Sept. 17, 1963 F. R. SAVORY 3,103,965

PLATE BENDING MACHINES

Filed Feb. 10, 1961 3 Sheets-Sheet 1

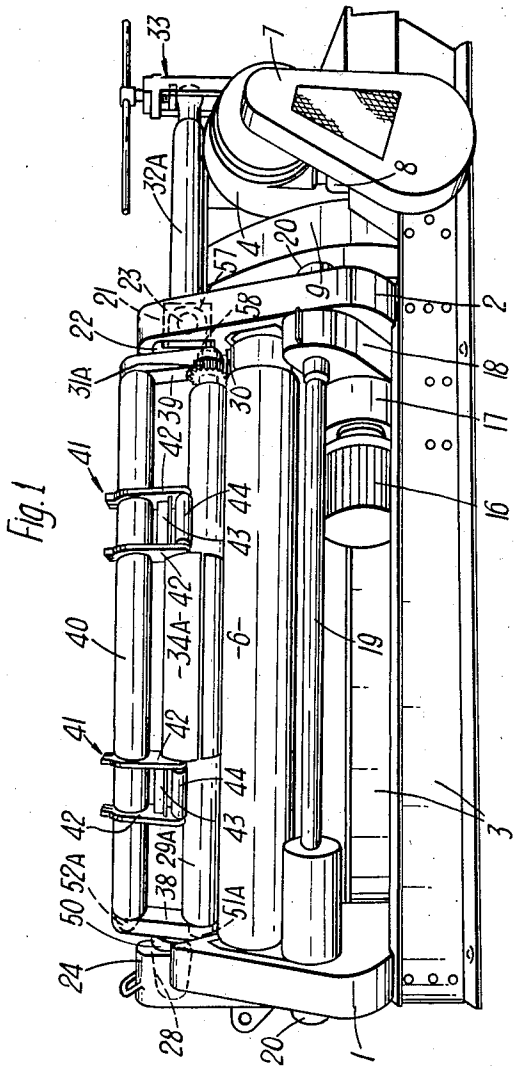


Fig. 1

Inventor
Frederick Ralph Savory
By
Watson, Cole, Grindle & Watson
Attorneys

Sept. 17, 1963 F. R. SAVORY 3,103,965

PLATE BENDING MACHINES

Filed Feb. 10, 1961 3 Sheets-Sheet 2

Fig. 2

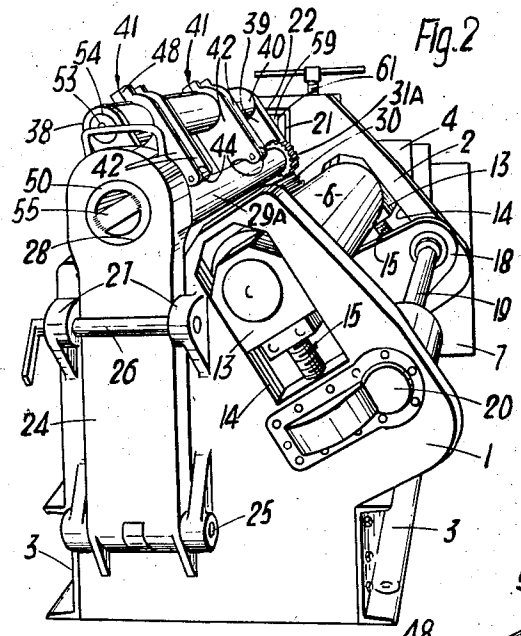
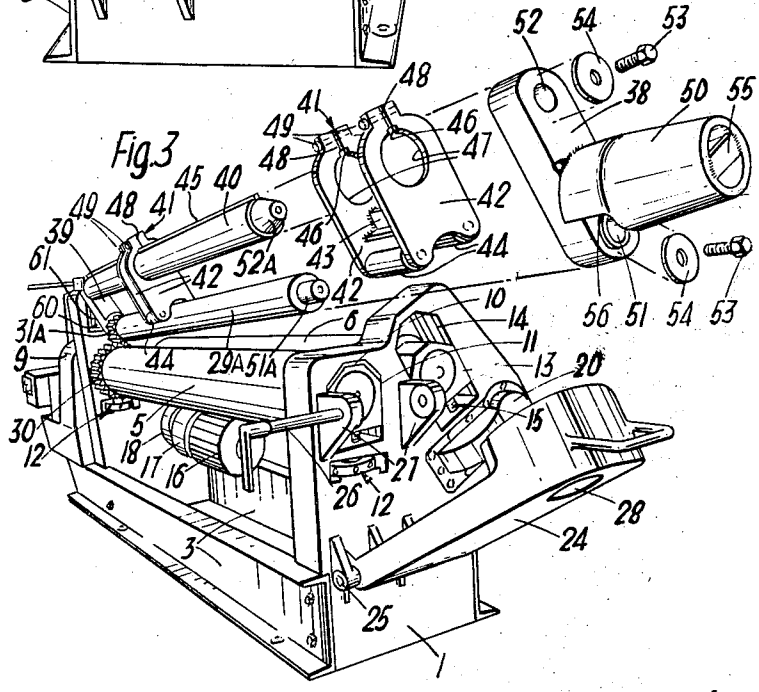


