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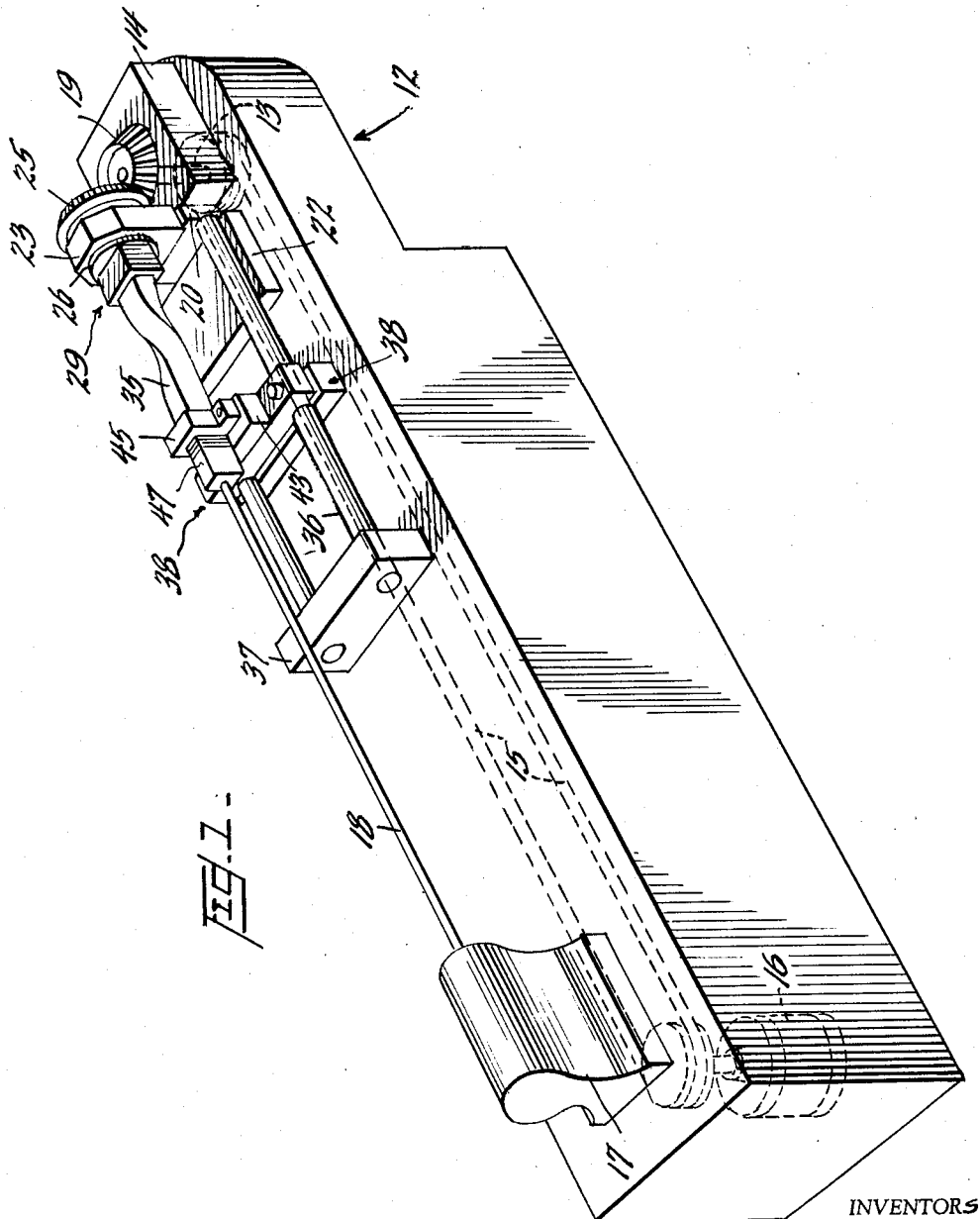
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2,902,080

