United States Patent [19]

Hofstede et al.

[11] **3,724,258**

[45] **Apr. 3, 1973**

[54] **APPARATUS FOR BENDING ELONGATE OBJECTS**

[75] Inventors: **Marinus Johannes Hofstede; Hendrik Logman,** both of Rijswijk, Netherlands

[73] Assignee: **Cojafex N.V.,** Rotterdam, Netherlands

[22] Filed: **Mar. 5, 1971**

[21] Appl. No.: **121,513**

[30] **Foreign Application Priority Data**

Jan. 8, 1971 Netherlands 7100269
Apr. 12, 1970 Netherlands 7003580

[52] **U.S. Cl.** **72/342,** 72/128, 72/149, 72/386

[51] **Int. Cl.**.....**B21d 7/024,** B21d 7/16

[58] **Field of Search**.....72/128, 149, 157, 342, 386, 72/387, 388

[56] **References Cited**

UNITED STATES PATENTS

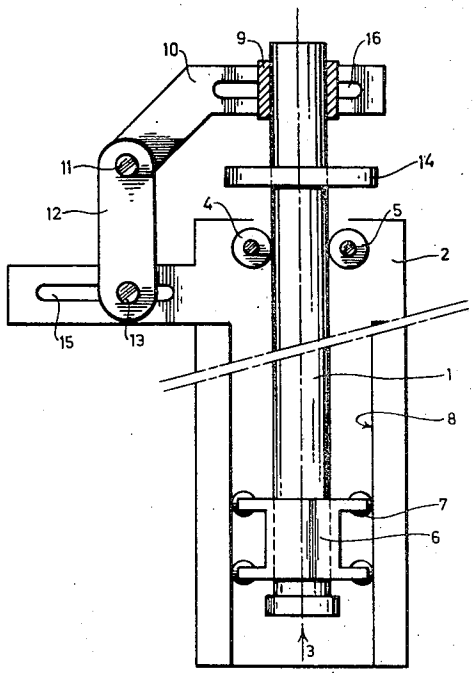
3,287,952	11/1966	Van Harten	72/157
2,286,893	6/1942	Boissou	72/342
785,083	3/1905	Brinkman	72/128
799,670	9/1905	Reynolds	72/128
2,812,004	11/1957	Huet	72/128
1,105,914	8/1914	Miller	72/128

Primary Examiner—Lowell A. Larson
Attorney—Jones and Lockwood

[57] **ABSTRACT**

The apparatus for bending tubes and like elongate objects is of the type in which a narrow transverse zone of the progressively and gradually forward driven tube is heated and in which bending is effected by means of a rotatable bending arm to which the tube is clamped, the center of rotation of the bending arm being situated substantially in the plane of the heated zone of the tube. In order to alleviate some of the forces acting on the tube and on the apparatus the latter is constructed so as to allow a limited movement of the center of rotation of the bending arm and of the heated zone of the tube in relation to each other. Deviations in the bend radius are corrected by displacing the means for heating the tube.