Fig. 3



Inventor
Frederick Ralph Savory
By
Watson, Cole, Grindle & Watson
Attorney

Sept. 17, 1963 F. R. SAVORY 3,103,965

PLATE BENDING MACHINES

Filed Feb. 10, 1961 3 Sheets-Sheet 3

Fig. 4

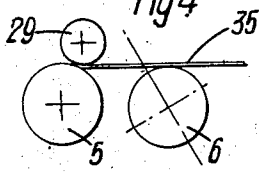


Fig. 5

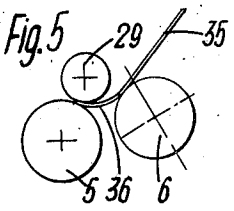


Fig. 6

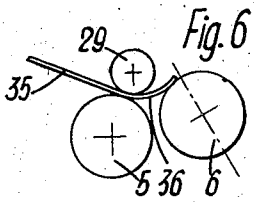


Fig. 7

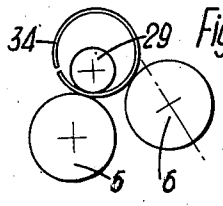


Fig. 8

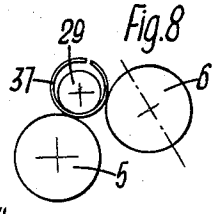


Fig. 9

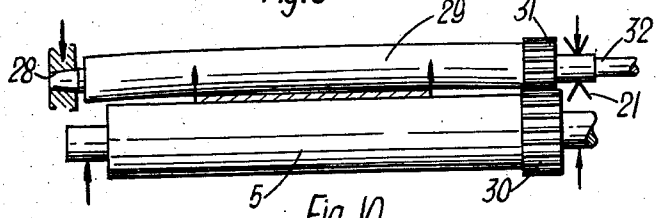


Fig. 10

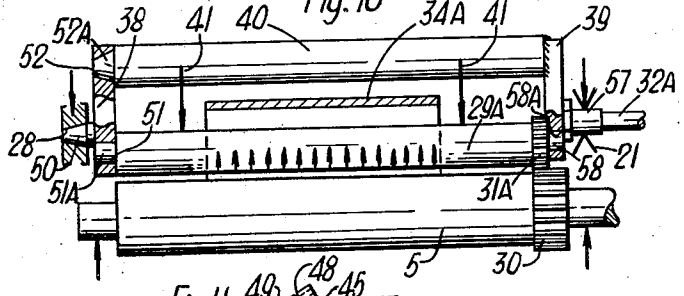
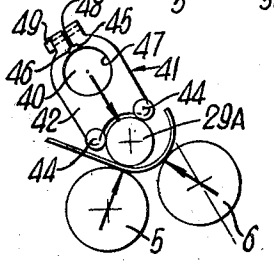


Fig. 11



Inventor
Frederick Ralph Savory

By
Watson, Cole, Grindle & Watson
Attorneys

United States Patent Office 3,103,965 Patented Sept. 17, 1963

3,103,965

PLATE BENDING MACHINES

Frederick R. Savory, Sutton-in-Ashfield, England, assignor to Steel Construction & Engineering Co. (Notts.) Limited, Sutton-in-Ashfield, England

Filed Feb. 10, 1961, Ser. No. 88,552
7 Claims. (Cl. 153—54)

This invention relates to plate bending machines of the initial pinch type in which a tube is formed by bending and rolling a plate round a roll, which along with another roll is adapted to be driven and form a nip through which the plate is passed, a third roll being movable with respect to the first two rolls to effect first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending of the rest of the plate.