APPARATUS FOR TWISTING WAVE GUIDES

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4 Sheets-Sheet 1



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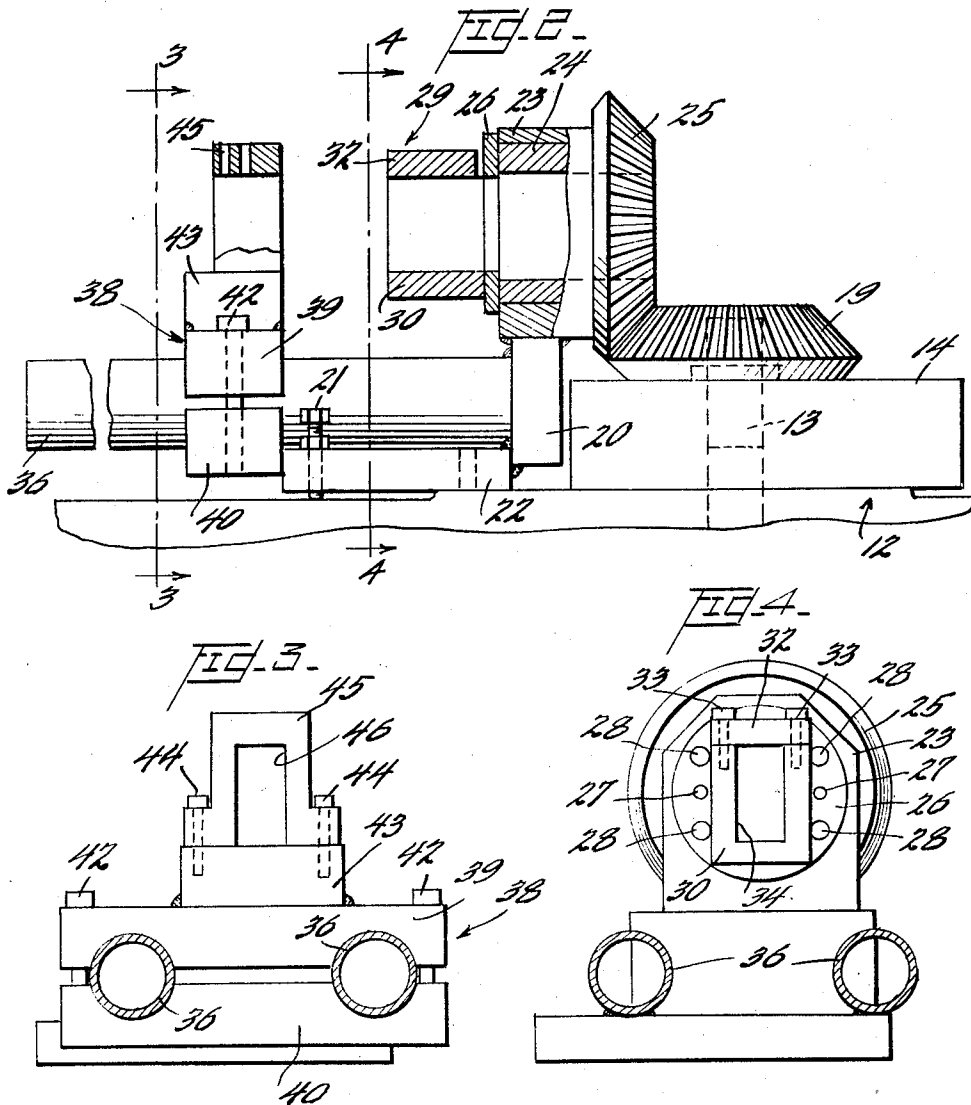
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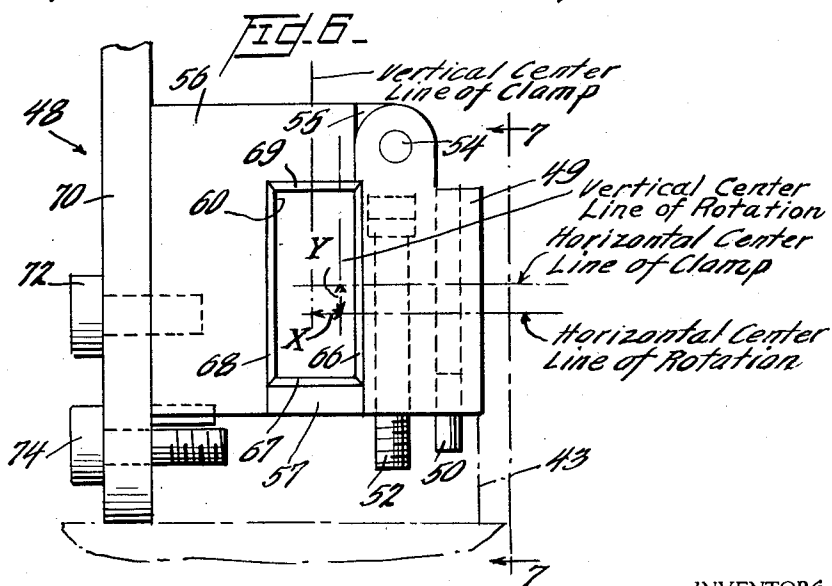
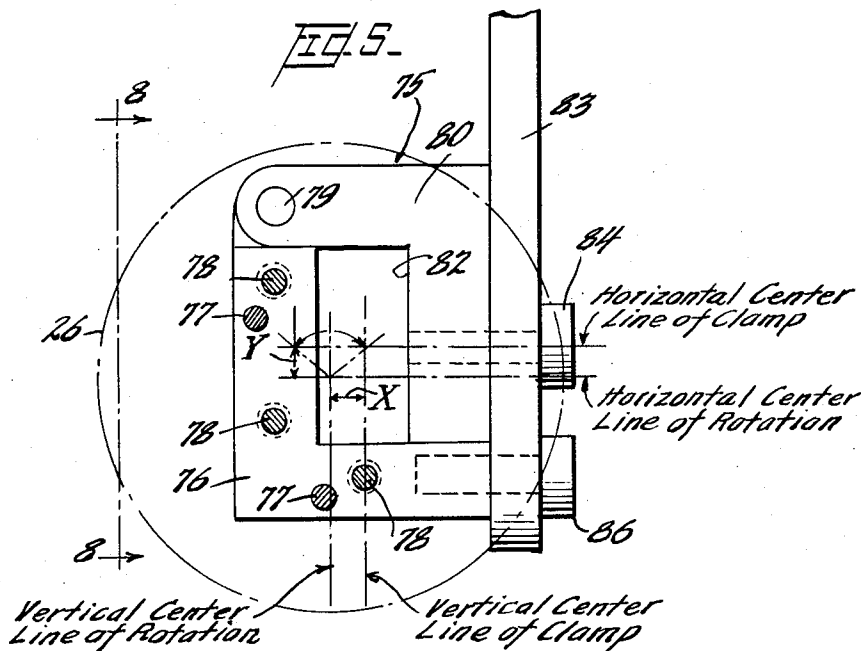
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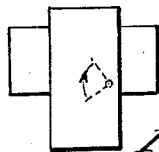
