Aug. 30, 1932. F. HOTCHNER 1,874,012

METHOD OF BENDING TUBING

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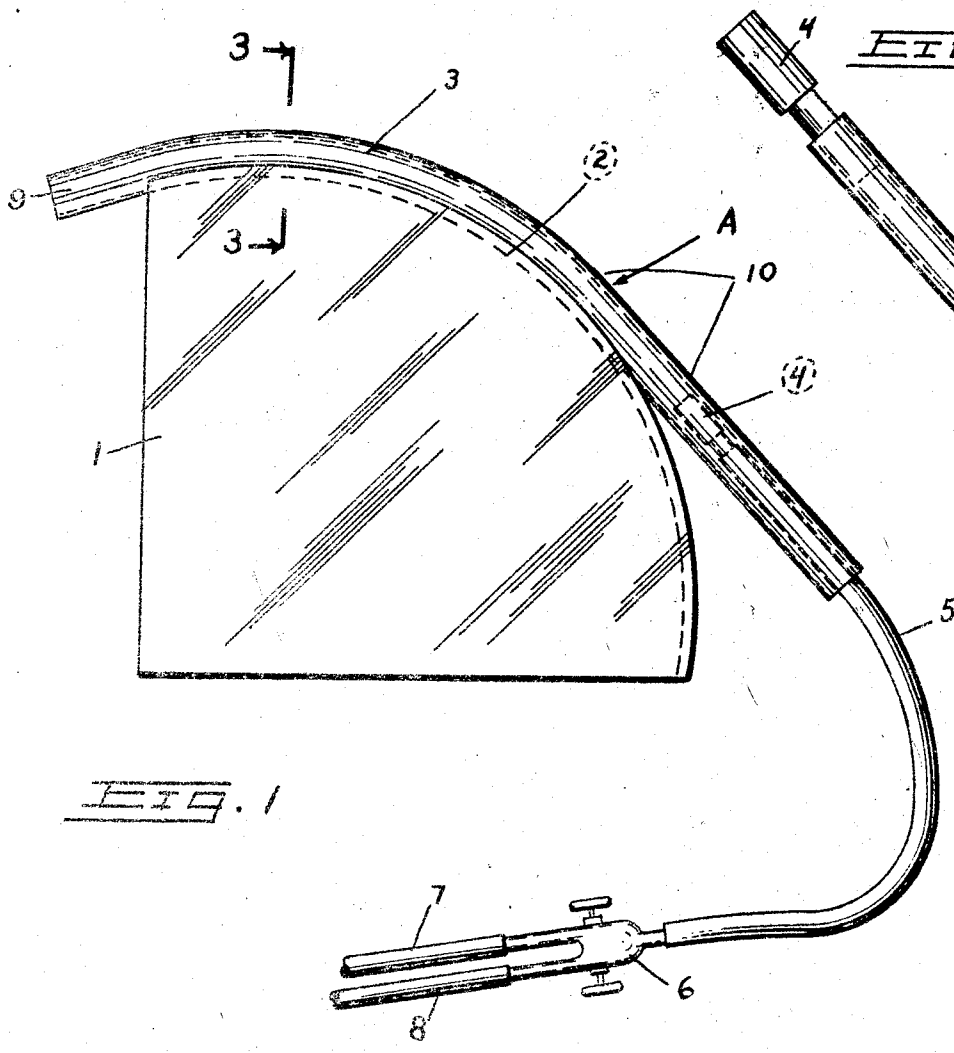


Fig. 1

Fig. 2.

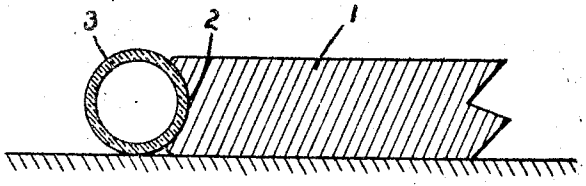


Fig. 3

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METHOD OF BENDING TUBING

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This invention relates to a method of bending tubing and the particularly illustrated application of the process pertains to the bending of tubing of vitreous material such as glass. The process includes the heating of the material and bending it while hot to the desired form.