The roll around which the tube is formed must be less in diameter than the required internal diameter of the finished tube, to allow for spring-back of the plate material after bending and, with the machine adapted to form a tube of small diameter in relation to its length, that roll is liable to bend axially under the stresses, with a consequent adverse effect on the straightness of the tube, whereas the other two rolls, not being encircled by the plate material may be of a sufficient diameter in relation to their length to withstand the bending stresses or, in the case of a very long machine, may be supported against bending at intervals along their length.

The object of the present invention is to provide an initial pinch plate bending machine of the type referred to having a small-diameter roll around which the tube is formed together with means for reducing to negligible proportions the bending of that roll.

According to the present invention, an initial pinch plate bending machine of the type referred to has the roll around which the tube is to be formed mounted with a stiff shaft parallel to it and at substantially the opposite side of the said roll to the side along which the bending stresses will be applied through the plate material by the other two rolls, and a pair of brackets non-rotatably mounted on the stiff shaft each carrying a pair of backing rollers to bear on the roll just beyond the ends of the tube to be formed, so as to transmit bending stresses from the said roll through the brackets to the stiff shaft. The stiffness of the stiff shaft thus provides added resistance against bending of the roll, which is particularly important when the roll diameter is very small, as when tubes of only a few inches bore are to be rolled. For example, the machine can be successfully used for rolling 4″ diameter tubes from stainless steel plate. The other two rolls are not so restricted as to diameter, and can therefore be stiff enough to withstand the bending stresses arising from their operation.

Preferably, the brackets are adjustable lengthwise of the stiff shaft to enable the backing rollers to be set just beyond the ends of any tube length within the capacity of the machine. Thus the shaft may be cylindrical and provided with a lengthwise key or keys for engagement by corresponding keyways in journals in the brackets, and the journals may be split to enable the brackets to be clamped in adjusted position. Again, a square shaft may be used, to fit square holes in the brackets. The brackets may also be interchangeable with other similar brackets of a size suitable for a different diameter of roll, in accordance with the diameter of tube to be formed.

Where, as is usual, one of the bearings for the roll around which the tube is to be formed is mounted in a swinging portion of the machine frame, to enable the

bearing to be removed from the end of the said roll for endwise withdrawal of the formed tube from around the roll, there may be provided an adaptor arm adapted to fit in the swinging frame portion and carry both the removable bearing and an end support for the stiff shaft, so that the bearing and the end support may be removed together to permit withdrawal of the formed tube. Removal of the shaft support also permits the roller-carrying brackets to be removed from the shaft, e.g., for replacement.

Where, as is also usual, the other bearing for the roll around which the tube is to be formed is mounted for pivotal movement in the frame to enable the said roll to be swung away from the roll with which it forms the nip, there may be provided an adaptor arm adapted to fit in the pivotal mounting and carry the roll bearing for that end of the roll and the other end support for the shaft, with a lever arm extending from the adaptor arm to be operated by screw-gear after removal of the first adaptor arm to balance the mounting of the roll and the stiff shaft on the second adaptor arm.

With adaptor arms as described above at both ends of the roll around which the tube is formed, the roll may be interchangeably mounted in the bearings in the adaptor arms, for replacement of a worn roll or substitution of a roll of a different diameter. Again the whole unit of roll, shaft, brackets, adaptor arms and lever arm extension may be interchangeable for replacement by a similar unit of dimensions appropriate to a different range of tube diameters.

The invention will now be described with reference to the accompanying drawings, in which

FIGURE 1 is a perspective view from one side of an initial pinch plate bending machine according to the invention;

FIGURE 2 is another perspective view of the machine from the same side but from the left-hand end of FIGURE 1;

FIGURE 3 is a perspective view of the machine from the other side at the same end;

FIGURES 4 to 8 are diagrammatic end elevations of the bending rolls of the machine, showing the manner of operation;

FIGURES 9 and 10 are diagrammatic side elevations showing the forces involved in a conventional plate bending machine and a plate bending machine according to the invention, respectively; and

FIGURE 11 is a diagrammatic end elevation of a plate bending machine according to the invention, showing the angular disposition of the forces involved.

