April 15, 1958 A. HUET 2,830,645

METHOD OF AND APPARATUS FOR APPLYING TENSION TO REDUCE RADIUS OF CURVATURE OF TUBE BEND

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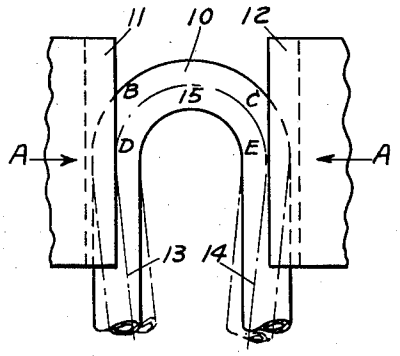


Fig. 1

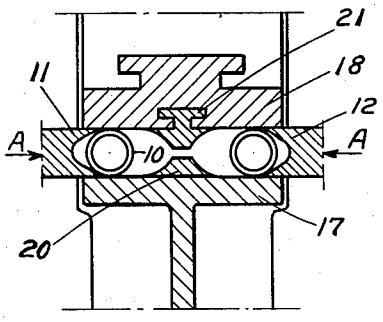


Fig. 2

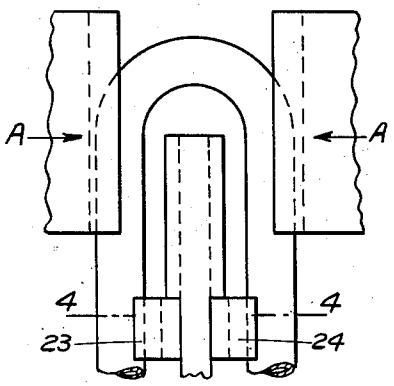


Fig. 3

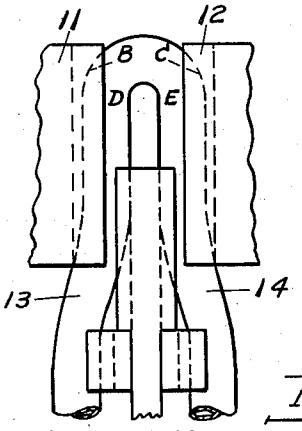


Fig. 5



Fig. 4

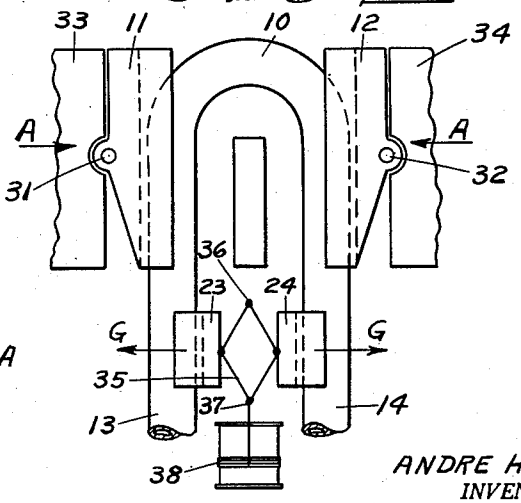


Fig. 7

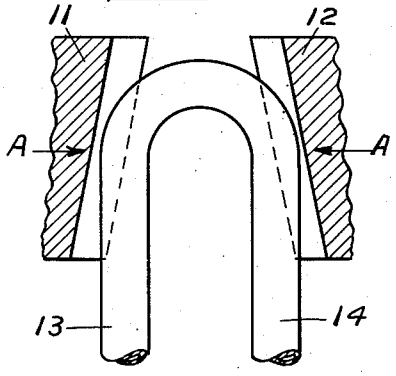


Fig. 6

ANDRE HUET
INVENTOR.

BY James J. Whalen
ATTORNEY

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METHOD OF AND APPARATUS FOR APPLYING TENSION TO REDUCE RADIUS OF CURVATURE OF TUBE BEND

Andre Huet, Paris, France, assignor to Combustion Engineering, Inc., New York, N. Y., a corporation of Delaware

Application March 14, 1952, Serial No. 276,663

8 Claims. (Cl. 153—48)

The present invention relates to metal working and particularly to improved methods and apparatus for decreasing the spacing of the parallel tube lengths of an 180° bend or decreasing the radius of curvature of the bend.

In order to diminish the radius of curvature of a tube bend the applicant has previously disclosed in a patent granted on September 21, 1954, under No. 2,689,596 a process and apparatuses consisting of subjecting a delimited area of the bent part of the bend to a range of suitable temperatures, and of compressing this bend between two half-dies animated by a movement of translation which brings them together, the said dies resting on the rectilinear arms of the bend.

In the case of bends made of special steels, or having great thickness of wall, it can happen that, when the two-half-dies are brought together the straight legs of the bend give more easily under the compressive action than the bent region, since the bent region naturally offers a greater resistance to compression than the straight tube parts. It results therefrom that at the beginning of the bringing together of the half-dies the tube legs, by yielding, give rise, in the regions where they join the bend, to folds or corrugations in the wall of the tube. These folds may not be eliminated during the subsequent compressive action, that is to say, when the arched region itself gives to the action of bringing the dies together, and the final bend with reduced radius of curvature has a defective appearance.

