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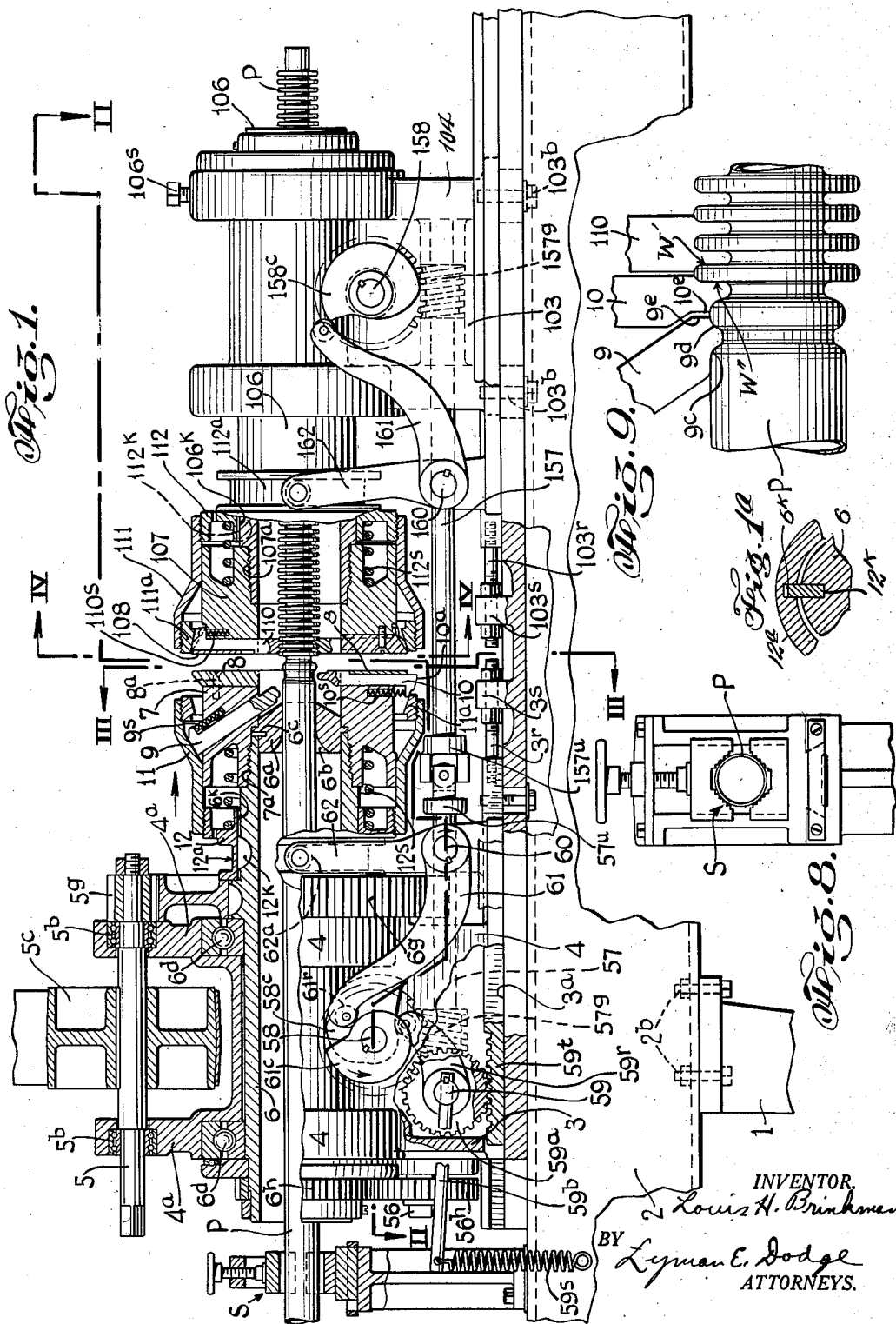
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2,092,873