17 Claims, 7 Drawing Figures



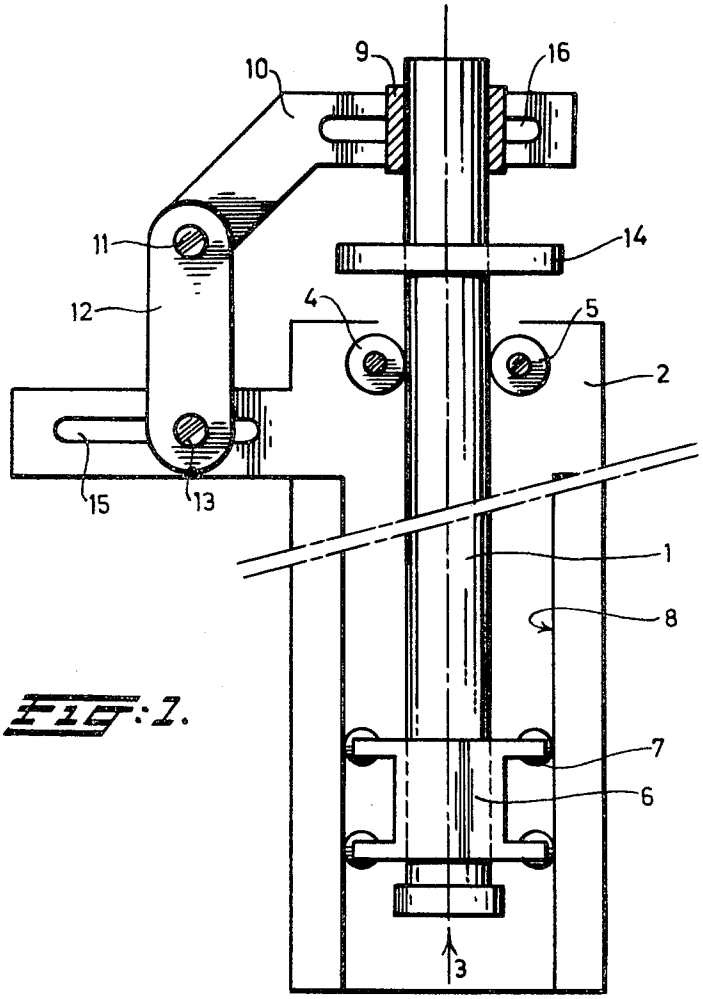


Fig. 1.

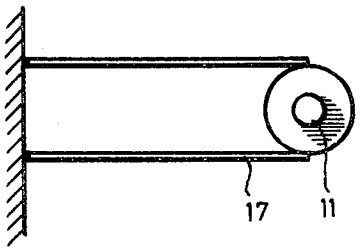


Fig. 2.

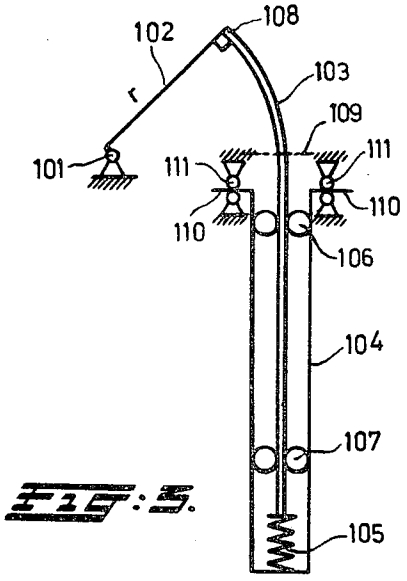


FIG: 5.

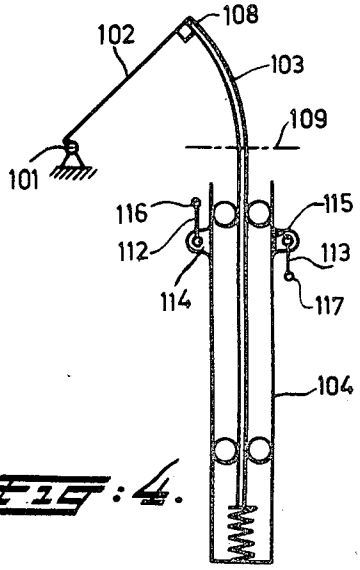


FIG: 4.

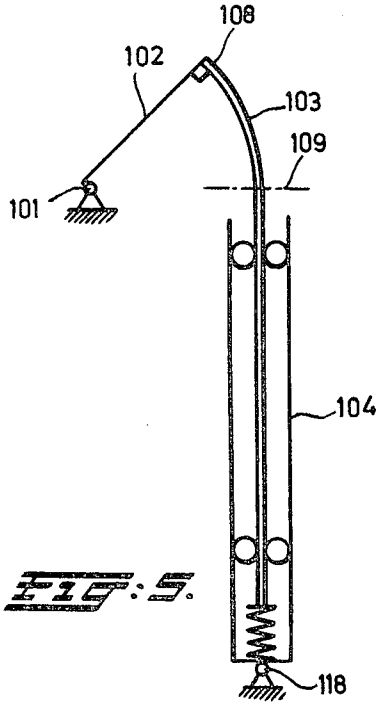


FIG: 5.

