Oct. 5, 1943. F. M. DARNER ET AL 2,330,811

MACHINE FOR CONFIGURING TUBING

Filed Jan. 24, 1942 2 Sheets-Sheet 1

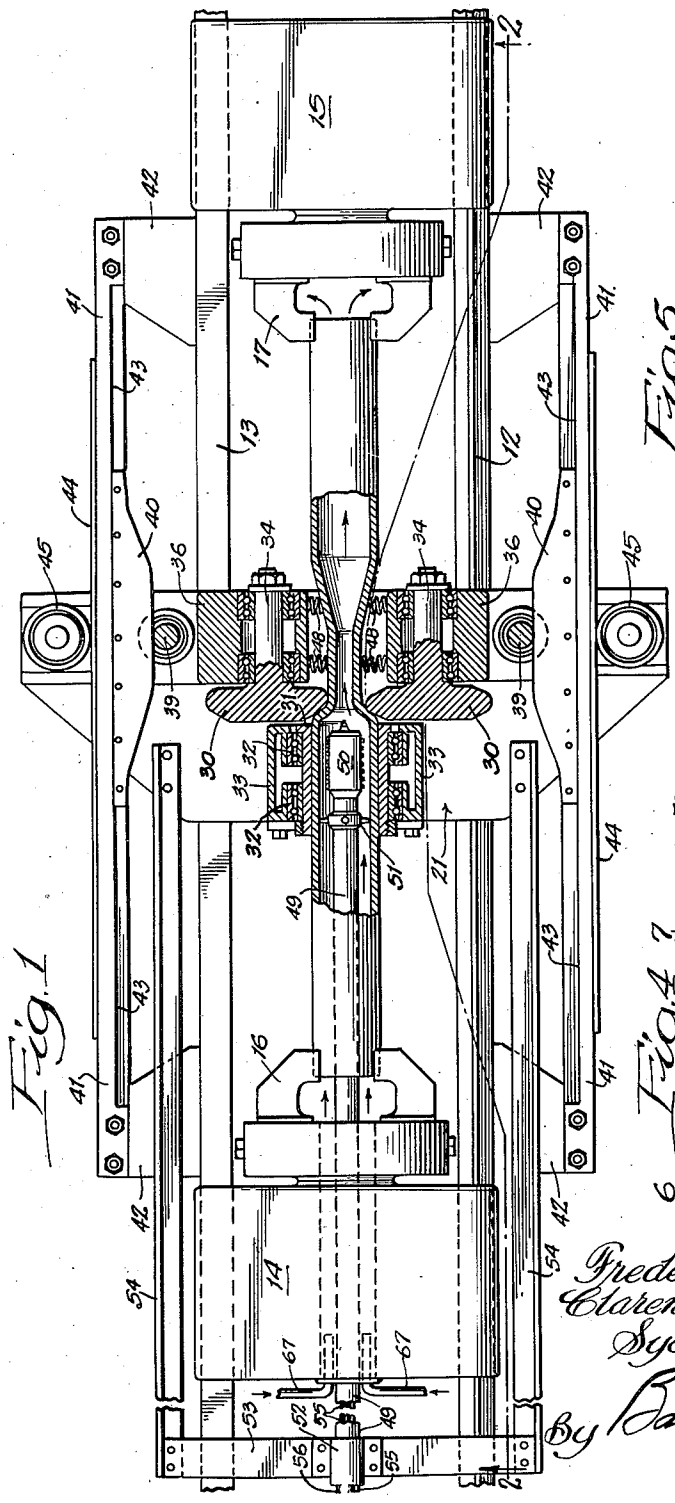


Fig. 1

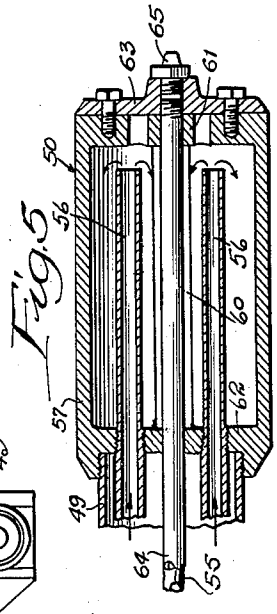


Fig. 5

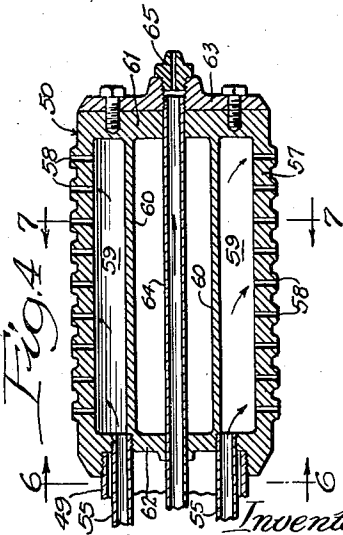


Fig. 4

Inventors:
Frederic M. Darner
Clarence L. Dewey and
Sydney L. Dewey.
By Banning & Banning
Attorneys.