METHOD AND MACHINE FOR CORRUGATING TUBES

Filed Aug. 26, 1933

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

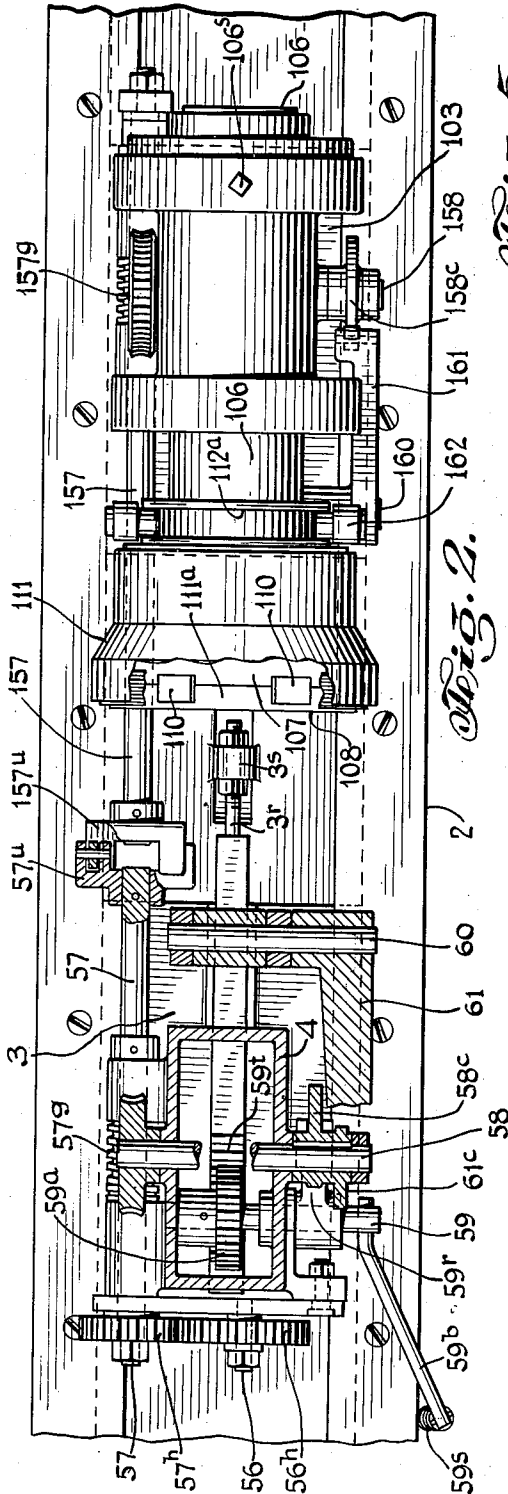


Fig. 2.

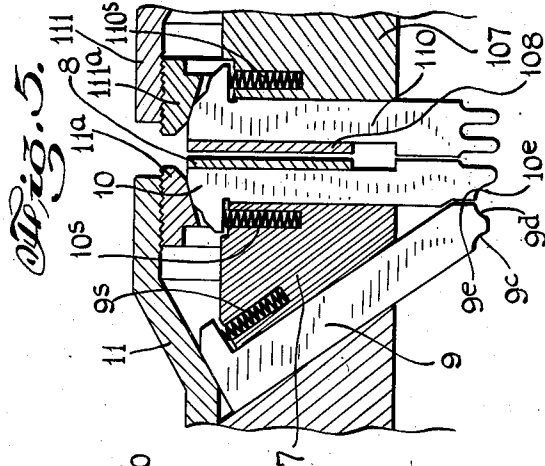


Fig. 5.

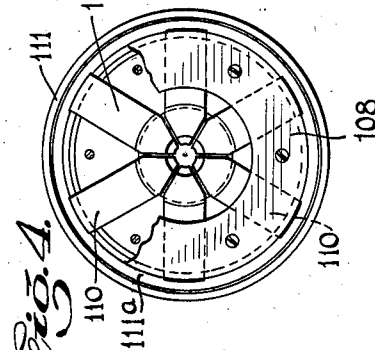


Fig. 4.

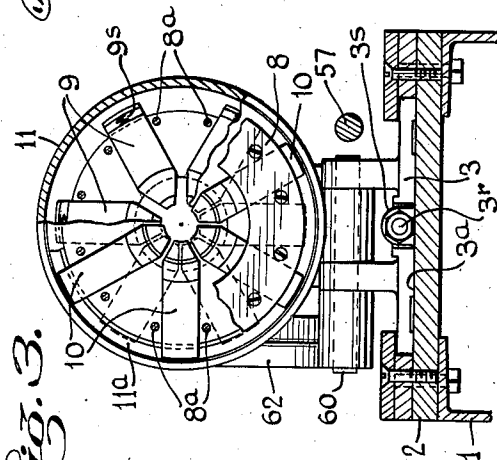


Fig. 3.