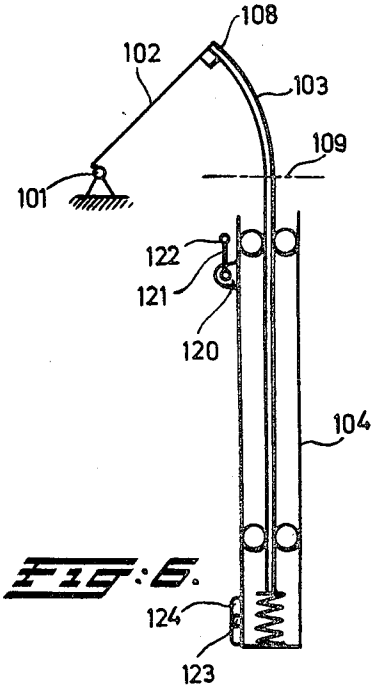
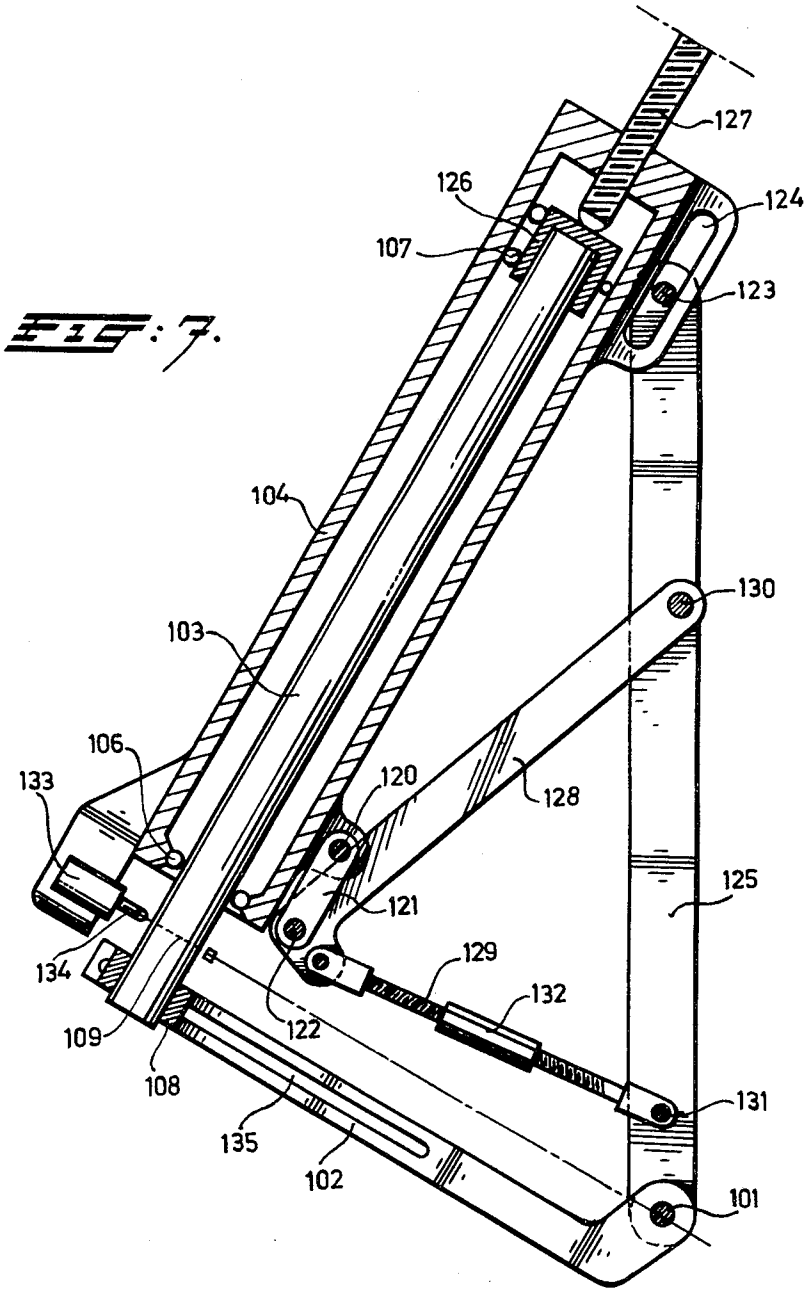


FIG: 6.

Fig. 7.


127
126
124
107
123
104
130
103
106
133
120
128
125
121
129
134
132
122
109
108
131
135
102
101

APPARATUS FOR BENDING ELONGATE OBJECTS

The invention relates to an apparatus for continuously and progressively bending elongate objects, more particularly tubes, but also for example rods or beams, and particularly to such an apparatus by which the object is subjected to a longitudinal force urging the object, guided by means such as rollers, progressively through a heating means, heating the object in a narrow transverse zone, so as to lower in said zone the limits of elasticity and of stretching strain, the object past the heating means being guided in a bend by means of a bending arm to which the object is connected in a rotation free way, said arm having its center of rotation in or nearly in the plane of the heated zone.

Such an apparatus for bending metal tubes is known from Czecho-Slovakian Patent Specification 111.259.

Bending takes place in the narrow heated zone, and as in this zone the bending moment is consequential to the force exerted on the tube in longitudinal direction thereof, stretching at the outer side of the bend is decreased and upsetting at the inner side of the bend is increased, so that at the outer side of the bend the wall thickness is reduced to a lower extent than when no such longitudinal force should be exerted on the tube.