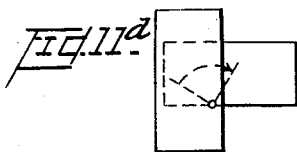
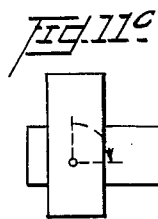
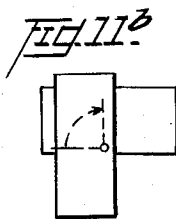
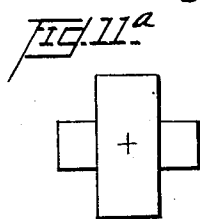
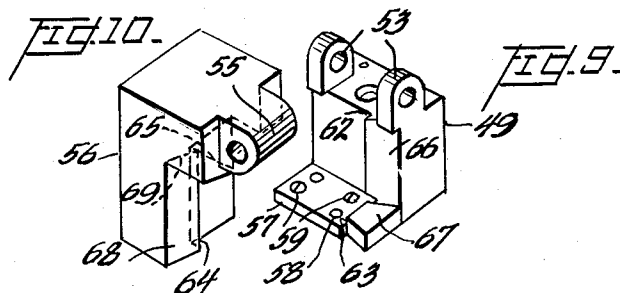
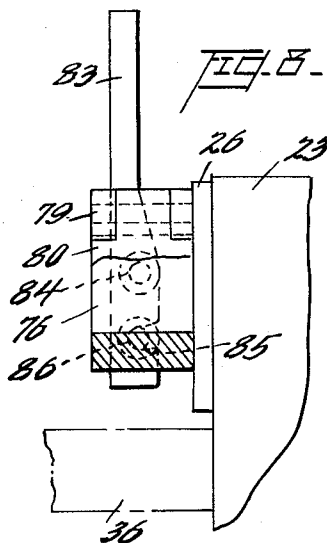
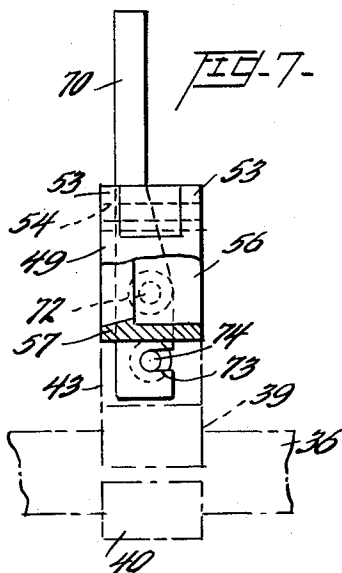
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APPARATUS FOR TWISTING WAVE GUIDES

