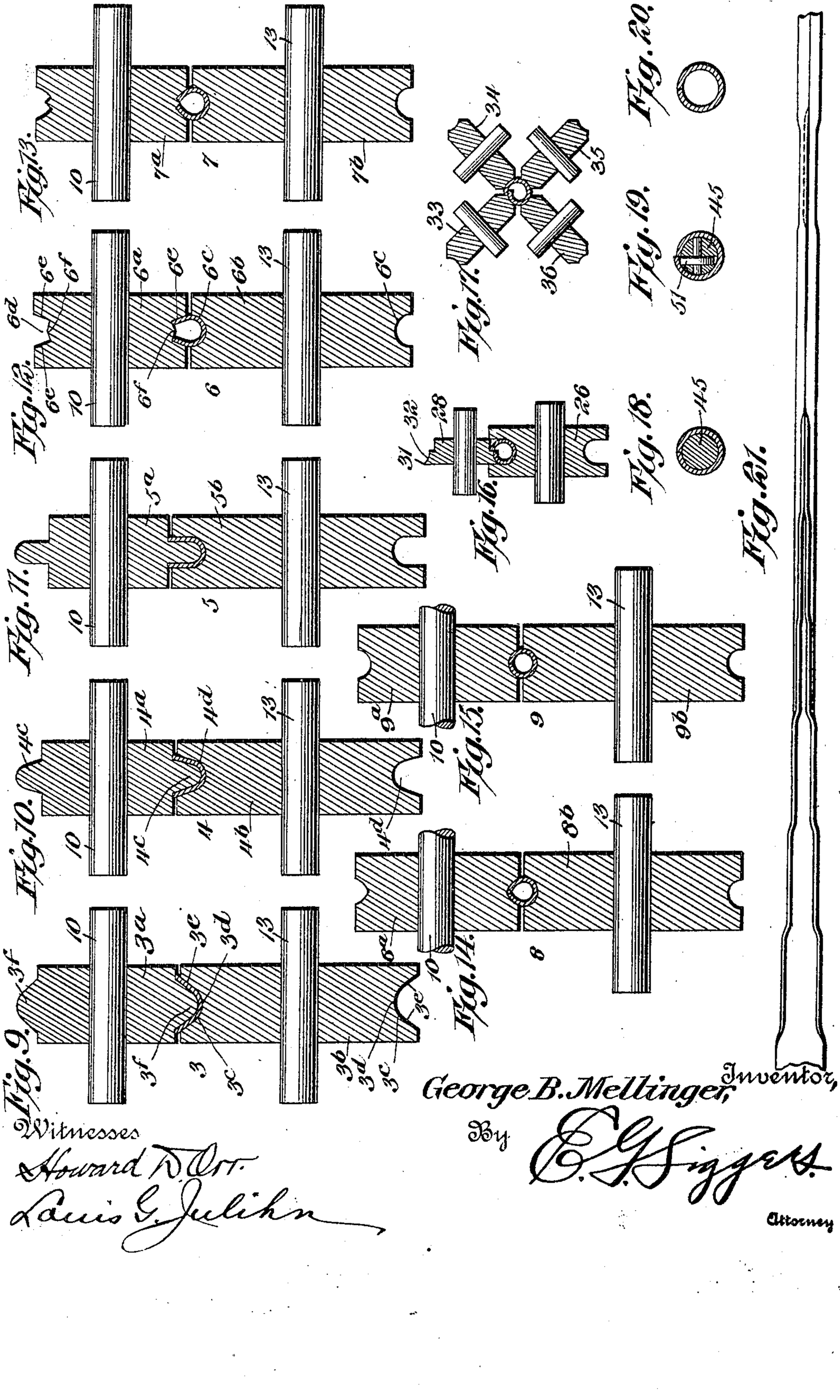
4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

GEORGE BRINTON MELLINGER, OF SCOTTDALE, PENNSYLVANIA, ASSIGNOR OF TWO-THIRDS TO ROBERT SKEMP AND JOSEPH R. STAUFFER, OF SCOTTDALE, PENNSYLVANIA.

METHOD OF PRODUCING TUBES.

No. 812,146. Specification of Letters Patent. Patented Feb. 6, 1906.