The object of this invention is a process and apparatus which contemplates eliminating the above-mentioned difficulty, and of producing flawless bends of a very small radius of curvature, even with particularly tough steels and with tube walls already quite thick, for example on the order of 0.05 of the outer diameter and more.

The process which is the object of this invention consists essentially in directing or concentrating the compressive action exerted by the dies first of all on the outer and already bent region of the bend, whereas on the contrary, the inside or crotch region of the said bend will remain subjected, at least at the start of the operation, to a pull which places it under tension. This tension effect will have in addition the advantage of aiding in maintaining, in the bent region, a circular section, or at least a regularly convex one.

To carry out the process which has just been mentioned, one method consists of preventing the straight tube legs of the bend from coming together or at least to hinder their coming together during the compressive action exerted by the half-dies. To this end there can be provided, between the tube legs and at a suitable distance

from the arched region, blocks or wedges of sufficient size to oppose the bringing together of the rectilinear arms.

According to another arrangement of the half-dies, instead of having working faces parallel to the tube legs of the bend, have slightly oblique faces, which carry the thrust exerted toward the outer, already arched region of the bend.

An improvement of the apparatus consists in that the half-dies, instead of being mounted rigidly on slides having a translation movement which brings them together, are articulated on these slides so that their faces which contact the legs of the bend can assume the suitable angle for having the force of compression exerted first of all on the outer region of the arched part of the tube. In addition, a device can be provided which, during the operation, permits of adjusting the distance between the arms of the bend, which will cause the rocking of the half-dies on their articulation and carry the pressure which they exert toward the bent region. In one variant mode of execution this separating or spacing device can act directly on the half-dies in order to give them the suitable inclination during the operation.

Since, according to this invention, it is sought to secure a compression in the elbow region of the bend, while the crotch of the bend remains subjected, as said above, to a tension, one may, in order to facilitate this double operation, create in the region of the bend which it is proposed to compress, a temperature gradient such that the elbow, which should be subjected to compression, is brought to a temperature greater than that of the crotch which remains subjected to tension, and this particularity constitutes one of the characteristics of the present invention. Thus, and because of the greater possibility of extrusion of the metal in the outer region of the bend, the action of the dies on the said outer region is insofar facilitated. By applying the temperature gradient which has just been described, and according to which the elbow is brought to the maximum temperature, one can even work so that it becomes, in certain cases, unnecessary to use other devices, such as articulated dies, etc., to produce the desired result.

The description which follows when read with respect to the attached drawing will make the manner in which the invention can be executed more understandable.

Figure 1 is a plan view showing a tube bend, of which it is proposed to diminish the radius of curvature, located in the compressing apparatus;

Figure 2 is a vertical section of the said bend as placed in the machine;

Figure 3 is a plan view of the bend with wedges put in place to prevent the tube legs from coming together;

Figure 4 is a section through 4—4 of Figure 3;

Figure 5 is a view similar to Figure 3, after bringing the half-dies together;

Figure 6 is a plan view of a variant illustrating inclined faces on the half-dies;

Figure 7 shows diagrammatically, in plan, another apparatus with articulated half-dies.

When it is desired to diminish the radius of curvature of a tube bend **10** by pressing between two half-dies **11**, **12** which move together in the direction of the arrows A of Figure 1 (after suitable heating of a delimited region of the bend **10**) it can happend, in the case of certain special steels, or of tubes with fairly thick walls, that the rectilinear arms of the bend **13**, **14** begin to yield and

come into the position shown in broken lines, which can cause collapse and foldings of the wall in the region where the tube legs join the arched part **15**.

As is known, the operation of bringing the half-dies **11**, **12** together in the direction of the arrows A, takes place in a machine such as that shown in section in Figure 2, where there can be seen the bend **10** held between two plates **17**, **18** during the operation. Center stops **20**, **21** are provided to limit the coming together of the tube legs of the bend.

According to this invention, in order to avoid collapsing and the formation of folds in the indicated region, the force of compression A is directed onto the outer and elbow region BC (Figure 1) of the bend **10**, while the inner and crotch region DE of the said bend will be placed under tension.

The simplest means for obtaining this result consists in providing, as may be seen in Figure 3, blocks such as **23**, **24** between the tubes **13**, **14** of the bend, the blocks resting on the central stops **25** (Figure 4) and maintaining certain distance between the tubes **13**, **14**. After bringing the half-dies **11**, **12** together, which causes the reduction of the curvature of the bend, as may be seen in Figure 5, it suffices, in case of necessity, to straighten by any suitable means, the parts of the tube legs which gave way during the operation.

The fact of having kept the tubes **13**, **14** at a sufficient distance during the compressing operation, has directed the force of compression onto the region BC of the bend, whereas the crotch region DE was subjected, because of the separation, to a pull which placed it under tension and prevented any yielding of the wall in the said region.