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2,902,080

APPARATUS FOR TWISTING WAVE GUIDES

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Application November 4, 1953, Serial No. 390,224

3 Claims. (Cl. 153—78)

This invention relates to tube twisting apparatus and more particularly to apparatus for twisting thin-walled rectangular tubing such as wave guides.

In processes of manufacture of electrical assemblies utilizing rectangular wave guide tubing it frequently becomes necessary to connect a first wave guide to a second wave guide or other similar structural element located in a position out of alignment with the first wave guide.

Accordingly, it is an object of the present invention to provide apparatus for effecting a straight twist in a first rectangular tube in order to align the end of the tube with the end of a second rectangular tube or similar structure having its horizontal and vertical axes rotated relative to the corresponding axes of the first tube.

It is another object of the invention to provide an apparatus to effect a displaced twist in a first rectangular tube in order to align the end of the first tube with the end of a second rectangular tube having its horizontal and vertical axes rotated relative to the corresponding axes of the first tube and its longitudinal axis displaced vertically and/or horizontally relative to that of the first tube.

In accordance with the stated objects of the present invention, there is provided a base, a vertical shaft rotatably mounted upon the base, means to rotate the vertical shaft, a horizontally disposed mandrel reciprocally mounted upon the base, a horizontally disposed shaft rotatably mounted upon the base, bevel gears connecting the vertical and horizontal shafts, a slidable clamp mounted upon the base for longitudinal movement thereon and adapted to grip one extremity of the tubing to be twisted, a rotatable clamp mounted upon an extremity of the horizontal shaft and alignable with the slidable clamp to grip the other extremity of the tubing whereby the tubing is twisted when the rotatable clamp is actuated.