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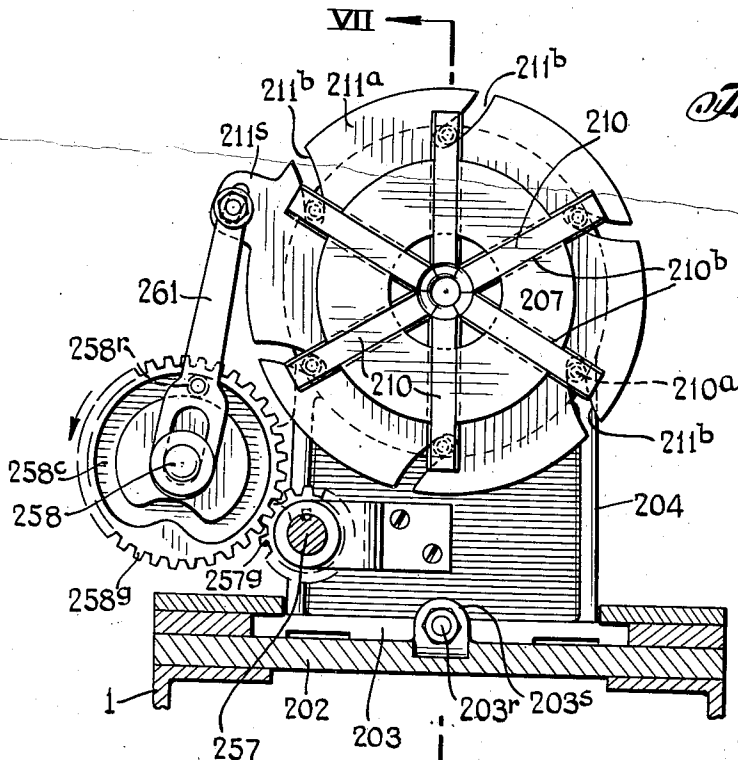
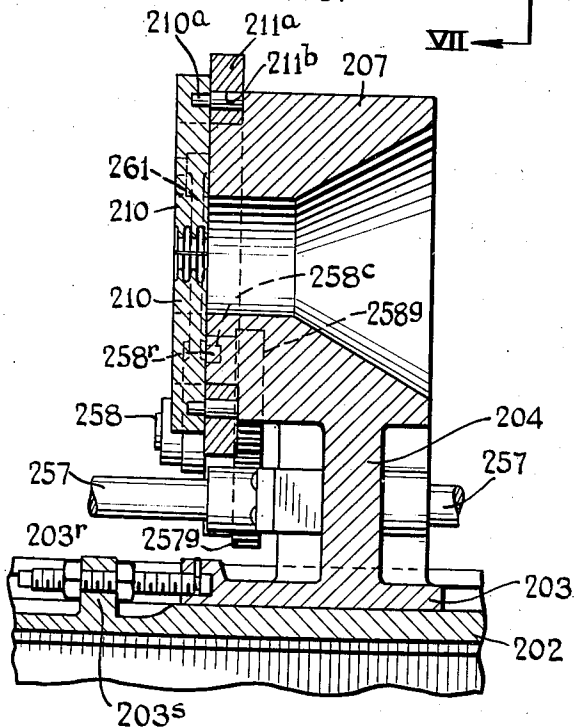
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3 Sheets-Sheet 3



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2,092,873

METHOD AND MACHINE FOR CORRUGATING TUBES

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Application August 26, 1933, Serial No. 686,881

16 Claims. (Cl. 153—73)

This invention relates to metal working; especially to the working of the metal of tubes and pipes, that is, long cylindrical hollow bodies, and more especially to the corrugating of tubes or pipes.

A principal object of this invention is the production of a device by means of which the wall of a tube or pipe, especially one with a comparatively thin wall, may be formed into a series of parallel independent corrugations or folds as a continuous process applicable to tubes of any length.

Other objects and advantages will appear as the description of the particular physical embodiment selected to illustrate the invention progresses, and the novel features will be particularly pointed out in the appended claims.

In describing the invention in detail, and the particular physical embodiments selected to illustrate the invention reference will be had to the accompanying drawings and the several views therein, in which like characters of reference designate like parts throughout the several views, and in which:—

Figure 1 is partly a side elevation and partly a longitudinal sectional view of a tube corrugating machine embodying the invention;

Figure 1a is a detail of the sleeve mounting;

Figure 2 is partly a top plan view and partly a sectional view on the plane indicated by the line II—II of Fig. 1;

Figure 3 is a sectional view on the plane indicated by the line III—III of Fig. 1, with some parts broken away to more clearly show the construction;

Figure 4 is a view along the line IV—IV of Fig. 1, viewed in the direction of the arrows at the ends of the line IV—IV of Fig. 1, with some parts broken away to more clearly show the construction;

Figure 5 shows the relative arrangement of the tools of Figs. 3 and 4 during one step in the manufacture;

Figure 6 is an end view, and Figure 7 a longitudinal sectional view, on the plane indicated by line VII—VII of Fig. 6, of another embodiment of the part of the apparatus shown at the right hand side of Fig. 1;

Figure 8 is a clamp or vice for preventing undesired movement of the pipe during one period in the manufacture;

Figure 9 illustrates a section of tubing, before, during and after corrugating, and shows the tools of Fig. 5 contiguous therewith;

Referring to Fig. 1, 1 represents one of the

supporting legs of the apparatus, 2 is a common bed rigidly fixed to base 1 by bolts 2b. This immovable common bed 2 supports two sub-frames 3 and 103. Sub-frame 3 carries a main frame 4 for shaft 6 and for the apparatus associated therewith and, as shown in Fig. 3, the whole is slidably mounted, as a unit, upon suitable bearing surfaces 3a, upon the common bed 2.

Sub-frame 103 is fixed on common bed 2 by bolts 103b. It is, however, adapted to be adjusted horizontally relative to sub-frame 3 by means of a threaded rod 103r operating in projections 103s. Sub-frame 3 is likewise adjusted by rod 3r and projections 3s. The relative spacing of sub-frame 3, in its idle position, and sub-frame 103 in its fixed position, and of the units associated therewith, is determined by the size and/or spacing of the corrugations to be formed in the tubing or pipe.

The racked tracks 59t, like studs 3s and 103s, form no part of either sub-frame 3 or sub-frame 103, but are rigidly fixed to and form a part of immovable common bed 2.

Frame 4 on sub-frame 3 is provided with a pair of vertically extending parallel supporting arms 4a. Drive shaft 5 is mounted in suitable bearings 5b on these arms 4a. Shaft 5 is adapted to receive power from a prime mover (not shown) by means of a pulley or wheel 5c or by other suitable means.