Original application filed October 20, 1904, Serial No. 229,348. Divided and this application filed January 28, 1905. Serial No. 243,057.

To all whom it may concern:

Be it known that I, GEORGE BRINTON MELLINGER, a citizen of the United States, residing at Scottdale, in the county of Westmoreland and State of Pennsylvania, have invented a new and useful Method for Producing Tubes, of which the following is a specification.

This invention relates to a novel method for producing tubes.

The object of the invention is to produce tubes of any desired length by bending the skelp or blank in a manner to create a normal tendency of the tube to contract, and thus effectually close the joint or seam formed by the meeting longitudinal edges of the skelp.

Another object is to so practice the method that the various steps may be performed simultaneously at successive points of the skelp in order that the manufacture of the tube may be accomplished continuously until a tube of the desired length is completed.

To the accomplishment of the recited objects the approved form of apparatus illustrated in the accompanying drawings and hereinafter fully described may be employed.

In said drawings, Figure 1 is a side elevation of the complete tube-making machine. Fig. 2 is a similar view of the machine viewed from the opposite side. Fig. 3 is a plan view of the same. Fig. 4 is a central longitudinal section on the line 4 4 of Fig. 3. Fig. 5 is a detail view in perspective showing the arrangement of the edge-flexing rolls and their relation to the contracting-rolls. Fig. 6 is a detail view of the contracting-rolls and their mounting. Fig. 7 is a detail view of the mandrel and its rod. Fig. 8 is a detail view of a modified form of mandrel. Figs. 9 to 15, inclusive, are detail sectional views through the successive pairs of skelp-bending or tube-forming rolls. Fig. 16 is a sectional view through a pair of edge-flexing rolls. Fig. 17 is a similar view of a set of contracting-rolls. Fig. 18 is a sectional view of the mandrel, showing the tube expanded thereon to true cylindrical form. Fig. 19 is a section through an advanced portion of the mandrel, showing the manner in which that edge of the tube whichwas previously deflected inwardly after the tube first assumed its normal dimensions is subsequently deflected or expanded outwardly from a tube of normal dimensions. Fig. 20 is a transverse section of the finished tube at a point beyond the mandrel; and Fig. 21 is a detail view of the skelp, showing the effect thereon of the various mechanisms.

Like reference characters designate corresponding parts throughout the views.

Since the method of forming a tube is incidental to the operation of the illustrated machine, although it may be otherwise practiced, I will describe the tube-forming mechanism by taking up the elements thereof in the order in which they act upon the skelp and will point out the various steps of the method, while describing one form of mechanism which may be utilized in their performance.

In a suitable frame structure, including a base-plate 1 and upright box-guides 2, are seven sets or pairs of skelp-bending or tube-forming rolls 3, 4, 5, 6, 7, 8, and 9, disposed in successive arrangement with the rolls of each pair disposed one above another. The shafts 10 of the upper rolls are received by vertically-movable bearing-blocks 11, coöperating with head-screws 12 in a manner well understood in the art. Certain of the shafts 13 of the lower rolls are provided with driving-gears 14, located beyond the bearing and meshing with pinions 15, fixed to stud-shafts 16, to which are also fixed beveled gears 17, meshing with beveled pinions 18 on a driving-shaft 19, mounted in suitable bearings 20 and driven in any suitable manner. The several gears and pinions constitute speed-reducing trains of power-transmitting gears between the driving-shaft 19 and the shafts 13 of certain of the lower rolls. Each of the shafts 13, equipped with a driving-gear 14, is provided at the opposite side of the machine (see Fig. 2) with a gear 21, meshing with a smaller gear 22, carried by the adjacent end of the upper shaft 10. Thus the rolls of each pair, whose lower member is geared to the driving-shaft, are geared together, so that both are positively driven. In the illustrated machine, which is designed more particularly for the manufacture of small tubes of comparatively light material, each alternate pair of rolls is positively driven.