Other features and advantages of the invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective view of the tube twisting apparatus mounted upon a base such as a tube bending machine and showing a piece of rectangular tubing being given a straight twist;

Fig. 2 is a front elevational view, partially in cross section, of the twisting apparatus shown in Fig. 1;

Fig. 3 is an end elevational view of the twisting apparatus taken on line 3—3 of Fig. 2;

Fig. 4 is an end elevational view of the twisting apparatus taken on line 4—4 of Fig. 2;

Fig. 5 is an end elevational view of a modification of the rotatable clamp;

Fig. 6 is an end elevational view of a modification of the slidable clamp;

Fig. 7 is a side elevational view, partially in cross section, of the modified slidable clamp and is taken on line 7—7 of Fig. 6;

Fig. 8 is a side elevational view, partially in cross sec-

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tion, of the modified rotatable clamp and is taken on line 8—8 of Fig. 5;

Fig. 9 is a perspective view of a portion of the modified slidable clamp shown in Fig. 6;

Fig. 10 is a perspective view of another portion of the modified slidable clamp shown in Fig. 6;

Fig. 11(a) is a schematic end view of a piece of rectangular tubing showing the relative relationship of the ends of the tubing after the tubing has been twisted through an angle of 90 degrees;

Fig. 11(b) is a view similar to Fig. 11(a) and shows a tube after being subjected to a laterally displaced twist;

Fig. 11(c) is a view similar to Fig. 11(a) and shows a tube after being subjected to a vertically displaced twist;

Fig. 11(d) is a view similar to Fig. 11(a) and shows a tube after being subjected to a twisting operation having both lateral and vertical displacement components, and

Fig. 11(e) is a view similar to Fig. 11(a) and shows another possible type of displaced twist obtainable by proper selection of both lateral and vertical displacement components.

Referring now to the drawings wherein like reference numerals designate the same elements throughout the several views, and more particularly to Fig. 1, the numeral 12 designates generally a base such as a tube bending machine having a vertically rotatable shaft 13, a bending head 14, and actuating means to drive the shaft such as sprocket chain 15 and motor 16. The base 12 also has mounted thereon a fluid pressure cylinder 17 for reciprocally operating a mandrel shaft 18. Bending machines having these elements are in common use for effecting bends in tubing of circular cross section but are not effective to produce longitudinal twists in tubing. Accordingly, the present invention, in order to effect such twists and to utilize the structural elements and power means of such a bending machine, provides for the attachment to the vertical shaft 13 of a first bevel gear 19. Mounted upon the base 12 by suitable means such as supporting members 20 and 22, is an apertured sleeve 23 having rotatably mounted in the aperture thereof a horizontal shaft 24. Supporting member 22 is removably attached to the base 12 by suitable means such as bolts 21, whereby all structures attached to the supporting member 22 may be easily detached from the base 12. Secured to the forward or right-hand extremity (Figs. 1 and 2) of the horizontal shaft 24 is a second bevel gear 25 meshing with the first bevel gear 19, whereby the vertical rotation of the vertical shaft 13 is transformed into a horizontal rotation of the horizontal shaft 24. A mounting plate such as circular disk 26 having locating pins 27 (Fig. 4) secured therein is attached by suitable means such as screws 28 to the rearward or left-hand extremity (Figs. 1 and 2) of the horizontal shaft 24. A rotatable clamp, designated generally by the numeral 29, consists of a U-shaped portion 30, mounted by suitable means such as welding on the disk 26, and a yoke piece 32 removably attached to the U-shaped portion 30 as by screws 33. U-shaped portion 30 and yoke piece 32 define, in their assembled position, a passageway 34 of rectangular cross section for gripping one end portion of a rectangular tubing 35 (Fig. 1) to be twisted.

Secured to the supporting members 20 and 22 are tubular slideways 36 extending longitudinally of the bed of the bending machine and terminating in a block 37 which is removably mounted on the base 12. Mounted upon the slideways for longitudinal movement thereon is a slide member, generally denoted by the numeral 38, consisting of two complementary slide sections 39 and 40 which are held in proper position upon the slideways by suitable means such as bolts 42. Rigidly mounted upon the upper slide section 39 is a mounting block 43. Removably mounted upon the mounting block by suitable

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means such as screws 44 is a U-shaped clamp 45. The mounting block 43 and the clamp 45 define, in their assembled position, a passageway 46 of rectangular cross section for gripping the opposite end portion of the piece of rectangular tubing 35 to be twisted.