In FIGURES 1 to 3, an initial pinch plate bending machine has end bearing housings **1**, **2** spaced apart by side channels **3**, which extend beyond the housing **2** to carry a main electric motor **4** for driving bottom and side bending rolls **5**, **6**, respectively, through a V-belt drive (protected by a casing **7**) and bevel-gear and gear-and-pinion gearboxes **8**, **9** respectively. The bottom roll **5** is mounted in bearing blocks **10** (only one of which is visible in the housing **1** in FIGURE 3) vertically adjustable in guide apertures **11** in the housings **1**, **2** by means of manually-operable screw-gear **12**, while the side roll **6** is mounted in bearing blocks **13** adjustable in inclined guide apertures **14** (also in the housings **1**, **2**) by means of screw-gear **15**, which is operated by a reversible electric motor **16** through a gearbox **17**, a chain-drive (protected by a casing **18**) to a common shaft **19**, and worm-and-pinion gearboxes **20** at the ends of the shaft. The housing **2** is also provided with bearing block **21**, which is pivotable within an aperture **22** about a fixed horizontal and transverse axis **23**, while the housing **1** is provided with a swinging portion **24** carried by a hinge **25** and normally held up-

right against the housing **1** by a locking pin **26** engaging eye-brackets **27**, the top of the portion **24** being formed with a bearing aperture **28**.

All the parts that have just been described are to be found in conventional initial pinch plate bending machines (except that where the screw-gear **15** is also manually-operable, in some machines, the motorised drive **16** . . . **20** is omitted). In addition, a conventional machine has a top roll **29** (FIGURE 9) mounted between the bearing aperture **28** and the pivotable bearing mounting **21**, the top roll being driven from the bottom roll **5** through pinions **30, 31**, having deep teeth so as to remain in mesh throughout the range of adjustment of the vertical position of the roll **5** (as controlled by the screw-gear **12**) available to suit the thickness of plate being bent. The roll **29** also has a lever arm **32** extending to screw-down gear **33** operable, after removal of the end bearing **28** by downward swinging of the housing portion **24**, to swing the top roll **29** away from the bottom roll **5** for endwise withdrawal of the formed tube from around the roll **29**.

A tube **34** (FIGURE 7) is formed from a plate **35** which is first fed over the side roll **6** and into the nip of the rolls **5** and **29** (FIGURE 4), to be held while the side roll **6** is moved with respect to the other rolls to effect an initial bending of the edge **36** of the plate (FIGURE 5) into the required curvature, due allowance being made for spring-back of the plate material. The plate **35** is then removed and reversed, and fed into the nip of the rolls **5** and **29** from the opposite side (FIGURE 6). With the roll **6** in the same respective position as in FIGURE 5, formation of the tube **34** is completed by rolling as the rolls **5, 6, 29** are simultaneously driven.

FIGURE 8 shows how a tube **37** of smaller diameter than the tube **34** is rolled by bringing the side roll **6** closer to the top roll **29**.

The rolls **5, 6** are of a sufficient diameter in relation to their length to withstand the bending stresses, but the roll **29**—for forming tubes of small diameter in relation to their length—is liable to bend axially under the stresses, as shown in FIGURE 9, with a consequent adverse effect on the straightness of the tube. Whereas the rolls **5, 6** may be supported (in the case of a very long machine) at intervals along their length, the encircling of the roll **29** by the tube being formed, as well as its position remote from the base channels **3**, makes it difficult to support that roll against the bending stresses.

In FIGURES 1 to 3, the roll **29** around which a tube **34A** (FIGURE 1) is formed is rotatably mounted between the lower ends of a pair of adaptor arms **38, 39** and has a correspondingly shorter pinion **31A** meshing with the pinion **30** of the roll **5**, and the other ends of the adaptors are connected by a stiff fixed shaft **40**, which carries a pair of support brackets **41** for the roll **29A**. Each bracket **41** has a pair of transverse end plates **42** spaced apart by a short length of inverted T-section **43** and carries a pair of backing rollers **44** to bear on the roll **29A** just beyond the ends of the tube **34A**, so as to transmit bending stresses from the roll **29A** through the plates **42** to the shaft **40** (FIGURES 10 and 11). The stiffness of the shaft **40** thus provides added resistance against bending of the roll **29A**. The shaft **40** is provided with a lengthwise key **45** for engagement by keyways **46** in journals **47** in the end plates **42**, to enable the brackets **41** to be adjusted lengthwise of the shaft **40** for the backing rollers **44** to be set just beyond the ends of any tube length within the capacity of the machine, and the journals are split at **48** to enable the brackets to be clamped in adjusted position by screws **49**. The brackets **41** may also be interchangeable with other similar brackets of a size suitable for a different diameter of roll, in accordance with the diameter of tube to be formed. However, as is indicated by FIGURES 7 and 8, any top roll is suitable for a range of tube diameters, so that the top roll only requires changing when a range of lower order diameters is required.