In Figs 9 to 15, inclusive, the several pairs of skelp-bending or tube-forming rolls are

shown in section. The skelp or blank is first presented between the upper and lower rolls 3^a and 3^b of the first pair 3. The roll 3^b is provided with a peripheral groove or channel 3^c, having a curved bottom 3^d and straight diverging sides 3^e. The coöperating roll 3^a is provided with a peripheral projection 3^f, substantially corresponding with the groove or channel 3^c and extended therein, as shown in Fig. 9. As the skelp is passed between the rolls 3^a and 3^b it is bent into trough shape and in this form is advanced to the second pair of rolls 4, the upper and lower rolls 4^a and 4^b being provided, respectively, with a peripheral projection 4^c and a peripheral groove 4^d, similar to the corresponding features of the rolls 3^a and 3^b, except that the radius of the curved bottom of the groove 4^d substantially corresponds with the radius of the finished tube and that the convergence of the side walls of the groove is somewhat less than in the case of the roll 3^b. As the skelp passes through this second set of rolls the straight sides thereof are urged toward each other preparatory to the bending of said sides into parallel relation as the skelp passes between the rolls 5^a and 5^b of the third pair or set 5. (See Fig. 11.) The rolls 6^a and 6^b of the next set 6, unlike the rolls of the preceding sets, are both formed with peripheral depressions or grooves, the groove 6^c in the lower roll 6^b being semicylindrical in cross-section and the groove 6^d in the roll 6^a having divergent side walls 6^e and an angular bottom wall 6^f. As the skelp passes through these rolls its semicylindrical base is supported in the groove of the roll 6^b, while its parallel sides are urged into convergent relation by the side walls of the groove in the roll 6^a, the edge faces of the skelp bearing against the angular bottom wall of said groove to prevent distortion of the metal during the bending operation.

The lower roll 7^b of the next set is identical with the roll 6^b, and the upper roll 7^a corresponds with the roll 6^a, except that the side walls of its peripheral groove or channel are transversely curved and have a somewhat greater convergence, the angle of the bottom wall of the groove being correspondingly changed to form a seat for the edge faces of the skelp. As the skelp passes between these rolls 7^a and 7^b its side edges, disposed above the semicylindrical lower portion or base of the skelp, are urged closer together and given an inward curvature. This approach of the skelp sides is augmented and the curvature increased until a nearly cylindrical or tubular form is assumed by the passage of the skelp between the rolls 8^a and 8^b of the next set, which corresponds to the rolls 7^a and 7^b, except for the greater curvature and convergence of the side walls of the groove in the upper roll 8^a. The skelp now passes to the final set 9 of the skelp-bending rolls, which complete the formation of a perfect tube or cylinder of normal dimensions—that is to say, of the size of the finished tube—the peripheral channels of those rolls 9^a and 9^b being semicircular in cross-section to form a true cylindrical opening or pass.

The mechanism thus far described constitutes one embodiment of skelp-bending means which is capable of bending the skelp into tubular form without material longitudinal bending or distortion; but it is to be understood that in practicing the method a greater or less number of sets of rolls may be employed, accordingly as it is desired to bend the skelp more or less gradually in the formation of the initial tube. In fact, the invention contemplates the bending of the skelp into tubular and true cylindrical form preparatory to the performance of certain other operations regardless of the instrumentality employed. It is therefore within the purview of the invention to utilize the several illustrated sets of rolls, a greater or less number thereof, or an entirely different character of mechanism for imparting tubular form to the skelp.

When the tube issues from between the last set 9 of the skelp-bending rolls, it is in true cylindrical form, as stated, and it is at this point that ordinary methods of producing a butt-joint 2 terminate. I find, however, that at this stage the edges of the skelp, although brought into abutting relation by the rolls 9^a and 9^b, have a tendency to spring apart as soon as the metal passes beyond the rolls and is relieved of the pressure exerted thereby. This tendency results in the opening of the seam or joint and is obviously due to the resiliency of the metal, which is frequently manifested by the opening of the seam, even when the edges of the tube are slightly overlapped. It is therefore the aim of the succeeding steps of the method to overcome this expansive tendency of the tube, so as to insure a close joint of either a butt or lap type.