The operation of the above described twisting apparatus in effecting a straight twist in a piece of rectangular tubing is as hereinbelow described.

The slide member 38 is positioned on the slideways 36 in accordance with the length of tubing to be twisted. The horizontal shaft 24 is rotated until the U-shaped portion 30 is in an upright position as indicated in Fig. 4, and the yoke piece 32 of the rotatable clamp is removed from engagement with the U-shaped portion 30. The one end portion of a piece of tubing to be twisted is then placed in engagement with the U-shaped portion 30 with the opposite end portion of the tubing resting on the mounting block 43. The yoke piece 32 is then firmly secured to the U-shaped portion 30 by means of screws 33, thereby firmly gripping the end portion of the tubing, and the clamp 45 is placed in position over the other end portion of the tubing and firmly secured to the mounting block 43 by screws 44.

A suitable flexible mandrel 47 may be mounted on the end of the mandrel shaft 18 and the cylinder 17 then actuated to position the mandrel 47 inside the tubing as shown in Fig. 1. Such a mandrel 47 is disclosed in detail in co-pending application Serial No. 390,138, now Patent No. 2,868,266, filed on November 4, 1953. Alternatively, the tube may be filled with a supporting medium such as sand or a low melting point fusible metal prior to positioning the tube in the clamps. The actuating means such as motor 16 is then actuated to rotate vertical shaft 13, bevel gears 19 and 25, horizontal shaft 24, and the rotatable clamp 29 to effect the desired twist in the tubing as shown in Fig. 11(a).

In order to effect a displaced twist in a piece of rectangular tubing, the clamp 45, as disclosed in Figs. 1, 2 and 3, is replaced by a modified clamp designated generally as 48 (Figs. 6, 7, 9, 10) which comprises an upright portion 49 (Fig. 9) which is rigidly secured to the mounting block 43 by suitable means such as locating pins 50 and screws 52, and is provided with apertured projections 53 which are pivotally hinged by means of hinge pin 54 to an apertured projection 55 of a complementary L-shaped portion 56 (Fig. 10). A bottom portion 57 is rigidly connected to the mounting block 43 as by locating pins 58 and screws 59. Manifestly, upright portion 49 and bottom portion 57 could be incorporated into a unitary portion if desired. In the closed position portions 49, 56 and 57 define a rectangular passageway 60 (Fig. 6) for gripping one end portion of a piece of rectangular tubing to be twisted. Portion 49 is provided with shoulder 62, portion 57 is provided with shoulder 63 and portion 56 is provided with shoulders 64 and 65 (Figs. 9 and 10) said shoulders projecting inwardly at right angles to the longitudinal axis of the passageway 60 for abutment against the extremity of a positioned tube. Portions 49 and 57 are further provided with inclined or beveled surfaces 66 and 67 respectively, and portion 56 is provided with inclined or beveled surfaces 68 and 69, portions of which beveled surfaces are in juxtaposition when the assembled clamp is in the closed position, thereby preventing relative movement between the portions of the clamp. The beveled surfaces 66, 67, 68 and 69 further serve to form a flared guideway to aid in inserting a mandrel into the interior of a positioned tube. A locking handle 70 is pivotally connected by means of pivot pin 72 to the L-shaped portion 56 of the clamp 48, and is provided with a slot 73 for manual engagement with a locking pin 74 rigidly attached to the mounting block 43 for holding the clamp 48 in a closed position.

The clamp 48 is mounted upon the mounting block 43 in a position such that the horizontal and/or vertical

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center lines of the closed clamp and the positioned tube to be twisted are offset from the axis of rotation of the horizontal shaft 24 by a lateral offset distance X and/or a vertical offset distance Y (Fig. 6).