However experience has taught that under some circumstances, in particular when heavy tubes are being bent, the apparatus is subjected to excessively high loads which are difficult to be coped with and which may lead to break down of the machine. Further a transverse force is set up in the heated zone of the tube, which force may lead to undesired deformations of the tube in the heated zone. The above high loads to which the apparatus is subjected are for a great deal a consequence of a very large bending moment occuring at the place where the tube is connected to the bending arm by clamping or otherwise, and of the big force exerted on the tube by a guiding roller situated near the heated zone.

It is an object of the invention to remedy the above drawbacks of the known apparatus.

According to the invention this object is reached by having the center of rotation of the bending arm and the guide means for the tube or the like arranged in the apparatus in such a manner that the said center and the heated zone of the tube have a certain freedom to move in relation to each other so as to change their distance to a certain amount, the said center remaining thereby substantially in the plane through the narrow heated zone.

This may be accomplished by having the center of rotation of the bending arm mounted in the machine not in a fixed manner, but in such a way that during a bending operation this center may move in a direction perpendicular or substantially perpendicular to the center line of the unbent portion of the tube or the like, the guide means for such unbent portion guiding this portion in a fixed track with regard to the base of the machine.

Another way of accomplishing the same result consists in having the center of rotation of the bending arm mounted in the machine base mounted in a fixed manner but mounting the guide means for the unbend portion of the tube or the like in such a way that the zone where heating is effected may move towards to or away from the center of rotation of the bending arm.

With this arrangement also the plane of the narrow zone of heating should remain substantially passing through the center of the bending arm, notwithstanding movements of the tube or the like.

It is to be understood that in both cases the movements of the center of the bending arm or of the heated zone of the tube or the like towards each other or away from each other during the bending process will only be relatively small; they may further be reduced by elastic means.

It has been shown in practice that with both arrangements drawbacks due to excessive loads on the bending machine as well as on the tube or like object are completely or substantially completely prevented, even if heavy tubes are being bent. Thus the advantages of the present invention reside as well in obtaining a bent object without undesired deformations as in the possibility to apply machines of lighter construction.

The desired mobility of either the center of rotation of the bending arm or of the heated zone of the elongated member may be accomplished in a number of ways. So in the case of a mobile bending arm center, the bending arm may for example be connected at its center of rotation pivotally to a rocking arm or coupling rod extending substantially parallel to the unbent portion of the elongate member, or to a slide movable substantially perpendicularly to the unbent portion of the elongate member.

As has been said above resilient means may be provided to counteract to a certain extent the displacement of the bending arm's center of rotation or the guiding means for the tube or other elongate object or member. Such resilient means may be formed by springs or rubber blocks.

The possibility of a relative movement between the bending arm's center of rotation and the guiding means for the unbent portion of the elongate member, present in a machine according to the invention, opens the way to a special method in affecting or controlling the bending process.

It was found that a small deviation in the radius over which the member is to be bent causes a small displacement of either the bending arm's center of rotation or of the member guiding means, and that such deviation can be corrected by a small displacement of the zone heating means in the direction of the longitudinal axis of the unbent member. Such a correction can be effected manually or automatically in dependence on a displacement as mentioned above.

The invention will now be further elucidated by the description of some examples of machines embodying the invention, reference being made to the accompanying drawing on which such machines are shown diagrammatically, as far as necessary for the understanding of the invention.

FIG. 1 shows a top view of a first example of a bending machine according to the invention.

FIG. 2 shows a detail thereof in modified form.

FIGS. 3 – 6 show in a very diagrammatic way how the principle on which the invention is based can be applied to bending machines, having a fixed center of rotation of the bending arm.

FIG. 7 shows a top view of an example of a bending machine according to the invention, constructed along the lines indicated in FIG. 6.

FIG. 1 shows a tube bending machine with a bending arm, the center of rotation which is movable.

In this figure the tube 1 to be bent is located in the machine, the base frame of which is indicated by the reference numeral 2, and is guided during its forward movement, caused by a force acting thereon in the direction of the arrow 3 (by means not shown in the drawing), by rollers 4 and 5, connected to the frame 2 and further guided by guiding means 6. This latter means can comprise a collar piece, fixed to the tube and having rollers 7 running along guide faces 8 of the frame 2.

The forward end of the tube is fixed to the bending arm 10 in a rotation free manner, e.g. by means of a clamping device 9. The bending arm is rotatably connected to a rocking arm or coupling rod 12 by means of a journal at 11, the rocking arm itself being pivotally connected to the frame 2 by means of a journal 13.