The main shafts, designated 6 and 106, respectively, are of hollow cylindrical construction. Shaft 6 (at the left hand side of Fig. 1) is mounted away from its ends in bearings 6d on frame 4; it is in energy transfer relation with drive shaft 5 through gears 5g and 6g.

Main shaft 6 is also provided with a second gear means 6h. Gear 6h meshes with gear 56h on idler shaft 56, and is adapted to revolve shaft 58 which in turn revolves shaft 59 to advance pinion 59a on rack 59t, thereby imparting a reciprocating motion to the entire assembly mounted on sub-frame 3, i. e., frame 4, drive shaft 5 and main shaft 6 and head 7.

Right hand shaft 106 does not revolve, nor is it or its main frame 104 subject to any reciprocating movement. As previously set forth, its sub-frame 103 may be adjusted horizontally on common bed 2. When so adjusted any tendency of shaft 106 to revolve in frame 104 is obviated by set screw 106s.

An annular bushing 6a is removably fixed by key 6c, to the inner periphery of hollow shaft 6. The inner circumference of annular bushing 6a is of a dimension sufficient to slidably support

a length of pipe of the particular size to be processed, and is preferably provided with a curved recess 6b for guiding the pipe or tubing P into proper position. Additional support for pipe P is provided, intermediate its length, by device S or of any other suitable type.

Bushings (not shown) similar to 6a may be provided on the interior of shaft 106 for slidably supporting the pipe P after it has been corrugated.

A removable head 7 is mounted by threads 7a, on shaft 6. End plate 8 is fixed by screws 8a to head 7 and moves therewith. End plate 8 is adapted to cooperate with end plate 108 on the oppositely located head 107, in a manner to be described.

The main body of head 7 is rigidly fixed to shaft 6 and adapted to move therewith. Head 7 is provided with radial recesses in which are mounted, respectively, a number of inwardly extending radially arranged grooving tools or fingers 9 and 10. (See Figs. 3 and 5.) The inner fingers 9 are preferably set at an angle to the vertical axis of the outer fingers 10.

Inner fingers 9 serve to form an annular groove when pressed against the smooth surface of pipe P, and outer fingers 10 serve to shape this initial groove (the pipe having been advanced) when forcibly contracted thereon.

The contracting pressure necessary to operate fingers 9 is provided by angular flange 11, which is slidably arranged on head 7, bearing directly against fingers 9.

Fingers 10 are set slightly ahead of fingers 9 and there is a slight time lag in their otherwise simultaneous contracting movement. This desired lag is simply attained by exerting pressure from angular flange 11 through a beveled ring 11a, against a curved surface 10a on the head of each finger 10.

Angular flange 11 is removably threaded on sleeve 12 operating on main shaft 6 and is adapted to revolve therewith.

Sleeve 12 is slidably mounted by key 12k, operating in keyway 6k, on shaft 6 and is adapted to be moved horizontally forward by pressure of vertical arm 62 operating in groove 12a provided for the purpose in sleeve 12. The necessary reversed horizontal movement of flange 11 and sleeve 12 is provided by coiled spring 12s.

Fingers 9 and 10 are provided, respectively, with springs 9s and 10s, which serve to restore them to their inoperative position upon completion of their contracting inward movement. As will be described in connection with Fig. 8, a more positive movement than that exerted by springs 9s and 10s may be provided wherever necessary or desirable.

Head 107 is removably fastened to shaft 106 by threads 107a. Head 107, on rigid shaft 106 like head 7 on the revolving, reciprocating shaft 6 carries an end plate 108. Corrugations made by tool 9 are separately compressed by reason of the reciprocating movement of head 7 and tools 10 toward tools 110 in stationary head 107.

Head 107 is provided with a series of radial recesses adapted to accommodate the series of radially arranged tools 110. As shown in Fig. 9, these tools 110 serve to cooperate in the compressing operation and act to insure uniformity of contour in the corrugations while being compressed into final form; they also serve to grip, and thereby obviate rotation or other undesired movement of pipe P.

The contracting pressure necessary to operate tools 110 (to grasp pipe P) is provided through beveled ring 11a by the sliding movement of angular flange 11 on head 108. Flange 11 is removably threaded on sleeve 112. Sleeve 112 is slidably keyed by key 112k operating in groove 106k on fixed shaft 106 and is adapted to be moved horizontally forward by the pressure exerted thereagainst by ring 112a. Ring 112a receives its forward movement, on shaft 106, through rocker arm 161 and vertical arm 162 operating on common shaft 160.

The reversed horizontal movement of angular flange 11, sleeve 112 and ring 112a, necessary to relieve the tension on springs 110s to release tools 110, is provided by coiled spring 112s.

As set forth in connection with Fig. 1, main shaft 6 is driven by drive shaft 5 through gear 5g—6g. Gear 6h, on main shaft 6 drives gear 56h on idle shaft 56, gear 56h in turn, meshes with gear 57h on shaft 57 (see Fig. 2). This longitudinal shaft 57 is provided intermediate its length with worm gear 57g which is adapted to mesh with a corresponding gear adjacent one end of lateral shaft 58. As shown in both Figs. 1 and 2 shaft 58 carries two eccentric cams 58c and 61c.