Similarly, the rotatable clamp 29, shown in Figs. 1, 2 and 4, is replaced by a modified rotatable clamp designated generally as 75 as shown in Figs. 5 and 8 which comprises a fixed L-shaped member 76 which is rigidly attached to the disk 26 by suitable means such as locating pins 77 and screws 78 and which is pivotally connected as by pivot pin 79 with a movable L-shaped member 80. Fixed member 76 and movable member 80, when in the closed position, define a rectangular passageway 82 for gripping an end portion of the tube to be twisted. A locking arm 83 is pivotally connected to member 80 as by pivot pin 84 and is manually engageable by means of a slot 85 (Fig. 8) with a locking rod 86 which is rigidly attached to member 76, thereby serving to lock the modified rotatable clamp in a closed position.

The horizontal and vertical center lines of the closed modified rotatable clamp 75, when in alignment with the closed modified clamp 48 are offset from the axis of rotation of the horizontal shaft 24 by the lateral offset distance X and/or the vertical offset distance Y.

In operation, to effect a displaced twist in a rectangular tube by use of the modified clamps disclosed above, the modified slidable clamp 48 is longitudinally positioned in accordance with the length of tubing to be twisted and the horizontal shaft 24 is rotated until the passageway 82 is in alignment with the passageway 60. Clamps 48 and 75 are then opened and a tube to be twisted is placed therein. Clamps 48 and 75 are then closed and locked. The tube may be pre-filled with a suitable plastic supporting medium or alternatively a mandrel, as disclosed in the noted co-pending application, may be inserted into the positioned tubing after which the horizontal shaft 24 is rotated through the desired angle of twist.

As shown by the dashed arcuate arrow in Fig. 5, the rotatable clamp may be rotated a full 90 degrees, and in the case where the horizontal offset X equals the vertical offset Y, thereby effecting a total lateral displacement equal to twice the lateral offset distance of the aligned clamps 48 and 75 from the axis of rotation of the horizontal shaft 24. By proper selection of the lateral and vertical offset distances a wide range of displacements may be obtained as exemplified by Fig. 11(b), 11(c), 11(d), and 11(e).

Thus it is evident that by use of the modified clamps and by proper selection of the mounting positions of the clamps relative to the axis of rotation, a wide range of displaced positions of the ends of the tubing to be twisted may be obtained as exemplified by Figs. 11(b) through 11(e).

Manifestly the invention is not restricted to use with a bending machine as described herein. It is evident that the horizontal shaft could be mounted upon any suitable base and provided with any suitable means for rotation of the horizontal shaft.

Similarly, the invention is not restricted to apparatus for twisting rectangular tubing, but is suitable for twisting any tubing having an internal cross-sectional configuration other than circular, such as hexagonal, octagonal, etc.

It is to be further understood that numerous other modifications of the invention as disclosed herein may be made without departing from the spirit and scope thereof.

What is claimed is:

1. An apparatus for imparting a longitudinal twist to tubing of rectangular cross section comprising a base, a horizontally disposed shaft rotatably mounted on the base, means to rotate the shaft, a mounting plate rigidly attached to one extremity of the shaft, a longitudinally disposed slideway mounted on the base, a slide member

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slidably mounted on the slideway, a first clamp mounted on the slide member in a position such that the center line of the first clamp is offset from the axis of rotation of the shaft by a distance predetermined by the desired amount of displacement of the ends of the twisted tubing, said first clamp including an upright portion rigidly mounted on the slide member, an L-shaped portion pivotally connected to the upright portion and a bottom portion rigidly attached to the slide member, said upright portion, L-shaped portion and bottom portion being provided with shoulders and beveled surfaces whereby when the first clamp is closed said beveled surfaces interlock to prevent relative movement between the portions and to form a flared guideway and whereby the shoulders of each portion are positioned so as to form about the periphery of a rectangular aperture formed by the interlocked portions a continuous shoulder for abutting an extremity of the tubing to be twisted, said first clamp also being provided with a locking handle pivoted in the L-shaped portion and having a slot adapted to be manually engaged with a locking pin rigidly attached to the slide member to hold the first clamp in a closed position, a second clamp including a first L-shaped member rigidly attached to the mounting plate, a second L-shaped member pivotally connected to the first member and a hooked locking arm pivotally connected to the second member and manually engageable with a locking rod to hold the second clamp in a closed position, said first and second L-shaped members forming in the closed position a rectangular aperture alignable with the aperture of the first clamp, a mandrel for supporting the interior of the tubing during the twisting operation, said mandrel being reciprocally mounted on the base and aligned with the flared guideway formed by the portions of the first clamp, and means to move the mandrel into and out of the tubing.