The objects of the invention are as follows:

To provide a method of heating tubing to be bent without the loss of heat occasioned by the prior art processes, all heat generated in the instant process being applied to the immediate section of tubing to be bent at each stage of the process and nowhere else;

To provide a method of forming tubing immediately upon its reaching a sufficiently high temperature without permitting the tubing to cool before the bending takes place;

To provide a method of heating tubing to be bent with a minimum of possibility of the tubing collapsing or shrinking in the process;

To reduce the peak temperature necessary in the process of bending tubing and to prevent rapid and extreme changes of temperature whereby to reduce to a minimum changes in the physical characteristic of the material occasioned thereby;

To reduce the time consumed in producing a given quantity of work, to simplify the process and to provide for uniform quality of the work;

To conserve energy used in heating the tubing to be bent and reduce the temperature of the room in which the work is carried on by avoiding the production of heat not effectively utilized in the work;

To protect workmen from contact with the flames;

To provide a method of annealing the sections of the tubing that have been bent without pausing in the work;

To provide a new technique for fabricating articles of vitreous material having the following advantages: reduction of the peak temperature to which the material is heated; reduction of the energy spent in heating the material; preventing deformation of work by fluid flow; preventing changes in characteristics of the material by excessive temperature changes; providing for annealing without interrupting the work.

The invention is illustrated in the drawing, in which

Fig. 1 is a plan view of a section of tubing on a work bench being bent around an appropriate form and being heated from the inside by a suitable device.

Fig. 2 is a view of the burner and a portion of the hose to which it is attached.

Fig. 3 is a cross section of the form and tube taken on the line 3—3 of Fig. 1.

Referring now to the drawing, numeral 1, Fig. 1, indicates a form having an edge 2 shaped to fit one side of the desired finished tube, the tube 3 being bent as shown in a partially completed form having been bent by this process as far as the point indicated by the arrow A and still to be bent to conform to the remainder of the edge 2. A gas burner 4 attached to the hose 5 which is fed by the mixing valve 6 is shown in position within the tube 3, heating the portion of the tube indicated by 10, which portion is to be bent as soon as it reaches the proper temperature. The mixing valve 6 is supplied with gas and air by the supply hoses 7 and 8.

The process is carried out as follows, it being understood that numerous variations of this process may be practiced.

The hose 5 is inserted through the tube to be bent and first allowed to extend through the end 9 in order that the fire may be lit at the burner. The hose and burner are then drawn back through the tube and the flame adjusted so as to heat such a length of the tube at one time as practice determines most desirable. Obviously, there will be considerable variation in different cases as regards the most suitable temperature of the flame and length of the flame within the tube.

When the first portion of the tube to be heated reaches a temperature at which it may be bent, the hose 5 and burner are withdrawn further through the tube and the heated section bent. This work may be carried out either by heating a section and then bending it or by continuously drawing the burner through the tube and bending at the same time. The exhaust gases from the flame cir-

culate through the portions of the tube that have already been bent and serve to gradually anneal them.

This invention may be practiced in the bending of tubing of any material that may be bent when hot. The invention is not limited to the bending of tubing of vitreous material although it is part of this invention to provide a new technique of fabricating bodies of viterous material, which technique will now be stated after first describing the prior art.

In the prior art, the method of bending tubing and, for that matter all methods that I know of of fabricating bodies of vitreous material, call for the heating of the body of material to a temperature much in excess of that at which the body may be formed. To the best of my knowledge, even in machine processes the same general sequence follows, apparently not because it could not otherwise be done but this being the attitude of mind in the art towards the treating of vitreous material.

There is no reason why a body of vitreous material may not be heated up to a given temperature and then moulded when it is at that temperature without letting it cool. However, the art has provided heretofore that the glass is first heated and then passed to a forming device during which time there is a drop in the temperature. In the hand process of bending tubing, the glass worker usually has before him an asbestos pattern to which he works and on an adjacent bench will be at least two burners which are operating all the time and consume a great deal of gas whether he is using the burners or not.

Actually he may use the burners only a very small percentage of the total time they are burning and only a very small percentage of the energy consumed in the burners is effectively utilized to heat the glass. Due to the fact that he must move from the burners to the pattern table, the glass is going to cool, hence he must heat it considerably above the temperature at which it can be worked to allow for this movement in carrying the work to the pattern, getting the proper angle of view and applying pressure to the work to bend it. This superheating of the work introduces the next difficulty which is that of the deformation of the glass when it is hot by fluid flow. Hence, in the majority of cases, the worker must have a hose connected to the inside of the work, one end of which he holds in his mouth and into which he blows to force the glass back to its shape. If he heats the glass too much in one place, it will be blown out at that place, hence a great deal of skill and slow manipulation must be used to uniformly heat the piece of glass before he carries it away from the flame. This means he must rotate the piece and heat it very carefully to a temperature at which it is almost in collapsing condition and then carry this piece of glass in a semi-collapsible condition to the moulding bench. Another restraining condition is impressed upon him in that the glass suffers in physical characteristics from a continual and extreme changes of temperature and each piece must be annealed after having been given its form by returning it to the flame and heating it slightly to anneal it. This annealing process consumes a very appreciable portion of the time of the worker and also consumes much of his energy as the annealing must also be done uniformly while the piece is rotated in the flame.