Oct. 5, 1943. F. M. DARNER ET AL 2,330,811

MACHINE FOR CONFIGURING TUBING

Filed Jan. 24, 1942 2 Sheets-Sheet 2

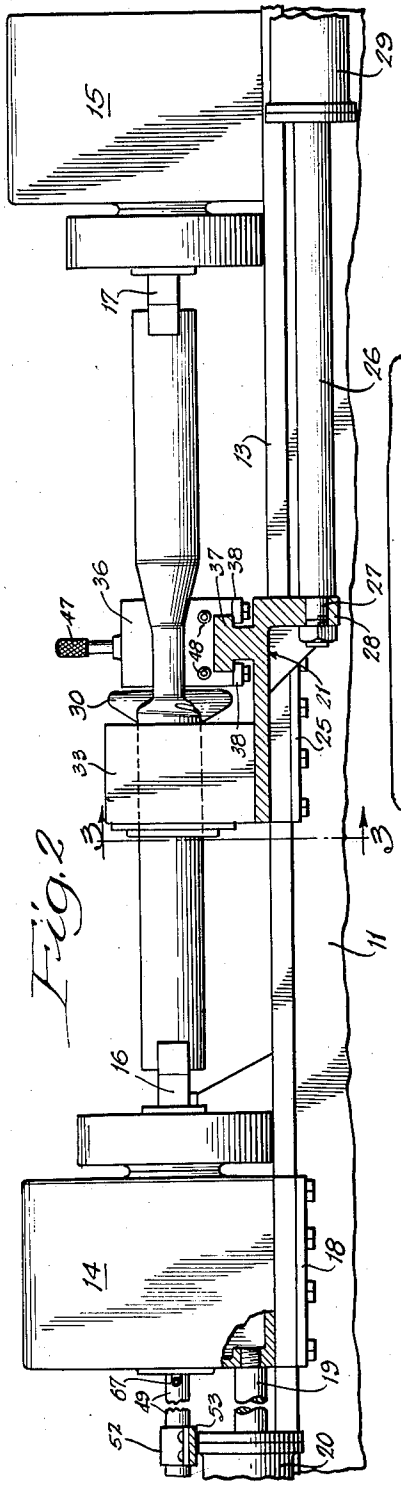


Fig. 2

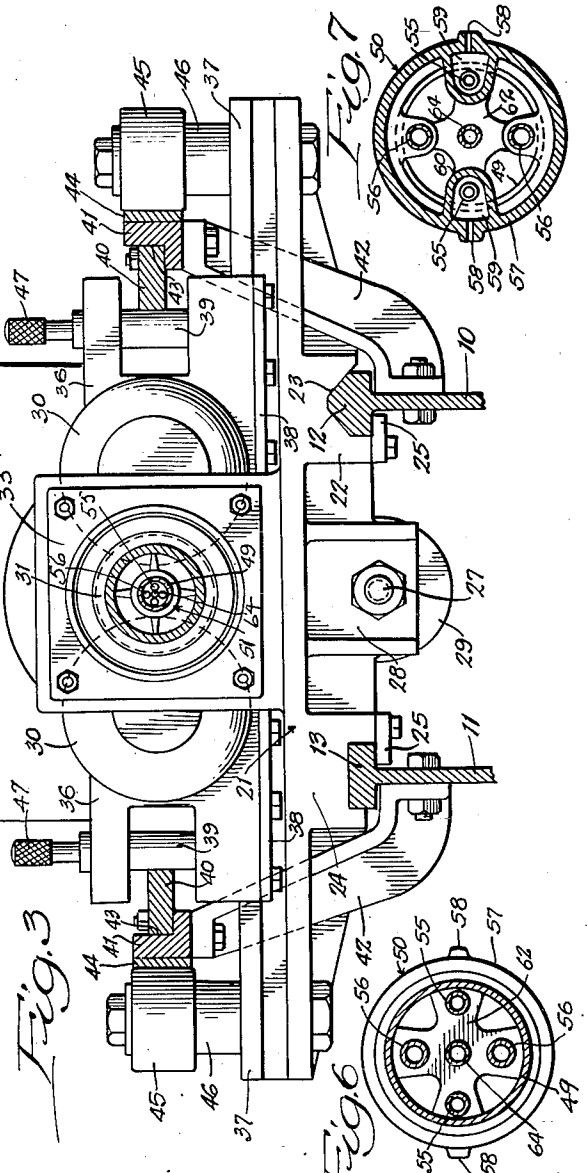


Fig. 3

Fig. 7

Fig. 6

Inventors:
Frederic M. Darner,
Clarence L. Dewey and
Sydney L. Dewey,
By Banning & Banning
Attorneys.

Patented Oct. 5, 1943

2,330,811

UNITED STATES PATENT OFFICE

2,330,811

MACHINE FOR CONFIGURING TUBING

Frederic M. Darner, Cleveland, Ohio, Clarence L. Dewey, Elkhart, Ind., and Sydney L. Dewey, Cleveland Heights, Ohio, assignors to Metal Tube Shaping Corporation, Elkhart, Ind., a corporation of Indiana

Application January 24, 1942, Serial No. 428,068

8 Claims. (Cl. 113—53)

The machine of the present invention is similar to the machine forming the subject matter of an application, Serial No. 419,050, filed November 14, 1941, but differs therefrom in that provision is made for the localized application of heat to the interior of the tube in a region undergoing deformation through the action of an exteriorly positioned forming tool, so that the metal will be rendered more fluid and more readily subject to deformation. With this object in view, provision is made for the discharge and ignition of an inflammable gas mixture which provides for the application of flame jets within the undeformed section of the tubing at a point immediately adjacent the region where the metal is caused to flow inwardly in the form of a constantly evolving shoulder under the pressure of the forming tool or tools, without, however, subjecting the more distant portions of the tubing to heat, so that no opportunity will be afforded for the cooling off of the tube prior to the time it is subjected to the deforming operation.

Further objects and details will appear from the description of the invention in conjunction with the accompanying drawings, wherein—

Figure 1 is a plan view of the machine with the operating mechanisms shown in section on a plane coincident with the axis of the tube;

Fig. 2 is a side elevation of the machine taken on line 2—2 of Fig. 1, with the nearby forming tool and associated mechanism removed to expose the tube and more distant forming tool;

Fig. 3 is a cross sectional elevation taken on line 3—3 of Fig. 2;

Figs. 4 and 5 are enlarged sectional details of the gas burner head which discharges the flame jets against the interior of the tube;

Fig. 6 is a cross sectional view taken on line 6—6 of Fig. 4 looking in the direction of the arrow; and

Fig. 7 is a cross sectional view taken on line 7—7 of Fig. 4 looking in the direction of the arrow.