In another variant execution, which can be taken in combination with the first, the faces or recesses of the half-dies **11**, **12** which rest on the rectilinear arms of the bend are given a slight inclination, such as shown in Figure 6. The half-dies **11**, **12** always move inversely to the direction of the arrows A, perpendicularly to the axis of symmetry of the apparatus, but the inclination of the faces or recesses causes the bend to be attacked first of all in its bent region, toward which, consequently, the force of compression is carried.

The apparatus can be improved, as shown in Figure 7, by means of half-dies **11**, **12** articulated at **31**, **32** on slides **33**, **34** which move inversely to the direction of the arrows A. Owing to the articulation the half-dies **11**, **12** can rock and come to exert their force on the already bent region of the bend, easing the rectilinear arms.

In combination with this articulation of the half-dies or not, one can provide an adjustable device which permits of regulating and maintaining the spacing of the tube legs **13**, **14**. This device can, for example, be effected by means of the two blocks **23**, **24** mounted on a toggle **35** in the form of a parallelogram articulated at its apexes, on the one hand, on a fixed point **36**, and on the other hand on the rod **37** of a piston **38** moved, for example, with compressed air. The movement of the piston in the direction of the arrow F provokes the opening of the toggle **35** and consequently makes it possible to regulate the spacing effort directed in the direction of the arrows G.

The articulated device which has just been described can also be used to directly control the pivoting of the two articulated half-dies **11**, **12** about their axis **31**, **32** so as to make it possible to adjust the point of application of the compressive force.

As has been said above, the compression process is taken in combination with the creation of a gradient of suitable temperatures in the already bent region of the bend. It can be indicated, in order to facilitate or to diminish the force of compression in the outer region BC, to bring this region to a temperature greater than that of the inner region DE and to thus make uniform the resistance which the different regions of the bend offer to the compression, so as to prevent any deformation of the wall.

What I claim is:

1. A process for reducing the radius of curvature of a 180 degree tube bend having spaced tube legs with their longitudinal axes in a common plane and merging into the crotch and elbow regions of the bend comprising: applying compressive forces acting in opposite direction against the outer sides of the tube legs in the arched region of the bend by means of an instrumentality having work faces that engage the bend and are formed with a curved contour that conforms to the shape of the tube legs and partially embraces the latter; confining the bend between die members located at opposite sides thereof parallel to the plane that contains the tube axes and acting to maintain the legs thereof in said plane; and maintaining the tube legs in portions thereof beyond but contiguous to the bend in a spaced relation greater than the spacing of the tube portions adjacent the crotch upon reduction of the radius of the bend, whereby the crotch region of the bend is placed under tension as the outer elbow region is subjected to compressive forces.

2. A process for reducing the radius of curvature of a 180 degree tube bend having spaced tube legs with their longitudinal axes in a common plane and merging into the crotch and elbow regions of the bend comprising: applying compressive forces acting in opposite directions against the outer sides of the tube legs in the arched region of the bend by means of an instrumentality having work faces that engage the bend and are formed with a curved contour that conforms to the shape of the tube legs and partially embraces the latter; confining the bend between die members located at opposite sides thereof parallel to the plane of the bend that contains the tube axes and acting to maintain the legs thereof in said plane; and maintaining the tube legs in portions thereof beyond but contiguous to the bend in said spaced relation by force applying means acting in directions opposite to those of said compressive forces, whereby the crotch region of the bend is placed under tension as the outer elbow region is subjected to compressive forces.

3. The process recited in claim 2 wherein the compression of the bend is effected by an instrumentality having work contact faces slightly inclined toward the axes of the tube legs.

4. A process for reducing the radius of curvature of a 180 degree tube bend comprising heating the arched end region of the bend to a temperature higher than the crotch region; applying compressive forces acting in opposite direction from the sides of the bend towards the arched elbow region of the bend; and simultaneously supporting the straight portions of the tube legs at a point spaced in substantial distance from the crotch by an instrumentality which maintains said legs in substantially the spaced relation they occupy in the original workpiece so as to subject the crotch region of the bend to a pulling force which keeps it under tension.

5. Apparatus for reducing the spacing of the parallel tube legs of a 180 degree tube bend comprising: restraining means engaging the bend at opposite sides thereof in planes parallel to the plane of the tube axis for maintaining the tube in said plane during reduction of the spacing thereof, die members engageable against the outer face of each tube leg at the arched elbow region of the bend and movable toward each other to compress the elbow region of the bend and narrow the spacing of the tube legs at the crotch region of the bend; and a spacing member adapted to be positioned between the parallel tube legs to engage them at a distance from the crotch of the bend and having a width substantially greater than the reduced spacing of the tube legs effected by compression so that the compressive force applied by said dies is directed toward the arched elbow region and said spacing member acts to apply tension along the tube legs to the crotch region.

6. Apparatus as recited in claim 5 wherein the die members have work contact faces conforming to the

contour of the tubes and slightly inclined toward the axes of the tubular legs of the workpiece.

7. Apparatus as recited in claim 5 wherein slidable members are provided movable toward the bend and said die members are articulated thereto so that the slides transmit to them their movement of translation in a manner to cause the dies to engage the elbow at angles.

8. Apparatus as recited in claim 7 including a device for regulating the spacing of the spacing members comprising an articulated toggle system which controls and determines the operating position of these parts.

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