Beyond the rollers 4,5 the tube is encircled by a heating device 14, adapted to heat at this place a narrow zone of the tube to a temperature required for the bending of the tube. Within the plane of said zone or substantially within said zone the center of rotation 11 of the bending arm 10 is situated, which is essential for satisfactory operation of the machine. The heating device 14 is preferably of the electric inductor type but may be of different construction, e.g. adapted for heating by gas. Essential however is that only a narrow zone of the tube will be heated thereby.

The operation of the machine is as follows.

With operative heating by 14 the tube is moved forward in the direction of the arrow 3, the force required for said movement being supplied e.g. by a motor driven screw spindle or a hydraulic cylinder. That end of the tube which is fixed at 9 to the bending arm can only move about the center of rotation 11 of the bending arm 10, which causes at the place heated by 14 a bending with a radius equal to the distance between the center 11 and the center-line of the unbent portion of the tube. In order to prevent deformation in that part of the tube which just passed the heating device 14 the tube, particularly when it is a thin-walled tube, will if necessary be cooled directly beyond the heated zone, e.g. by spraying water thereon.

It should be noted that during the bending operation, the side force acting on the roller 5 will only be small. In the heated zone of the tube the transverse or shearing force has a neglectable value, so that it will not give rise to undesirable deformations. The cold and therefore rigid tube sections adjacent to the heated zone tend to keep up the original round sectional shape in the heated zone; thus it is unnecessary to fill the tube with sand or a mandrel. Further the compressive force working in the heated zone counteracts wall thinning at the outer side of the bend.

In principle the center of rotation 11 of the bending arm 10 stays at exactly the same place during the bending process, and also the radius of the bend will be kept constant.

By disturbances of secondary nature, e.g. irregularities on the wall thickness, however a deviation can arise in the bend radius, which deviation is accompanied by a slight displacement of the center of rotation 11 towards the right or the left (in FIG. 1). According to the invention this phenomenon is made use of to effect a correction. It appeared that by slightly shifting the heating device 14 in the longitudinal direction of the tube the bend radius is modified in length. The method of correction according to the invention now consists in measuring in an arbitrary way the displacement of the center of rotation 11, and shifting in dependence on the measured value the heating device until the center 11 again takes up its original position. Such method can be performed by the attendant of the machine but automatically as well. In the latter case a sensing device, responsive to a displacement of the said center of rotation may e.g. give a signal, that via a transmission (electric, pneumatic, etc.) causes a mechanism for shifting the heating device to operate.

As an equivalent to shifting of the heating device one may consider shifting of the center of rotation 11 of the bending arm 10 in a direction perpendicular to the unbent position of the member to be bent.

The machine diagrammatically shown in FIG. 1 is arranged for adaptation to different tube diameters and radius of bending by adjustment or exchange of the rollers 4,5 of the guide shoe 6, of the fixing member 9 and by change of the effective length of the bending arm 10. An example of means to attain the latter is shown in FIG. 1 by the guide slots 15 and 16, in which slots the center of rotation 13 of the rocking arm 12 and the fixing member 9 can be set tight.

The machine can be arranged for bending tubes or other elongate objects in a helical shape by displacing during the bending process the center of rotation 13 gradually in a direction perpendicular to the plane of drawing in FIG. 1.

The movability of the center of rotation 11 can, as has already been said, be attained in other ways than by means of the rocking arm 12, e.g. by means of a slide movable along guides, by means of a straight motion mechanism, or as indicated in FIG. 2, by means of two or another member of flexible strips or blade springs 17.

Prevention of a permanent transverse force on the center of rotation of the bending arm can, when a slide is provided to which the arm is pivotally connected, also be attained by adjusting the position of the slide by means of a mechanism controlled by such a temporarily occuring force until said force will be annihilated or nearly so. The force concerned may be determined at the center of rotation itself but also at roller 5.

In the FIGS. 3,4,5 and 6 is shown in a very diagrammatic way how the principle on which the invention is based can be applied in bending machines in which (for a given bending radius) the center of rotation of the bending arm has a fixed position with regard to the base of the bending machine.

In these figures the reference numeral 101 indicates the stationary center of rotation of the bending arm 102, which at 108 is in a rotation free manner connected to tube 3 (or other elongate object) to be bent, e.g. by means of a clamping member.

The distance 101 – 108 is of course equal to the radius over which the object is to be bent; in these figures bending has taken place already over some length of the object. De facto the bending arm 102 and the bent portion of the tube constitute a rigid assembly, providing the theoretical lever of the length r, which constantly remains perpendicular to the longitudinal

axis of the object to be bent. The tube **103** (by which denomination any elongate object to be bent shall be indicated hereinafter) is guided over its unbent portion in a guide frame or support **104**, with interposed guide rollers **106** and **107**, transmitting transverse forces from the tube to the guide frame. A longitudinal force is applied to the tube by means of a power device operating on the tube on one hand and on the guide frame on the other hand. In the figures the power device is symbolically sketched as a spring **105**, but in practice it may consist of a hydraulic or pneumatic cylinder, a motor driven screwspindle or screw rack or the like.