The machine as a whole is mounted upon a suitable frame comprising front and rear side walls 10 and 11, which are suitably connected to afford a rugged frame for the support of the operating mechanisms. The front frame wall 10 terminates at its upper edge in a bevelled track rail 12, and the rear frame wall likewise terminates in a flat faced track rail 13. The track rails in conjunction serve to support a head stock 14 and a distantly located tail stock 15, which are adjustable upon the trackway to vary the spacing to accommodate tube sections of the desired length.

The head stock is provided with a chuck 16 and the tail stock with a chuck 17, details of which need not be described. The head stock and tail stock may both be adjusted and held in position by means of clamping plates 18 which engage the rails 12 and 13, one of which clamping plates is shown in Fig. 2. However, it will ordinarily be desirable to permit the head stock to slide upon the rails to accommodate variations in length of the tube occasioned by its reduction in diameter during the deforming process, and under the thrust of a plunger rod 19 connected with a piston located within a cylinder 20 to which a fluid medium under pressure may be admitted to either impart a force resisting the natural elongation of the tube in order to increase the wall thickness at the point of deformation, or, if desired, to impart a pull or strain upon the tube, tending to thin the tube wall while undergoing deformation. The application of such pressures to either resist or assist the natural elongation of the tubes may be suitably controlled, but these features do not constitute an essential part of the present invention and therefore need not be described in detail. They are fully set forth, however, in Patent No. 2,265,723, issued December 9, 1941. The chucks 16 and 17 are both positively driven by electric motors, not shown, which are mounted respectively on the head stock and tail stock, and impart rotation through suitable reduction gearing of the general character illustrated in co-pending application, Serial No. 419,050, filed November 14, 1941.

The mechanisms which actively serve to reduce the tubing are mounted upon a traveling carriage 21 which bridges across the space between the rails 12 and 13, and is suitably configured on its under side to make sliding contact with the rails. For this purpose the carriage is provided with a depending rib 22 having a V-shaped channel 23 which registers with the beveled track rail 12 and is also provided with a depending rib 24 which provides flatwise contact with the flat surface of the rear rail 13. The ribs 22 and 24 are each provided with a guide plate 25 which underlies the overhanging portion of the rail head as shown in Fig. 3.

The carriage is adapted to be advanced by the thrust of a feed ram 26, the forward reduced end 27 of which is entered through a bracket lug 28 depending from the carriage. The feed ram 26 is entered at its rear end within a hydraulic cyl-

inder 29 which is under suitable automatic control, so that a relatively slow speed of advance can be imparted to the carriage assembly during the deforming operation, with a quick return movement of the parts to the starting position after the configured tube has been removed and in preparation for the gripping of a new section of tubing. It is not deemed necessary to illustrate or describe the control mechanism for regulating the speed of advance and return of the hydraulic ram, since such mechanism is of standard type and well understood in the art. Furthermore, it will be understood that other mechanism for imparting longitudinal movements to the carriage assembly may be employed in lieu of the hydraulic mechanism herein described. It will further be understood that the speed of advance of the carriage will be comparatively slow in ratio to the speed of rotation of the tube, so that the tube while passing through the region of deformation will be repeatedly subjected to the pressure of the forming tool or tools, and any grooving effect will be smoothed out or ironed down during the period while the tube is being subjected to the contact of the forming tool. In respect to the feed ratios observed as between the advance of the tube and its rotation, the present machine conforms to the principles fully set forth in Patent No. 2,265,723, previously referred to.