A second lateral shaft 59, is mounted in suitable housings on frame 4 and carries pinion 59a, rocker arm 59r, and lever bar 59b. Rocker arm 59r in following eccentric cam 58c is depressed, and, being keyed to shaft 59 will advance pinion 59a (and hence the entire units 4, 5, 6, etc.) on rigid track 59t. Lever bar 59b, which is also keyed to lateral shaft 59 will rise, at its outer extremity, and increase the tension upon spring 59s. When the downward pressure by eccentric cam 58c on rocker arm 59r is removed, the tension exerted by spring 59s through lever bar 59b will cause shaft 59, pinion 59a (and the entire assembly mounted thereabove) to move in the reverse direction on racked tracks 59t.

Rocker arm 61 moves on axle 60. Axle 60, like shafts 6—57—58—59, is mounted on main frame 4 and moves therewith. Rocker arm 61 follows eccentric cam 61c and, its outer end being raised, will cause shaft 60 to move in a direction opposite to that of cam 61c.

Axle 60 serves as a pivot for vertical arms 62. Arms 62 are provided with suitable rollers 62a operating in groove 12a of sleeve 12. As previously described, sleeve 12 is slidably keyed on shaft 6, it carries angular flange 11 which serves to depress grooving tools 9 and 10 when sleeve 12 is advanced by vertical arm 62.

The tension of spring 12s is exerted against sleeve 12 and provides the necessary return horizontal movement therefor. Vertical arms 62, axle 60 and rocker arm 61 are moved in a reverse direction by the return of sleeve 12. As the return movement of rocker arm 61 is thus positively provided, outer roller 61r will contact eccentric cam 61c at all times.

From the foregoing it will be apparent that the rotary motion of shaft 6 (provided by drive shaft 5 through gears 5g—6g) is in no wise interrupted by the reciprocating horizontal movement of sleeve 12, or by the radial movement of grooving tools 9 and 10.

In the preferred embodiment, Fig. 1, shaft 106 does not revolve nor is it or the sub-frame 103 subject to any reciprocating movement. The pressure necessary to contract the radially arranged gripping tools 110 is provided, through keyed sleeve 12, by ring 112a. Ring 112a re-

ceives its forward movement on shaft 106 through vertical arm 162 and rocker arm 161 mounted on common pivot shaft 160. Rocker arm 161 follows an eccentric cam 158c. This cam 158c rotates with lateral shaft 158, which like the corresponding lateral shaft 58 on the opposite unit is driven by similar worm gears 157g on the sectional longitudinal shaft 57—157.

As shown in both Figs. 1 and 2 shaft sections 57 and 157 are flexibly joined by means of extensible and contractible coupling members 57u and 157u.

The only functions of shaft 106 and the assembly mounted thereon are to (1) support pipe P, (2) to grip pipe P, (3) provide a face against which the corrugations may be separately compressed.

The apparatus shown in the embodiment of Figs. 6 and 7 fulfills all of these functions and, in addition, provides a more direct movement for actuating and more positive movement for releasing the radially arranged gripping tools 110, than that shown in Figs. 1, 3, and 4.

Like digits and characters represent similar or corresponding parts in all of the figures. Thus, referring to Figs. 6 and 7: 202 is the common bed; 203 the horizontally adjustable sub-frame; 203r the threaded rod and 203s a threaded projection providing this horizontal adjustment for sub-frame 203; 204 represents the main frame or supporting arbor for the gripping tool assembly. The longitudinal drive shaft is 257, the driven shaft is 258.

In the embodiment shown in Figs. 6 and 7, the radially arranged gripping tools are designated 210; they are slidably supported on bearing surfaces in suitable recesses 210b in end member 207. Each gripping tool 210, carries near its outer extremity, a finger or stud 210a. These studs 210a are adapted to slide in cam slots 211b provided for the purpose in an annular or ring-like member 211a. These cam slots reach the periphery of 211a, so that by disconnecting 261 from 211a, then by rotating 211a the studs 210a may be removed entirely from the slots, and tools 210 removed radially. Annulus 211a carries a slotted stud 211s in which arm 261 operates. Arm 261, near its lower extremity, is slotted to receive shaft 258 and carries a roller 258r cooperating with cam 258c. Cam 258c is mounted on shaft 258 and is driven by shaft 257 through gears 257g and 258g, thus oscillating 211a and tools 210.

In the embodiment, Figs. 6 and 7, above described, it is apparent that the upward or releasing movement of gripping tools 210 is no less positive than the inward or gripping movement and for this reason may be preferred to the spring actuated gripping tool assembly of Fig. 1.

Although the machine is entirely automatic in operation when all of the several grooving and gripping tools are functioning, it is nevertheless necessary to use a clamping device S (which may be of any suitable or convenient type) for preventing undesired rotary or other movement of pipe P during the formation of the first few grooves, and to allow subsequent advance of the pipe.