The adaptor arm is provided with a spigot **50** to fit the bearing aperture **28** in the swinging portion **24** of the housing **1**, when the portion **24** is in upright position, the adaptor arm **38** also being provided with a removable bearing **51** for the journal **51A** of the roll **29A** and a removable socket **52** for a spigot **52A** on the end of the stiff shaft **40**, normally secured by means of set-screws **53** and washers **54**. The spigot **50** is tubular and has a cross-piece **55** welded into its free end to serve as a handgrip, while a cut-away **56** provides accommodation for and affords access to the lower set-screw **53** and washer **54**. The adaptor arm **39** is provided with a spigot **57** to fit the pivotable mounting **21**, with a lever arm **32A** extending from the spigot **57** to the screw-down gear **33**, so that the roll **29A** and stiff shaft **40** may be swung upwardly, after downward swinging of the housing portion **24** away from the spigot **50**, to facilitate removal of the adaptor arm **38** for endwise withdrawal of the formed tube **34A** and/or interchange of the brackets **41**. The other journal **58** of the roll **29** is removable endwise from a bearing **58A** in the adaptor arm **39** for replacement of a worn roll by a new one of the same diameter or substitution of a roll of a different diameter, while the stiff shaft **40** is permanently secured by welding to the adaptor arm **39**.

During rolling, the roll **29A** is subjected not only to stresses arising from the nip with the roll **5** but also to stresses arising from bending of the plate by the roll **6** (see FIGURE 11), so that the axis of the stiff shaft **40** is required to be offset from the vertical plane through the axis of the roll **29A** in order that the roller-carrying brackets **41** may have effect in substantially direct opposition to the resultant of the stresses applied through the plate material by the rolls **5, 6**. The adaptor arms **38, 39** are held at the necessary angle by providing the arm **39** with projections **59, 60** respectively above and below the spigot **57**, to fit in a vertical groove **61** in the pivotable mounting **21**.

What I claim is:

1. An initial pinch plate bending machine of the type comprising a roll around which a tube is to be formed by bending and rolling a plate, a second roll for forming with the first roll a nip through which the plate is to be passed, means for driving the two rolls, and a third roll movable with respect to the first and second rolls for effecting first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending and rolling of the rest of the plate, the machine being further provided with a stiff shaft, means for supporting the stiff shaft parallel to the first roll at substantially the opposite side of the first roll to the side along which the bending stresses will be applied through the plate material by the second and third rolls, a pair of brackets non-rotatably mounted on the stiff shaft, and a pair of backing rollers carried by each bracket to bear on the first roll just beyond the positions to be occupied by the ends of the tube to be formed, so as to transmit bending stresses from the first roll through the brackets to the stiff shaft.

2. An initial pinch plate bending machine as in claim 1, wherein the roller-carrying brackets are adjustable lengthwise of the stiff shaft, to enable the backing rollers to be set just beyond the positions to be occupied by the ends of a tube of any length within the capacity of the machine.

3. An initial pinch plate bending machine of the type comprising a roll around which a tube is formed by bending and rolling a plate, a second roll for forming with the first roll a nip through which the plate is to be passed, means for driving the two rolls, and a third roll movable with respect to the first and second rolls

for effecting first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending and rolling of the rest of the plate, the machine being further provided with a stiff cylindrical shaft, means for supporting the stiff shaft parallel to the first roll at substantially the opposite side of the first roll to the side along which the bending stresses will be applied through the plate material by the second and third rolls, a pair of brackets, journals in the brackets for closely fitting on the stiff shaft, a lengthwise key on the stiff shaft, keyways in the journals corresponding to the key on the stiff shaft, and a pair of backing rollers carried by each bracket to bear on the first roll just beyond the positions to be occupied by the ends of a tube of any length within the capacity of the machine, so as to transmit bending stresses from the first roll through the brackets to the stiff shaft.

4. An initial pinch plate bending machine as in claim 3, wherein the journals in the roller-carrying brackets are split, and screws are provided for clamping the split journals on the stiff shaft with the brackets adjusted lengthwise of the stiff shaft for the backing rollers to bear on the first roll just beyond the positions to be occupied by the ends of a tube of any length within the capacity of the machine.