The range of temperature within which the worker may operate is usually so close and the cooling of the glass so rapid when it is taken out of the flame that he must reheat his piece several times before he brings it to the desired shape.

Now in one form or another this above procedure describes the prior art of fabricating bodies of vitreous material. Whether by hand or machinery, this is the physical basis upon which the art has been built.

The present process contemplates the application of heat to the place which is to be bent and nowhere else. No heat is dissipated in the atmosphere and the exhaust gases from the section that is being bent at any instant of times are utilized to anneal the portions which have already been bent without the worker stopping for that purpose. A limited section of the body is heated at any one time, the remainder being in a very rigid condition and assisting to maintain the shape of the portion being heated. The body is not moved from one location to the other but rests on the work bench continuously during the process. The body is heated up to a temperature at which it may be worked and no higher and is maintained substantially at that temperature while being worked and then falls in temperature very slowly. Thus materials may be utilized in this process which would suffer very severely from the extreme change of temperature of the prior art or may not be utilized at all because of such restriction. The deformation of the glass by fluid flow occasioned by the prior art is substantially eliminated and the necessity of applying air pressure to maintain the shape of the walls of a tube being bent according to this process is practically eliminated.

Certain parts of my process may be utilized independently of the others or in various combinations or all of the parts of the process may be utilized within the purview of the invention. The invention in its broad generic sense as set forth above, contemplates the fabrication of tubing of any material capable of being worked with the use of heat and the fabricating of any kind of tube or

body of vitreous material utilizing the procedure of the new technique set forth above.

What I claim is:

1. The method of bending tubing which consists in heating the tubing from the inside in progressive stages and bending the tubing in progressive stages as it is raised to the proper temperature.

2. The method of bending tubing which consists in heating the tubing from the inside by means of a burner inserted within said tubing, burning a combustible within said tubing, moving the burner through said tubing, and bending the sections of the tubing as they reach a suitable temperature.

3. The method of bending tubing which consists in inserting a hose through said tubing having a burner on the end of the same, heating said tubing by means of combustion near said burner, bending said tubing as it reaches an appropriate temperature and withdrawing said hose as the work progresses to heat successive sections of said tubing.

4. The method of bending tubing which consists in providing a form having an edge to conform to an edge of the desired finished tube, inserting a heater within a length of tubing to be bent, heating said tubing from the inside in stages to a temperature sufficient to allow it to be bent, and bending said tubing in stages to fit said form.

5. The method of forming an elongated hollow body of vitreous material which consists in raising the temperature of successive portions of said body by means of internal heating to a temperature at which it may be formed, and forming said successive portions without permitting the temperature thereof to fall to a material degree.

6. The method of forming an elongated hollow body of vitreous material which consists in raising the temperature of successive portions thereof by means of internal combustion to a temperature at which it may be formed, and bending said successive portions as they reach an appropriate temperature and annealing the bent portions by means of the exhaust gases from said combustion.

7. The method of bending an elongated hollow body of vitreous material which includes heating intermediate portions of said body from the inside to a temperature at which said body may be bent while maintaining both portions adjacent to the portion being bent at any one stage of the process at a substantially lower temperature such that said adjacent portions are in a rigid state and assist in preventing the collapse of the portion being heated.

8. The method of bending an elongated hollow body of vitreous material which consists in heating successive portions of said body from the inside to such a temperature that said body may be bent while maintaining both portions adjacent the portion being heated at any stage in the process at a substantially lower temperature such that said adjacent portions are in a rigid state and assist in preventing the portion being heated from collapsing, and bending said heated portions as they are raised to a suitable temperature before they begin to collapse.

9. The method of bending an elongated hollow body of vitreous material which consists in heating successive portions of said body from the inside by means of combustion to such a temperature that said body may be bent while maintaining both portions of said body immediately adjacent the portion being heated at any stage in the process at a substantially lower temperature such that said adjacent portions are in a rigid state and assist in preventing said heated portion from collapsing, and bending said heated portions one at a time as they reach an appropriate temperature before they begin to collapse, and circulating the exhaust products of said combustion through the portions already bent whereby to gradually anneal said bent portions.

10. The method of bending tubing of vitreous material which consists in heating successive short sections of said tubing to such a temperature that said tubing may be bent while maintaining both sections adjacent to the portion being heated at any stage in the process in a rigid condition and immediately bending each section as it reaches a temperature at which it may be bent without permitting any material drop in the temperature thereof before bending.

Signed at Los Angeles, California, this 6th day of January, 1931.

FRED HOTCHNER.