The carriage provides a mounting for a pair of oppositely disposed forming rollers 30, each having a bevelled or rounded rim which stands immediately adjacent the reinforcing bushing 31 which closely surrounds the tube at a point immediately adjacent the region of deformation, so that the deforming action will be confined to the evolving shoulder of the tube immediately in contact with the forming tools, and so that the distribution of the deformation will not be extended backwardly into the region reinforced by the bushing. The bushing is mounted within ball bearings 32 so that it will rotate freely with the tube, and the bearings are supported within a cored bearing block 33 which is rigidly secured to the carriage and movable therewith.

Each of the forming rollers is provided with a stem 34 which is journalled at widely separated points within a slide block 36 mounted upon a T-shaped track 37 formed on the face of the carriage, each of the slide blocks being held in position by flange bars 38, which underlie the head of the T-shaped track and permit transverse movements to be imparted to the respective slide blocks and the deforming rollers carried thereby.

It is desirable to have one of the forming rollers positioned very slightly in advance of the other, as indicated in Fig. 1, so that the forwardly positioned roller will initiate the deforming operation, which will be continued by the companion roller rearwardly in stepped relation and on the opposite side of the tube, and the two rollers acting in conjunction will serve to mutually resist any bending or displacement of the tube under the thrust imparted by the respective forming rollers.

Each of the slide blocks 36 journals a vertically disposed templet roller 39, which bears against the configured inner face of a templet 40 secured to a templet beam 41 rigidly supported at its opposite ends by bracket plates 42 which extend laterally and in fixed relation to the frame of the machine. Each of the templet beams is of L-shaped formation to provide a ledge or shoulder 43 to which the templet is bolted, the arrangement being one which permits the templet to be built up of removable units or sections which in conjunction afford the desired configuration for every portion of the tube.

The templet beam is provided on its rear face with a hardened face plate 44 which affords contact for a backing roller 45 carried by a stem 46 suitably journaled upon the associated end of the carriage, and the rear face of the templet beam will extend in exact parallelism with the axis of the tube, so that the backing roller, being fixedly positioned, will reinforce the templet beam against displacement under the thrust of the forming roller and thus maintain the parts in the necessary relationship to impart to the tube a substantial replica of the pattern afforded by the face of the templet.

The templet roller 39 terminates in an upwardly projecting arm 47, which permits the templet roller to be elevated above the acting surface of the templet in order to facilitate the return movement of the carriage without imparting in and out movements to the slide blocks 36. The slide blocks are backed by springs 48 which serve to maintain the templet rollers in contact with the respective templets.

The above portions of the machine conform in the main to the structure described in co-pending application, Serial No. 419,050, filed November 14, 1941, and it will be understood that the heating features presently to be described need not necessarily be employed in a structure of this particular character, which, however, serves as an exemplification of a suitable forming mechanism to be supplemented by the heating features which more particularly form the subject of the present invention.

The head stock 14 has entered therethrough a pipe 49, which extends axially through the center of the tube undergoing deformation and carries at its inner end a burner head 50, and also carries adjacent thereto a star-shaped spacer 51 bearing against the inner surface of the tube wall to properly center the inner end of the pipe with its burner head. The rear end of the pipe is supported within a clamp 52 carried by a bridge bar 53 supported by spaced angle bars 54, the opposite ends of which are rigidly secured to the carriage, so that the pipe and the burner head mounted thereon will travel on the interior of the tube and in constantly spaced close relation to the forming rollers, for the purpose of heating the tube from the interior at a point immediately adjacent the region of deformation.

A suitable gaseous inflammable mixture is supplied to the burner head through two or more gas tubes 55, which extend continuously through the pipe 49 to the burner head, and in order to afford the necessary cooling of the parts, two or more water tubes 56 are provided, which run in parallel relation to the gas tube through the pipe 49 and into the burner head.

Each gas tube is connected with a suitable torch, not shown, which supplies the gaseous mixture to the tube, and the water tubes are connected to a suitable source for supplying cold water thereto for cooling purposes. Both the water and gas tubes, at their inner ends, are threaded into the burner head, which may be formed in the manner illustrated in Figs. 4 to 7.