In advance of the bending set 9 a supplemental frame 23 is mounted on the base-plate 1. Within this frame, at its rear end, are mounted a pair of guide-rolls 24 and 25, grooved to form a pass of true cylindrical form for the reception of the tube as it extends beyond the rolls 9^a and 9^b. The rolls 24 and 25 serve to guide the tube to what may be arbitrarily termed the "edge-flexing" mechanism. The illustrated embodiment of this mechanism includes two comparatively large lower rolls 26 and 27, mounted in the supplemental frame 23 in closely-adjacent relation, as shown in Fig. 5, and each having a semicircular peripheral channel corresponding in radius with that of the tube, as shown in Fig. 16.

Disposed in a plane above the rolls 26 and 27 are three somewhat smaller edge-flexing

rolls 28, 29, and 30, the rolls 28 and 30 being located directly above the rolls 26 and 27 and the roll 29 being disposed between the rolls 28 and 30 and directly above the interval between the two lower rolls 26 and 27. The two lower rolls afford an extended support for the tube, and the three upper rolls serve to flex or depress one edge of the tube to present it immediately below the other edge thereof, each of these upper rolls being provided with a peripheral depressing or flexing flange 31, approximately half as wide as the tube and having a curved peripheral surface 32, which engages and flexes an upper quarter-section of the tube for the purpose of presenting the edges of the skelp in different horizontal planes, as stated. The reason for the employment of a series of these edge-flexing rolls instead of a single roll is that this repeated or continued flexing of the metal is required in order to overcome the reactive tendency of the metal, which would otherwise cause the depressed edge of the tube to spring back to its original position opposite the other edge of the skelp.

The next step in the practice of my method comprehends the contraction of the tube to lap the edges thereof by the external application of radial pressure at a number of points. This contraction of the tube is preferably effected by urging the same through a comparatively restricted pass defined by the edges of four contracting-rolls 33, 34, 35, and 36, having their shafts disposed in rectangular arrangement and mounted in bearing-blocks 37, carried on the front and plate 38 of the supplemental frame 23. While the mounting of these rolls is subject to variation, the blocks 37 are preferably provided with longitudinal tongues 39, slidably received by radial guides 40, formed in the plate 38. For the purpose of effecting the longitudinal adjustment of the blocks and the consequent adjustment of the rolls I provide each block at the outer end thereof with a lug 41, through which is passed an adjusting-bolt 42, the inner end of which is screwed into the plate 38, as shown in Fig. 5. When the block has been adjusted, it is rigidly retained by retaining-screws 43, screwed into the plate 38 and passed through slotted ears 44, extending from the opposite sides of the block, as shown in Fig. 6.

As the tube advances beyond the edge flexing or depressing rolls 28, 29, and 30 it enters the constricted pass formed by the four contracting-rolls, each of which engages a quarter-section of the tube. As the tube advances through this constricted pass it is uniformly contracted by the application of radial pressure at a plurality of points, and the skelp is thus coiled upon itself sufficiently to cause the overlapping of its longitudinal edges. Thus when the skelp has passed beyond the contracting-rolls it is in the form of a tube closed at one side by a lap-joint or seam, which may or may not be subsequently welded in any approved manner. The formation of this lap-joint tube is incidental to the preparation of the skelp in the manufacture of a butt-joint tube in accordance with my method, and since it may be desired to construct lap-joint tubes attention is directed to the fact that the method thus far practiced constitutes a complete embodiment of the invention in one aspect—that is to say, when viewed as a method for the production of lap-joint tubing.