At the place indicated at **109** the tube is locally heated in the plane, indicated by a dotted line, passing or nearly passing through the center of rotation **101** of the bending arm. Driven forward by the longitudinally acting force the tube is bent over the radius *r* in the heated zone which gradually is displaced along the tube.

According to the invention measures have been taken to allow the guide frame or support **104** to move at its forward end, bearing the heating device, to some extent towards the center of rotation **101** of the bending arm or away from it, in order to suppress wholly or partly the shearing force in the heated zone and to reduce the load on the bending arm and its center of rotation.

In the sketch of FIG. **3** the guide frame **104**, in order to attain the movability as mentioned above, is provided at its forward end with sideways extending guide rails or bars **110**, adapted to move slidingly between guide rollers **111** with stationary axis.

Instead thereof the guide frame may bear rollers adapted to move between stationary rails, or guiding surfaces may be applied instead of rollers.

The sketches of FIGS. **4**,**5** and **6** show in a diagrammatic way arrangements in which a sideways displacement as obtained with the arrangement of FIG. **3** is at least approximated.

Thus in FIG. **4** the guide frame **104** has pivotally connected to it at the points **114**, **115** respectively two short coupling rods or tie rods **112** and **113**, the other ends of said rods being pivotally connected at **116**, respectively **117** to stationary points.

In FIG. **5** the rear end of the guide frame is adapted to pivot about the fixed point **118**.

In FIG. **6** the guide frame **104** has pivotally connected to it at **120** one tie rod, the other end of which is pivoting about a fixed point **122**, whereas the rear end of the guide frame is provided with a slot **124** adapted to slide along a stationary pin or roller **123**.

It will be appreciated that the same object can be reached with other combinations.

FIG. **7** shows more detailed a machine according to the principle of FIG. **6** as seen from above.

The numeral **125** indicates in diagrammatic way the base frame on which the various parts are mounted, such as the journal **101** constituting the center of rotation of the bending arm **102**, and the pin **123**, cooperating with the slot **124** of the guide frame **104**. The tube **103**, here shown in a position in which bending has not yet been effected, is connected to the bending arm **102** by means of a clamping member **108** in a rotation free manner. Adjacent the forward end of the guide frame **104** the tube **103** is guided by guide rollers **106** of the guide frame, whereas at its rear end the tube is enclosed by a shoe or chuck **126** provided with rollers **7** for guiding the rear end of the tube within the frame **104**.

The force for moving the tube in forward direction in the guide frame is supplied by a screw spindle **127**, threaded in the rear end of the frame **104**, and adapted to be rotated by means of e.g. an electromotor (not shown in the drawing). As already said other devices can be applied for supplying the force required.

At some distance from the forward end of the guide frame **104** a tie rod **121** parallel to the frame is connected thereto by means of the pivot **120**; the other end of the rod pivots at **122** about a point fixed with regard to the base frame **125**. The connection between the pivot **122** and the base frame **125** is brought about with the aid of both rods **128** and **129**, the first adapted to pivot about a point **130** of the base frame, the latter about a point **131** of the base frame. The point **130** is situated about halfway between the points **101** and **123**, the point **131** in the neighborhood of point **101**. Whereas the rod **128** has a fixed length, the length of the rod **129** can be altered by means of a turnbuckle **132**. The purpose thereof will be described later on.

At its forward end the guide frame **104** supports a device **133** to heating the tube in the narrow zone, indicated by **109**, transverse to the longitudinal axis of the unbent tube portion. This device may comprise electrical apparatus for feeding alternating current to an induction ring, **134** encircling the tube in the said zone. Other heating appliances may be used provided the tube will be heated thereby in a narrow zone only. The heating device may be combined with means for cooling the progressily moving tube in the zone which just had been heated.

The plane of the zone **109** and of the heating ring **134** passes or nearly passes through the center of rotation **101** of the bending arm, otherwise stated: the longitudinal axis of the unbent portion of the tube is substantially perpendicular to the line connecting zone **109** and the center of rotation of the bending arm. This relation is essential to the proper operation of the machine and should therefore remain when the radius over which a tube is to be bent is altered.

When the radius of bending should be altered the effective length of the bending arm **102** as well as the position of the guide frame **104** with regard to the base frame **125** is modified.