Pipe P is inserted through clamping and supporting device S, shaft 6, bushing 6a to a point past the first grooving tools or fingers 9 and preferably between the two sets of fingers.

The jaws of clamping device S are clamped and the power turned on. Power developed by the prime mover (not shown) will be transmitted through pulley 5c to drive shaft 5 and thence

to main shaft 6 through gears 5g—6g. As head 7 bearing the radially arranged grooving tools 9 and 10 is fixed to shaft 6 at 7a; an as sleeve 12 carrying actuating flange 11 and ring 11a is slidably keyed to shaft 6 by key 12k, the entire assembly, i. e., shaft 6, head 7, end plate 8, tools 9 and 10, flange 11, and sleeve 12, will rotate about pipe P.

As shaft 6 revolves, it drives longitudinal drive shaft 57 (by means of gears 6h and 56h, Fig. 2). Shaft 57 operating through worm gear 57h, shaft 58, rocker arm 61 and vertical arm 62 advances sleeve 12 on main shaft 6 and forces flange 11 and ring 11a against tools 9 and 10. Tools 9 and 10 are thereby pressed against pipe P and form a pair of parallel grooves therein. The pipe is then released from clamping device S, and head 7 in moving forward, (tools 9 and 10 being still in position), the outer groove will be squeezed against the gripping tools 110. The first corrugation or bellows fold having been formed, the pipe is further advanced (manually) at which time tools 110 operate to firmly grasp the corrugation already formed.

As previously set forth, gripping tools 110 may be actuated in a manner similar to that provided for the operation of grooving tools 9 and 10, or in the manner described in connection with the embodiment shown in Figs. 6 and 7. In any event, the operation of all of the tools 9—10 and 110 is in a predetermined order. The sequence of operation is preferably as follows:

The radially arranged set of grooving tools or fingers 10 are set slightly ahead of fingers 9 in order to allow them to obtain a grip on the tubing and prevent it from slipping when fingers 9—which operate at an angle, begin to close. When these two sets of fingers 9 and 10 have obtained a grip on the tubing, gripping tools 110 in right hand head 107 open and release the tube. Left hand head 7 jumps forward suddenly and advances the tubing the distance of one corrugation. Tools 110 close again and grip this new corrugation while head 7 continues moving forward and compresses the bridge formed between the two grooves made by fingers 9 and 10, causing it to swell out into the form of a corrugation. As shown in Fig. 9, during this latter operation, grooving tools 9 and 10 and gripping tools 110 are still within the grooves and serve to ensure uniformity of contour during the compressing operation. As shown by both Figures 5 and 9 at the point of furthest outward movement, tools 10 are adjacent or contiguous to gripping tools 110.

After the corrugation or bellows fold has been formed by the motion forward of head 7 against stationary head 107, the gripping tools 110 remain closed while grooving tools 9 and 10 open and are released from pipe P while head 7 moves quickly back. Tool 10 is now contiguous the shallow groove formed during the first cycle by tool 9, and tool 9 is in position to initiate a new groove. When these two sets of fingers 9—10 have obtained a grip on the tubing, tools 110 open and release the tube and the entire cycle is repeated.

It is essential that tool 10 does not actually contact with the bottom of the groove formed by tool 9, that is, tool 9 in forming a groove somewhat thins the metal at the bottom of the groove, so that if tool 10 further acted to depress the bottom of the groove the metal would be thinned still more. Applicant prevents this undesired result by so timing the operations that tool 10 has not quite reached the bottom of the initiated groove

when head 7 moves forward. As head 7 moves forward, pressure by tool 110 is exerted on the end wall W', i. e., the forward side of the bridge between grooves, so that the outer periphery of the bridge moves outwardly and the bottom of the next to the last groove formed moves inwardly, followed closely by tool 10, so close as not to actually spin the metal of the bottom of the groove but closely enough to produce the proper shape. Concurrently, pressure is exerted by tool 10 against the end wall W'' of the bridge.

As the top of the bridge moves outwardly, the metal of the bridge decreases in thickness, so that the final result is a tube in which the metal is of substantially the same thickness throughout.

If the bridge between grooves is not slightly convex outwardly, there is danger that the bridge will cave inwardly instead of bulging outwardly when squeezed between tools 10 and 110. Because of this applicant forms the ends of tools 10 and 110 so that the proper form is assured. Tool 9 is formed with the curved portions 9c and 9d. These portions ensure a properly rounded form for the bridge between grooves before it is compressed. Further, the edge 9e of the tool 9 in its final inner position is as close as it can conveniently be brought to edge 10e of tool 10, so as to cover substantially all of the bridge by the forming tools.

The tools 9, 10, and 110 are placed, as shown in Figs. 3 and 4, so that when they are pushed inwardly to their greatest extent their ends form practically a circle with a space between tools of about the thickness of the stock being worked. The radius of the arc of the face or working end of tool 9 is about 0.01 of an inch greater than one-half the outside diameter of the tube being worked. This prevents any catching of the corners of the tool in the material.

The arc of tool 10 is that of a circle whose radius is one-half the diameter at the initiated groove when completely formed, plus about 0.005 of an inch.