It is new, so far as I am advised, to form a lap-joint tube by first bending the skelp into true cylindrical form with its edges abutted, to subsequently flex one edge of the tube toward the axis thereof, and to thereafter effect the uniform contraction of the tube to impart a transverse convolute configuration thereto, and thus present the edges of the skelp in lapping relation. Primarily, however, the invention is directed to the production of a butt-joint tube in which the edges instead of having a normal tendency to spring apart will have a normal tendency toward each other—in fact, a tendency to move beyond each other—which tendency is resisted by the contact of the abutting edges of the skelp. Up to this point the method consists in first bending the skelp into true cylindrical form, next depressing one edge, and finally uniformly contracting the skelp to impart a spiral form thereto. It will now be apparent that if the skelp is expanded in a manner to cause the reassumption of its cylindrical form the inherent stress or resiliency of the metal, caused by the previous contraction of the tube to less than normal dimensions, will urge the edges of the skelp toward each other with considerable force and will hold said edges in close relation after they have been presented in a common plane by the expansion of the lap-joint tube to the true cylindrical form. This expansion of the lap-joint tube is effected by the application of internal pressure produced by the movement of the tube over a mandrel 45. This mandrel is located beyond the contracting-rolls 33 and 36 and is detachably secured at the front end of a mandrel-rod 46, which extends back through the passes defined by the contracting-rolls, the edge-flexing rolls, the guide-rolls, and the last two sets 8 and 9 of skelp-bending rolls, beyond which latter it is terminally supported by a sleeve 47, connected to a mandrel-rod bracket 48 by a thin intermediate web 49, sufficiently narrow for the reception between the edges of that portion of the skelp located between the bending sets 7 and 8. The rod-bracket 48 is rigidly secured to the frame structure of the machine at a suitable point, and longitudinal movement of the rod 46 within the sleeve 47 is prevented by a key 50, as shown.

The diameter of the mandrel-rod 46 is such as to prevent its interference with the bending of the skelp; but it nevertheless serves the function of a guide for the tube at those points upon which the edge flexing and contracting rolls operate. The diameter of the rear end 45^a of the mandrel 45 corresponds with that of the mandrel-rod 46; but from this end the dimensions of the mandrel gradually increase until they correspond with the internal diameter of a completed butt-joint tube, the remaining portion of the mandrel being of cylindrical form, as shown. In other words, the mandrel comprises a plain cylindrical portion 45^b of a diameter corresponding to the internal diameter of a finished butt-joint tube and a tapered end 45^c, which connects the plain cylindrical portion 45^b with the mandrel-rod. The tapered end 45^c constitutes an expander, which causes the lapped or contracted tube to be gradually expanded as it moves rearwardly, so that when said tube passes onto the cylindrical portion 45^b of the mandrel it will have been restored to its original cylindrical form and with its edges abutted. The form of that portion of the tube passing over the cylindrical portion of the mandrel will be identical with that portion of the tube which is passing between the skelp-bending rolls 9^a and 9^b. While the form of the tube at these points is the same, however, the stress of the metal is reversed. In other words, when the tube issues from between the rolls 9^a and 9^b, its tendency is to expand, and thus separate the abutting edges, while the tendency of that portion of the tube located on the mandrel is to contract, and thus urge its edges into close contact. It is in this tendency of the tube to contract, and thus keep its edges in close relation, that the special merit of my invention viewed as an advance in the manufacture of butt-joint tubes is apparent, and it will be obvious that this meritorious characteristic of the tube results from its contraction to less than normal dimensions and its subsequent uniform expansion to normal dimensions. At this stage—that is to say, when the tube has again assumed its normal dimensions by expansion upon the mandrel—the tendency of the tube to contract is not only sufficient to retain the edges of the skelp in close contact, but is sufficient to cause the previously deflected or depressed edge of the skelp to move inward and under the opposed edge in case the tube receives rough handling—such, for instance, as will exert an inward pressure on such edge, and thus augment its natural tendency to contract. To avoid this possibility, the next step in the practice of the method involves the outward flexing of that edge of the skelp which was inwardly flexed prior to the contraction of the tube by the contracting-rolls. This outward flexing of the skelp edge is effected by a die 51, carried by and projecting slightly beyond the surface of the mandrel, and this while sufficient to counteract the tendency of the previously-flexed edge of the skelp to move inward toward the axis of the tube is insufficient to counteract that tendency to contract which insures the close engagement of the edges. As the tube, which is of true cylindrical form, advances from the cylindrical portion of the mandrel the edge thereof, which has heretofore been flexed inwardly from its normal position, rides over the die 51 and is flexed outwardly from its normal position. As the tube passes beyond the die 51 the outwardly-flexed edge springs back to its normal position; but since the outward flexing will have counteracted its excessive tendency to move inward the product of the method will be a butt-joint tube having its edges urged into close contact by the inherent resiliency of the metal and capable of sustaining rough handling without danger of opening the seam or joint or of causing the lapping of the edges.