5. An initial pinch plate bending machine of the type comprising a frame, a roll around which a tube is to be formed by bending and rolling a plate, a second roll for forming with the first roll a nip through which the plate is to be passed, means at one end of the frame for driving the two rolls, a third roll movable with respect to the first and second rolls for effecting first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending and rolling of the rest of the plate, a bearing at the driving end of the frame for one end of the first roll, a swinging frame portion at the other end of the frame, and a removable bearing in the swinging frame portion for the other end of the first roll, the machine being further provided with a stiff shaft, means at the driving end of the frame for supporting one end of the stiff shaft at substantially the opposite side of the first roll to the side along which the bending stresses will be applied through the plate material by the second and third rolls, an adaptor arm removably mounted in the swinging frame portion, a removable bearing at one end of the adaptor arm for the other end of the first roll, means at the other end of the adaptor arm for supporting the other end of the stiff shaft with the stiff shaft parallel to the first roll, a pair of brackets non-rotatably mounted on the stiff shaft, and a pair of backing rollers carried by each bracket to bear on the first roll just beyond the position to be occupied by the ends of the tube to be formed, the removable bearing permitting withdrawal of the formed tube from around the first roll after swinging of the swinging frame portion and removal of the said bearing.

6. An initial pinch plate bending machine of the type comprising a frame, a roll around which a tube is to be formed by bending and rolling a plate, a second roll for forming with the first roll a nip through which the plate is to be passed, means at one end of the frame for driving the two rolls, a third roll movable with respect to the first and second rolls for effecting first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending and rolling of the rest of the plate, a bearing at the driving end of the frame for one end of the first roll, a pivotal mounting for the bearing, a swinging frame portion at the other end of the frame, a removable bearing in the swinging frame portion for the other end of the first roll, a lever arm extending from the pivotal mounting, and screw-gear for operating on the free end of the lever arm, to balance the mounting of the first roll, after swinging of the swinging frame portion and removal of hte removable bearing to permit withdrawal of the formed tube from around the first roll, the machine being further provided with an adaptor arm removably mounted in the swinging frame portion, a removable bearing at one end of the adaptor arm for one end of the first roll, a stiff shaft, means at the other end of the adaptor arm for supporting one end of the stiff shaft at substantially the opposite side of the first roll to the side along which the bending stresses will be applied through the plate material by the second and third rolls, a second adaptor arm carried by the pivotal mounting, a bearing at one end of the second adaptor arm for the other end of the first roll, means at the other end of the second adaptor arm for supporting the other end of the stiff shaft with the said shaft parallel to the first roll, a pair of brackets non-rotatably mounted on the stiff shaft, and a pair of backing rollers carried by each bracket to bear on the first roll just beyond the positions to be occupied by the ends of the tube to be formed.

7. An initial pinch plate bending machine of the type comprising a frame, a roll around which a tube is to be formed by bending and rolling a plate, a second roll for forming with the first roll a nip through which the plate is to be passed, means at one end of the frame for driving the two rolls, a third roll movable with respect to the first and second rolls for effecting first an initial bending of one edge of the plate fed to the nip from the side to which the third roll lies and then, after removal and reversal of the plate and feeding of the plate to the other side of the nip, the required bending and rolling of the rest of the plate, a bearing at the driving end of the frame for one end of the first roll, a pivotal mounting for the bearing, a swinging frame portion at the other end of the frame, a removable bearing in the swinging frame portion for the other end of the first roll, a lever arm extending from the pivotal mounting, and screw-gear for operating on the free end of the lever arm, to balance the mounting of the first roll, after swinging of the swinging frame portion and removal of the removable bearing to permit withdrawal of the formed tube from around the first roll, the machine being further provided with an adaptor arm removably mounted in the swinging frame portion, a removable bearing at one end of the adaptor arm for one end of the first roll, a stiff cylindrical shaft, a removable support at the other end of the adaptor arm for supporting one end of the stiff shaft at substantially the opposite side of the first roll to the side along which the bending stresses will be applied through the plate material by the second and third rolls, a second adaptor arm carried by the pivotal mounting, a removable bearing at one end of the second adaptor arm for the other end of the first roll, means at the other end of the second adaptor arm for supporting the other end of the stiff shaft with the said shaft parallel to the first roll, a pair of brackets, split journals in the brackets for fitting the brackets on the stiff shaft, a lengthwise key on said shaft, keyways in the journals corresponding to the key on the shaft, a pair of backing rollers carried by each bracket, and screws for clamping the split journals on the stiff shaft with the brackets adjusted lengthwise of the stiff shaft for the backing rollers to bear on the first roll just beyond the positions to be occupied by the ends of a tube of any length within the capacity of the machine.

References Cited in the file of this patent

UNITED STATES PATENTS

160,647	Chapman	Mar. 9, 1875
518,765	Plecker	Apr. 24, 1894
2,432,666	Isenberg et al.	Dec. 16, 1947