The arc of tool 110 is that of a circle whose radius is one-half of the diameter at the groove when completely formed plus about 0.002 of an inch.

Although I have illustrated and described one particular physical embodiment of my invention and explained the principle, construction, and mode of operation thereof, nevertheless, I desire to have it understood that the form selected is merely illustrative, but does not exhaust the possible physical embodiments of the idea of means underlying my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A machine for forming parallel corrugations in a tube of indeterminate length comprising a plurality of spaced axially aligned supporting members through which said tube is adapted to pass, a plurality of series of grooving tools arranged about said tube near an end of one of said supporting members, means to cause relative rotation between said tools and said tube, gripping tools adjacent the adjacent opposed end of another of said members, means for pressing all of said series of grooving tools against the outer surface of said tube to form a plurality of parallel grooves therein, means for actuating said gripping tools to prevent undesired movement of said tube while said grooving tools are operating and means to cause certain of said tools to approach each other for successively squeezing each

of said parallel grooves during said simultaneous grooving and gripping operations.

2. A machine for forming parallel corrugations in a tube of indeterminate length comprising a plurality of spaced axially aligned supporting members through which said tube is adapted to pass, a plurality of series of grooving tools arranged about said tube near an end of one of said supporting members, means for rotating said last-mentioned supporting member, with said grooving tools, relatively to said tube, gripping tools adjacent the opposed end of another of said members, means for pressing all of said series of grooving tools against the outer surface of said tube to form a plurality of parallel grooves therein, means for actuating said gripping tools to prevent undesired movement of said tube while said grooving tools are operating and means to cause relative movement between said first mentioned and said second mentioned supporting members for advancing said grooves relative to said gripping tools.

3. A machine for forming parallel corrugations in a tube of indeterminate length, comprising a plurality of spaced axially aligned supporting members through which said tube is adapted to pass, a plurality of series of grooving tools arranged about said tube near an end of one of said supporting members, means to cause relative rotation between said tools and said tube, gripping tools adjacent the opposed end of another of said members, means for pressing all of said series of grooving tools against the outer surface of said tube to form a plurality of parallel grooves therein, means for actuating said gripping tools to prevent undesired movement of said tube while said grooving tools are operating, means for causing intermittent relative approaching movements of said grooving tools and gripping tools, for successively squeezing each of said parallel grooves and means for releasing said gripping tools to permit advancing said tube bodily relative to said gripping tools during periods intermediate said successive squeezing operations, and by virtue of certain of said approaching movements.

4. A machine for forming parallel corrugations in a tube of indeterminate length, comprising a plurality of spaced axially aligned supporting members through which said tube is adapted to pass, a plurality of series of grooving tools arranged about said tube near an end of one of said supporting members, means for rotating said last mentioned supporting member with said grooving tools, relatively to said tube, gripping tools adjacent the opposed end of another of said members, means for pressing all of said series of grooving tools against the outer surface of said tube to form a plurality of parallel grooves therein, means for actuating said gripping tools to prevent undesired movement of said tube while said grooving tools are operating, means for causing intermittent relative approaching movements of said grooving tools and gripping tools, for successively squeezing each of said parallel grooves during said simultaneous pressing and gripping operations, and means for advancing said tube bodily relative to the initial position of said grooving tools after completion of the squeezing operation upon each preceding corrugation.

5. A machine for forming parallel corrugations in a tube of indeterminate length comprising a plurality of spaced axially aligned supporting members through which said tube is adapted to

pass, a plurality of series of grooving tools arranged about said tube near an end of one of said supporting members, means for rotating said last mentioned supporting member with said grooving tools, relatively to said tube, gripping tools adjacent the opposed end of another of said members, means for pressing all of said series of grooving tools at predetermined intervals against the outer surface of said tube to form a plurality of parallel grooves therein, means for actuating said gripping tools to prevent undesired movement of said tube while said grooving tools are operating, means for causing intermittent relative approaching movements of said grooving tools and gripping tools for successively squeezing each of said parallel grooves during said grooving and gripping operation and means for moving said tube bodily to an advanced position relatively to the initial position of all of the tools during periods intermediate said repeated simultaneous grooving, gripping and squeezing operations.

6. The method of corrugating a tube which consists in forming an annular groove in said tube, initiating a second groove, and initiating a third groove, and concurrently deepening said second groove by applying force laterally to the posterior wall of said groove to cause the leading wall of said second groove to approach the adjacent end wall of said first mentioned groove.

7. The method of deforming tubular metal stock of indeterminate length and approximately uniform original diameter, to form the walls thereof into corrugations embodying concave portions of less diameter than the original, and convex portions of greater diameters than the original, with walls of diminished, substantially uniform thickness, said method comprising the steps of advancing said stock intermittently and applying a multiplicity of compressive forces acting exclusively upon and uniformly against the exterior superficies of said stock tube to form in its walls a series of longitudinally spaced constrictions or concave portions of diminished wall thickness and lesser diameter than the original, and connected by convex portions, and to compress said convex portions one by one to cause protrusion thereof beyond the original tube diameter and simultaneously to reduce the wall thickness of said convex portions, each corrugation in its final form being completed by two constrictive steps and a consecutive compressing step.