While the precise method described is thought at this time to be preferable, I desire to reserve the right to effect such variations thereof as may come fairly within the scope of the protection prayed.

While the foregoing is a complete description of the method so far as the mere formation of a butt-joint tube is concerned, it happens that even when the bending of the skelp is effected gradually the completed tube will not be absolutely straight as it passes from the mandrel. I therefore practice an additional step, comprehending the straightening of the tube. This may be accomplished by tube-straightening mechanism, comprising a set of horizontal rolls 52, 53, and 54 and a second set of vertical straightening-rolls 55, 56, and 57, the first roll 55 of the vertical set being located in a plane intermediate of the second and third rolls 53 and 54 of the horizontal set, as shown in Fig. 3.

This application is a division of the copending application, Serial No. 229,348, filed October 20, 1904, in which application the apparatus is claimed.

What I claim is—

1. That improvement in the art of tube-making which consists in bending the skelp into tubular form with its longitudinal edges opposed, flexing the skelp to present its edges out of coincidence, and contracting the tube to lap the edges of the skelp.

2. That improvement in the art of tube-making which consists in bending the skelp into cylindrical form with its longitudinal edges opposed, flexing one edge inwardly by radial pressure to present its edges out of coincidence, and uniformly contracting the tube by the application of radial pressure at a plurality of diametrically-opposed points.

3. That improvement in the art of tube-making which consists in bending the skelp

into tubular form with its edges lapped, and thereafter expanding the tube to present the longitudinal edge faces of the skelp in abutting relation to each other.

4. That improvement in the art of tube-making which consists in bending the skelp into tubular form with its edges lapped, expanding the tube to present the edges out of lapping relation, and flexing the inner edge outwardly by the application of sufficient force to partially counteract its inward stress while insuring the apposition of the edge faces of the skelp when the flexing pressure is relieved.

5. That improvement in the art of tube-making which consists in bending the skelp to the form and dimensions of the finished tube, contracting the tube into convolute form, and expanding the tube to its original form.

6. That improvement in the art of tube-making which consists in bending the skelp into convolute form and thereafter expanding the tube into cylindrical form with the longitudinal edge faces of the skelp abutting each other.

7. That improvement in the art of tube-making which consists in bending the skelp into convolute form, expanding the tube into cylindrical form, flexing outwardly that edge of the skelp having the greatest inward stress, and relieving the flexing pressure to permit the flexed edge of the skelp to spring back into the plane of the cylindrical tube.

8. That improvement in the art of tube-making which consists in bending the skelp into cylindrical form, flexing one edge only of the skelp inwardly, contracting the tube into convolute form, and expanding the tube to cylindrical form, substantially as and for the purpose specified.

9. That improvement in the art of tube-making which consists in bending the skelp into cylindrical form, inwardly flexing one edge of the skelp, contracting the tube into convolute form, expanding the tube into cylindrical form, outwardly flexing the edge previously flexed inwardly, and permitting the flexed edge to spring back to complete the formation of a cylindrical butt-joint tube, all substantially as and for the purpose specified.

10. That improvement in the art of tube-making which consists in bending the skelp into cylindrical form, flexing one edge inwardly by the application of radial pressure thereto, contracting the tube to cause the overlapping of its edges, expanding the tube to present the edges thereof out of lapping relation, and flexing the inner edge outwardly by the application of radial pressure to partially counteract its inward stress while insuring the apposition of the edge faces of the skelp when the flexing pressure is relieved.

11. That improvement in the art of tube-making which consists in bending the skelp to the form of a tube having its edges lapped, urging the inner edge outwardly beyond a point opposite the other edge, and releasing the outwardly-urged edge to permit the same to spring back into abutting relation with the other edge of the skelp to complete the formation of a butt-joint tube.

12. That improvement in the art of tube-making which consists in urging the inner edge of a lap-joint tube outwardly beyond a point opposite the other edge to partially counteract the inward stress of the outwardly-urged edge, and in releasing said outwardly-urged edge to permit the same to spring back into abutting relation with the other edge to form a butt-joint tube.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

GEORGE BRINTON MELLINGER.

Witnesses:
R. S. SKEMP,
ELTA F. BURNS.