A modification of the length of the bending arm **102** is effected by displacing the clamping block **108** along the arm, the latter being provided with a slot **135**, in which the block **108** can be fixed at the place desired. A modification of the position of the guide frame, fitting the first-mentioned modification, is obtained by altering the length of the rod **129**; thereby the rod **128** pivots about the center of rotation **30**, whereas the slot **124** slides along the pin **123**. The location of the points **130** and **123** and the length of the rod **128** are chosen such that with any selected bending radius the right angle between the longitudinal axis of the unbent tube portion and the line connecting **109** and **101** is practically maintained.

During the bending process small deviations of the desired bending radius may occur due to incidental

causes such in homogenity of the tube material. Such deviations manifest themselves in a slight rotation of the guide frame **104** about the point **123** and a corresponding rotation of the rod **121** about the fixed point **122**. Such a deviation can be corrected by a suitable shifting of small extent of the zone **109** in the longitudinal direction of the unbent tube portion. Thus when a rotation of the tie rod **121** is observed a suitable shifting of the zone **109** can be accomplished by adjusting the position of the heating device **133, 134** with regard to the forward end of the guide frame, which can be done either by hand or automatically. In the latter case a sensing device can be applied which upon e.g. a rotation of the rod **121** delivers a signal causing a displacement of the heating device by electric, pneumatic or hydraulic means.

Application of the present invention is not limited to the embodiments described. For example, the construction shown in FIG. 7 can be modified in such a way that the pivot **120** and the slot **124** of the guide frame **104** are located in the vertical plane through the center line of the unbent tube portion and the guide frame. Another possible modification of the machine of FIG. 7 would be to mount the guide rollers **106** and the heating device **133, 134** not on the guide frame **104**, but on a separate auxiliary support, slidably arranged in the guide frame and connected to the base frame **125** by means of rods similar to the rods **121** and **128** of FIG. 7. With such construction the guide frame **104** need to be shifted lengthwise upon altering the bending radius, so that the shot-and-pin guiding means **123,124** at the rear end of the guide frame can be replaced by a pivot, such as the pivot **118** in FIG. 3.

In order to increase the compressive force in the heated zone, so as to counteract wall thinning in the outer side of the bend, an additional braking force can be applied to the bending arm; on the other hand it may prove desirable, e.g. with thin-walled tubes and very plastic materials, to apply to the bending arm an additional driving force. For both purposes an electric or hydraulic motor with driving as well as braking properties can be used.

The invention has been explained in the above mainly in connection with the bending of round tubes, such as steel tubes. It will be understood that on the base of the principle of the invention machines can be built for bending other elongate members, such as rods, rails, beams etc. The material of these members need not be metal, but may be another thermoplastic material, such as an artificial thermoplastic polymer or glass. The method of heating should of course be in agreement with the nature of the material to be bent. In stead of heating by electric inductance, only applicable with electrically conductive materials, heating by a source of radiation, by hot air, by gas, etc. can find employment under suitable conditions.

We claim:

1. Apparatus for bending elongate objects such as tubes, with a substantially constant bending radius comprising a base frame, guide means connected to said base frame for guiding the object to be bent, means for urging an object when placed within said guide means in a forward direction, heating means provided beyond the forward end of the guide means so as to encircle the object to be bent and adapted to heat such object in a narrow transverse zone thereof, a bending arm, pivotally arranged within the apparatus and having its pivot point situated in or nearly in the plane in which the heating means can effect heating of the elongate object and means for clamping the bending arm to the elongate object beyond the place of heating, said clamping means constituting the only connection between the bending arm and the object to be bent, the pivot point of the bending arm and the guide means for guiding the object to be bent being connected to the base frame in such a way that the said pivot point and the zone of heating of the object to be bent are adapted to move in relation to each other so as to change to a limited amount the distance therebetween.

2. Apparatus for bending elongate objects such as tubes, with a substantially constant bending radius comprising a base frame, longitudinally extending guide means fixedly connected to said base frame for guiding the object to be bent, means for urging an object when placed within said guide means in a forward direction, heating means provided beyond the forward end of the guide means so as to encircle the object to be bent and adapted to heat such object in a narrow transverse zone thereof, a bending arm, pivotally arranged within the apparatus, and having its pivot point situated in or nearly in the plane in which the heating means can effect heating of the elongate object, and means for clamping the bending arm to the elongate object beyond the place of heating, said clamping means constituting the only connection between the bending arm and the object to be bent, the pivot point of the bending arm being movably connected to the base frame in such a way that the said pivot point is adapted to move to a limited amount in a direction substantially perpendicular to the longitudinal axis of the guide means.