As shown, the burner is of generally cylindrical formation comprising an outer wall 57 provided with rows of burner nozzles 58, which

in each instance open into a closed chamber 59 afforded by a surrounded inner wall 60 which merges at its ends into the inner and outer walls of the burner heads 61 and 62 respectively. The outer wall 62 is of open spider formation and has the inner end of the pipe 49 threaded thereinto, so that cold water which is admitted through the water pipes 56 will return through the pipe 49, to be drained away at the end of the pipe.

The inner ends of the water tubes 56, as shown in Fig. 5, terminate at a point short of the inner end wall of the burner head, so that water discharged therethrough will circulate freely throughout the burner head, being blocked off, however, from the chambers 59 into which the gaseous mixture is admitted.

The inner end wall of the burner head is closed by a cap plate 63 which is bolted thereto, and through the center of the pipe 49, and through the burner head, extends a gas tube 64 which terminates in a nozzle 65 constituting a flare or pilot nozzle, which may remain constantly ignited to ignite the gaseous mixture discharged through the burner nozzles 58.

To assist proper combustion and the disposal of burnt gases, an air blast is admitted to the interior of the tube undergoing deformation through air tubes 67 which are inturned into the head stock and flow therethrough and into the open end of the tube. This provides secondary air for insuring complete combustion and scavenges all burnt gases toward the tail stock 15.

It will be noted that the head and tail chucks 16 and 17 are of such shape that the ends of the tube are held away from the bodies of the chucks. This provides openings at either end of the tube, preferably of greater area than the inside of the tube through which burnt gases may escape. These openings also provide a safety escape for the force of any explosion which may result in the tube from improper combustion.

Operation

In adjusting the apparatus for use, the carriage with the forming rollers will be advanced to a point closely adjacent the tail stock chuck 17, at which point the templet will be configured to allow the forming rollers to be separated sufficiently to permit a section of tubing to be introduced and clamped at each end within the chucks 16 and 17. Thereafter, power will be applied to rotate the chucks at each end to impart the desired speed of rotation to the tube.

The gaseous mixture of proper consistency will be admitted from the torches through the gas tubes and ignited by the pilot light, so that jets of flame discharged from the burner nozzles will impinge against the interior of the tube in the region surrounded by the reinforcing bushing 31 and at a point immediately adjacent the forming rollers 30. At the same time, cold water or other cooling medium will be admitted through the water tubes 56 to the interior of the burner head and recirculated back therefrom through the surrounding pipe 49, in order to prevent overheating of the burner head. Likewise, cold water or other cooling medium will be admitted to the interior of the bearing block 33 to prevent overheating and possible injury to the bearings.

With the tube thus locally heated, at a point immediately adjacent the region of deformation, the carriage with the forming rollers will be advanced by the thrust of the plunger 26 at a speed in proper ratio to the rotation of the tube, to prevent grooving, and as soon as the templet rollers encounter the configured edge of the templet, the rollers will move radially inward to impart the desired contour to the rotating tube, which will be exteriorly reinforced by the bushing 31, and with the metal heated to the desired temperature the deforming will continue and the metal be caused to flow inwardly in the form of a constantly evolving shoulder, with the speed of rotation sufficiently high to cause each portion of the tube to rotate repeatedly beneath the acting edges of the forming rollers during its progression through the region of deformation.

If it is desired to regulate the wall thickness, this can be accomplished by either imparting a thrust or a pull through the piston rod 19, which either resists or supplements the natural elongation of the tube occasioned by its reduction in diameter. This control of the wall thickness is facilitated by the localized heating of the tube wall, and it is particularly advantageous in the case of heavy walled tubing of a size and gage which it might be difficult to configure while cold.