8. The method of deforming tubular metal stock of indeterminate length and approximately uniform original diameter, to form the walls thereof into corrugations embodying concave portions of less diameter than the original, and convex portions of greater diameter than the original, with walls of diminished, substantially uniform thickness, said method comprising the steps of advancing said stock intermittently and applying forces acting upon the exterior superficies of said stock tube to form in its walls a series of longitudinally spaced constrictions or concave portions of diminished wall thickness and lesser diameter than the original, and connected by convex portions, and a force acting concurrently to compress said convex portions one by one to cause protrusion thereof beyond the original tube diameter and simultaneously to reduce the wall thickness of said convex portions, each corrugation in its final form being completed by two constrictive steps and a consecutive compressing step, the constrictive steps including an initiatory

constriction performed by a force applied rotatively and laterally as to advance the portion of stock under treatment, and a perfecting constriction also performed during said advance, while the leading portion of stock is held against rotation and against advancement, and each compressing step being performed by a force applied during said advance and contributing thereto while the leading portion dwells, and said tube, including both the perfected portion, a partially treated portion and the untreated portion, being fed bodily during a dwell in the operation of the constrictive and compressing forces.

9. The method of forming parallel corrugations in a longitudinally movable, non-rotating tube of indeterminate length which consists in producing a groove in said tube adjacent the section to be corrugated, inserting separable dies within said groove, producing another parallel annular groove by lateral pressure while restraining said tube from longitudinal movement, advancing said group of later grooves towards said first mentioned groove while maintaining said first mentioned groove from longitudinal movement whereby the surface connecting said first mentioned groove and the first groove of said later formed group is expanded outwardly to form an annular ridge in said tube, advancing said tube, inserting said separable dies in the first and second grooves of said group, forming other parallel annular grooves, in succession, advancing each such preceding group while maintaining said grooves of each such preceding group from longitudinal movement whereby said first mentioned groove, said annular ridge and said first groove of said preceding group form a single complete corrugation in said tube, and so continuing until the desired portion of said tube is corrugated.

10. A continuous method of parallelly corrugating a tube of substantially uniform diameter and indeterminate length, which comprises forming successively by progressively applied increments of rotary, exclusively exterior lateral pressure, a series of grooves in said tube and, concurrently with the formation of said series, subjecting the surface forming an end wall of each already formed groove of said series and the surface constituting the partly formed adjacent wall of another of said grooves to longitudinal pressure and advancing the tube bodily from time to time, said operations being performed upon the walls of all of the grooves seriatim.

11. A method of parallelly corrugating a tube which comprises forming by rotary, exclusively exterior, lateral pressure a plurality of grooves in said tube and then, consecutively with said grooving operation, subjecting the surface forming an end wall of each of said grooves successively to longitudinal pressure while limiting the radially outward movement of the surface connecting said wall and the wall of the next preceding groove.

12. A continuous method of parallelly corrugating a tube which comprises forming by lateral pressure a plurality of grooves in said tube and then, simultaneously with a continuance of said grooving operation, subjecting the surface forming an end wall of each of said grooves and the surface forming the adjacent end wall of another of said grooves to longitudinal pressure, applied intermittently to each such successive pair of end walls, while limiting the radially outward movement of the surface connecting said end walls.

13. The method of forming corrugations in a tube which comprises initiating grooves by rotating compressive forces simultaneously around the entire periphery of the tube while thinning the metal at the bottom of the grooves, then squeezing a bridge thus formed, between two tools so that the bridge becomes a corrugation having a greater diameter than the original tube and the initiated groove is depressed so that the metal of the corrugation becomes thinner than the original tube wall to correspond to the thickness at the bottom of the groove.

14. The method of forming corrugations in a tube which comprises forming two separated grooves therein by applying compressive forces simultaneously around the entire periphery of the tube, revolving said forces circumferentially against the periphery of the tube while applying compression thereto, and then squeezing the bridge between certain of said forces and complementary peripherally applied non-revoluble forces, while allowing the outer periphery of the bridge to expand outwardly and the bottom of the grooves to go inwardly while forming the side thereof.

15. The method of corrugating a tube which comprises initiating separated grooves therein by rotating compressive forces simultaneously

around the entire periphery of the tube, while thinning the material at the bottom of the grooves and then squeezing the bridge between grooves while limiting the outward movement of the bridge and keeping the bottom of the grooves free from thinning action.

16. The method of deforming tubular metal stock of indeterminate length and approximately uniform original diameter, to form the walls thereof into corrugations embodying concave portions of less diameter than the original, with walls of diminished, substantially uniform thickness, said method comprising the steps of advancing said stock intermittently and applying rotatively a multiplicity of compressive forces acting simultaneously and uniformly upon the exterior superficies of said stock tube in a direction normal to said periphery at each such region of compression to form in its wall a series of longitudinally spaced constrictions or concave portions of diminished wall thickness and lesser diameter than the original, and connected by convex portions, and of compressing said convex portions one by one to cause protrusion thereof beyond the original tube diameter and simultaneously to reduce the wall thickness of said convex portions.

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