3. Apparatus for bending elongate objects such as tubes, with a substantially constant bending radius comprising a base frame, a longitudinally extending guide frame connected to said base frame for guiding the object to be bent, means for urging an object when placed within said guide frame in a forward direction, heating means provided adjacent the forward end of the guide frame so as to encircle the object to be bent and adapted to heat such object in a narrow transverse zone thereof, a bending arm, pivotally connected to the base frame and having its pivot point situated in or nearly in the plane in which the heating means can effect heating of the elongate object and means for clamping the bending arm to the elongate object beyond the place of heating, said clamping means constituting the only connection between the bending arm and the object to be bent, the guide frame for guiding the object to be bent being connected to the base frame in such a way that its forward end carrying the heating means is adapted to move to a limited amount towards to and away from the pivot point of the bending arm.

4. Apparatus according to claim **2** in which the bending arm is pivotally connected to one end of a rocking arm, the other end of which arm is pivotally connected to the base frame, the rocking arm extending in a direction substantially parallel to the guide means for the unbent portion of the object to be bent.

5. Apparatus according to claim **2** in which the bending arm is pivotally connected to a slide member adapted to slide along guide means in a direction per-

pendicular to the guide means for the unbent portion of the object to be bent.

6. Apparatus according to claim 2 in which the pivot point of the bending arm is connected to the base frame by resilient means.

7. Apparatus according to claim 3 in which the guide frame is mounted in the apparatus in such a way that the said forward end of the guide frame, together with the heating means, can move in a transverse direction.

8. Apparatus according to claim 3 in which and the forward end of the guide frame is provided with a straight motion mechanism allowing movement in a transverse direction.

9. Apparatus according to claim 3 in which the forward end of the guide frame is connected to the base frame by means of one or more coupling rods, each of said rods having one end pivotally connected to the base frame of the apparatus and the other end pivotally connected to the said end of the guide frame.

10. Apparatus according to claim 3 in which the effective length of the bending arm is adjustable and the position of the guide frame for the unbent portion of the elongate object with regard to the base frame is also adjustable to meet the adjustment of the bending arm length.

11. Apparatus for bending elongate objects such as tubes with a substantially constant bending radius comprising a base frame, a guide frame for the elongate object to be bent, means for urging an object to be bent forward along said guide means, means carried by the guide means for heating the object to be bent in a narrow transverse zone beyond said guide means; a bending arm having its pivot point situated in or nearly in the plane in which the heating means can effect heating, and means for clamping the bending arm to the object to be bent, which means are displaceable along the length of said arm, at least one coupling rod the ends of which are pivotally connected respectively to the forward end of the guide frame and to the base frame, and means for connecting the rear end of the guide frame to the base frame, which latter means allow a rotation as well as a translation of the guide frame with regard to the base frame.

12. Apparatus according to claim 11 in which the pivot of the coupling rod for connecting it to the base frame, is arranged at the end of a second rod, the other end of which is pivotally connected to a point of the base frame situated about half way between the pivot point of the bending arm and the point where the rear end of the guide frame is connected to the base frame.

13. Apparatus according to claim 11 in which the pivot of the coupling rod for connecting it to the base frame, is arranged at the end of a second rod, the other end in which is pivotally connected to a point of the base frame situated about half way between the pivot point of the bending arm and the point where the rear end of the guide frame is connected to the base frame and in which a third rod of adjustable length is pivotally connected at one end to the end of the second rod near to its pivot with the coupling rod and at the other end with a point of the base frame near the pivot point of the bending arm.

14. Method of correcting deviations in the desired bending radius of a progressively forward driven elongate object, comprising heating the object in a narrow transverse zone by moving the object through a heating means which encircles the object, clamping the object to a rotatable bending arm, determining during bending small deviation of the nominal distance between the center of rotation of said bending arm and the heating means, and slightly shifting the heating means in the longitudinal direction of the unbent part of the object in one or the other sense in dependence on such deviations.

15. Method according to claim 14 in which the position of the heating means is adjusted in dependence on slight variations in the distance between the center of rotation of the bending arm and the guide means for the elongate object, such guide means carrying the heating means.

16. Apparatus for carrying out the method of claim 14, comprising mechanical, electrical or optical sensing means for detecting a small displacement of the displaceable center of rotation of the bending arm with regard to the heating means and means for operationally connecting such sensing means to means for shifting the heating means along the elongate object.

17. Apparatus for carrying out the method of claim 14 comprising mechanical, electrical or optical sensing means for detecting a displacement of the displaceable guide means for the elongate object, which guide means carry the heating means, and means for operationally connecting such sensing means to means for shifting the heating means along the elongate object.

* * * * *