Where relatively light walled tubing is operated upon, it is highly desirable to heat the tube locally from the interior in order to maintain the desired temperature, since it will usually not be practical to bring such a tube to operating temperature in a separate furnace and then introduce the tube into the shaping machine without substantial loss of temperature or the necessity of applying additional heat. Furthermore, the heating loss under such conditions would be progressive, so that the temperature of that portion of the tube last subjected to the configurating process would be materially less than at the beginning.

To overcome such difficulties and to avoid the necessity of transferring and introducing a tube while in the hot state into the forming machine, and furthermore to insure the application of an even degree of heat to all portions of the tube during the deforming process, the present invention has been designed, which heats the tube, in situ as it were, and thus most effectively utilizes the heating affect at the precise point where a softening of the metal is required.

Although the form and arrangement of the operating parts of the machine as a whole have been described in detail, it will be understood that the present invention is directed primarily to the means provided for the application of heat to the interior of the tube at a point adjacent the region of deformation, and that the method of mounting and actuating the forming rollers or other forming tools may be varied or modified; and it will also be understood that although the machine as shown is one in which longitudinal travel is imparted to the forming rollers rather than to the tube itself, the reverse arrangement may be employed, since, from the standpoint of the present invention, relative movement only is required, it being understood, however, that in all cases the burner head will maintain a fixed proximate relation to the forming tools and thus apply the heat directly to the tube at or near the region of deformation.

Furthermore, although we have shown and described a burner head and means for supplying combustible gas thereto as the heating medium, it will be understood that the term "burner head," unless otherwise limited, is intended to cover and include various types of heating devices adapted to locally impart heat to the interior of the tube,

and that the expression "heating medium" is intended to cover and include any suitable agency for imparting heat to the desired region. For instance, high frequency induction heating might be employed, in which case a burner head of the form shown would be replaced by a coil preferably of copper tubing, with current leads for the coil taking the place of the gas tubes, and with the cooling tubes extending backwardly from the coil and through the spindle pipe 49, the general arrangement of the parts being essentially the same as that shown.

The heating coil would consist of a number of turns of copper tubing wound in a helix whose outside diameter would be slightly less than the inside diameter of the tubing and wound upon a suitable support of non-conductive material. Cooling water would be forced through the copper tubing of the coil. In such a construction an air blast would not be required, nor would it be necessary to make provision for the escape of burnt gases. The current leads would be connected to a high frequency generator of standard design.

We claim:

1. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, means for imparting radial movements to said tool relative to the axis of the tubing, means for imparting relative rotation between said tool and said tubing, and means for imparting relative longitudinal movement between the tubing on the one hand and the forming tool and reinforcing member on the other, and a heating member positioned to extend within the tubing to a point within the reinforcing member and in advance of and adjacent to the region to be acted upon by the forming tool and mounted to maintain unvarying adjacency during the relative longitudinal movement aforesaid.

2. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted for radial movement with respect to the axis of the tubing, means for imparting radial movements to said mounting, means for imparting relative rotation between said tool and said tubing, and means for imparting relative longitudinal movement between the tubing on the one hand and the forming tool and reinforcing member on the other, a pipe adapted to be entered through the tubing and carrying at its inner end a burner head located within the reenforcing member and closely adjacent the region of the tubing to be acted upon by the forming tool, and means entered through said pipe for supplying a heating medium to the burner head, the pipe being mounted to maintain the burner head in unvarying relation and adjacent the region of the tube undergoing deformation irrespective of the relative movements aforesaid.

3. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted for radial movement with respect to the axis of the tubing, means for imparting radial movements to said mounting, means for rotating the tubing, and means for imparting relative longitudinal movement between the tubing on the one hand and the forming tool and reinforcing member on the other, a pipe adapted to be entered through the tubing and carrying at its inner end a burner located within the reenforcing member and closely adjacent the region of the tubing to be acted upon by the forming tool, and means entered through said pipe for supplying a heating medium to the burner head, means entered through said pipe for supplying a cooling medium to the burner head, the pipe being mounted to maintain the burner head unvaryingly adjacent the region of the tube undergoing deformation irrespective of the relative longitudinal movements aforesaid.

4. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted for radial movement with respect to the axis of the tubing, means for imparting radial movements to said mounting, means for rotating the tubing, and means for imparting relative longitudinal movement between the tubing on the one hand and the forming tool and reinforcing member on the other, a pipe adapted to be entered through the tubing and carrying at its inner end a burner located within the reenforcing member and closely adjacent the region of the tubing to be acted upon by the interior of the forming tool, means for supplying a heating medium to afford open communication to the burner head, means entered through said pipe for supplying a cooling medium to the burner head, the head unvaryingly being constructed to permit said cooling medium to drain back through said pipe, the pipe being mounted to maintain the burner head adjacent the region of the tube undergoing deformation irrespective of the relative longitudinal movements aforesaid.

5. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted for radial movement with respect to the axis of the tubing, means for imparting radial movements to said mounting, means for rotating the tubing, and means for imparting relative longitudinal movement between the tubing on the one hand and the forming tool and reinforcing member on the other, a pipe adapted to be entered through the tubing and carrying at its inner end a burner head within the reenforcing member and located closely adjacent the region of the tubing to be acted upon by the forming tool, a mounting for said pipe adapted to maintain the burner head in said position irrespective of the relative longitudinal movements aforesaid, a gas tube entered through said pipe and into the burner head for supplying a gaseous medium to the head for discharge therefrom and ignition, a tube for a cooling medium entered through said pipe and into said burner head for cooling the same, the head being constructed to afford open communication to permit a return flow of said cooling medium for final discharge, and an air blast tube positioned to maintain an axially directed air blast current through the tube and around the pipe while the tube is undergoing deformation.

6. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted

for radial movement with respect to the axis of the tubing, a carriage upon which the reinforcing member and the forming tool and mounting are positioned, means for imparting longitudinal movements to said carriage, fixed means for imparting radial movements to the mounting and forming tool to impart a desired contour to the tubing, means for rotating the tubing, a pipe carried by and movable with the carriage and adapted to be entered through the tubing and mounting at its inner end a burner head located within the reenforcing member and in unvarying closely adjacent relation to the region of the tubing to be acted upon by the forming tool, and means entered through said pipe and into the burner head for supplying a heating medium to the burner head for discharge therefrom and ignition.

7. In a machine for configuring tubing, the combination of a reinforcing member adapted to exteriorly engage the tubing, a forming tool located in close proximity to the reinforcing member, a mounting for the forming tool adapted for radial movement with respect to the axis of the tubing, a carriage upon which the reinforcing member and the forming tool and mounting are positioned, means for imparting longitudinal movements to the carriage, means for imparting radial movements to the mounting and forming tool to impart a desired contour to the tubing, means for imparting relative rotation between the tubing and the forming tool, a pipe carried by and movable with the carriage and adapted to be entered through the tubing and mounting at its inner end a burner head located closely adjacent the region of the tubing to be acted upon by the forming tool, and means entered through said pipe and into the burner head for supplying a heating medium to the burner head for discharge therefrom and ignition at a point immediately in advance of the region of the tubing currently undergoing deformation

8. The method of configuring tubing which consists in exteriorly reinforcing the tubing and exteriorly applying a radially directed deforming pressure to the tube wall closely adjacent the area of reinforcement and in applying relative rotation to the tubing and the direction of application of the deforming pressure, imparting relative longitudinal movement between the direction of application of the deforming pressure and the tubing to bring successive sections of the tubing to the region of deformation, and applying a heating medium to the interior of the tubing at a point closely adjacent the region of deformation and maintaining said adjacency during said longitudinal movement to locally heat the tube wall immediately in advance of the region progressively subjected to the deforming operation.

FREDERIC M. DARNER.
CLARENCE L. DEWEY.
SYDNEY L. DEWEY.