2. Apparatus for holding and twisting rectangular tubing comprising a base, a shaft rotatably mounted on the base, means to rotate the shaft, a slide member mounted on the base and movable parallel to the axis of rotation of the shaft, first clamping means mounted on the slide member in a position offset from the axis of rotation of the shaft, said first clamping means including an upright portion rigidly attached to the slide member, an L-shaped portion pivotally connected to the upright portion, a bottom portion rigidly attached to the slide member and a first locking handle pivotally connected to the L-shaped portion and manually engageable with a first locking pin rigidly attached to the slide member to hold the first clamping means in a closed position wherein the portions define a rectangular aperture for receipt therein of the tubing and having its longitudinal axis parallel to the axis of rotation of the shaft, the sides of the portions forming said aperture being provided with shoulders projecting inwardly at right angles to the longitudinal axis of the aperture, said shoulders in the closed position of the first clamping means defining a continuous rectangular surface for abutment with an extremity of the tubing to be twisted, said portions being further provided with inclined surfaces between the edges of the shoulders and an outlet of the aperture, said inclined surfaces interlocking with one another to prevent relative movement between the portions, a second clamping means including a first L-shaped member rigidly secured to an extremity

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of the shaft, a second L-shaped member pivotally connected to said first member, a second locking pin secured to said first member and a second locking handle manually engageable with said second pin to hold the second clamping means in a closed position wherein said members define a rectangular aperture alignable with the aperture of the first clamping means, a mandrel for supporting the inside of the tubing during twisting, and means to move the mandrel into and out of engagement with the tubing.

3. In a tube bending machine of the type having a vertically disposed rotatable shaft, means to rotate the shaft and mandrel means for supporting the interior of the tube, the improvement which comprises a horizontally disposed shaft rotatably mounted upon the bending machine, a first clamp mounted on the bending machine and slidable thereon in a direction parallel to the axis of rotation of the horizontal shaft, said first clamp including a pair of relatively pivotable L-shaped jaws, said jaws when closed forming a passageway of rectangular cross section for gripping a rearward portion of a rectangular tube, shoulders formed on the jaws and projecting into the passageway for abutment with the rearward extremity of the positioned tube, beveled surfaces formed on the jaws and extending from the shoulders to the rearward opening of the passageway, portions of said beveled surfaces being in juxtaposition when the jaws are closed to reduce relative movement between said jaws and to facilitate the entry of the mandrel means into the positioned tube and means to lock said jaws together to hold the tube unyieldingly, a second clamp mounted on the horizontal shaft and rotatable therewith, said second clamp including a pair of relatively pivotable L-shaped members, said members when closed forming a rectangular passageway alignable with the passageway of the first clamp and adapted for receipt therein of a forward portion of the tube and means to lock said members together to hold said forward portion of the tube unyieldingly, and means connecting the vertical shaft and the horizontal shaft whereby rotation of said vertical shaft rotates the second clamp and thereby produces a twist in the rectangular tube.

References Cited in the file of this patent

UNITED STATES PATENTS

475,181	Burton	May 17, 1892
757,592	Atwood	Apr. 19, 1904
1,687,143	Richards	Oct. 9, 1928
1,690,724	Frederick	Nov. 6, 1928
1,826,077	Johnson	Oct. 6, 1931
1,958,982	Wintercorn	May 15, 1934
2,039,646	Horsington	May 5, 1936
2,701,002	Arbogast	Feb. 1, 1955

FOREIGN PATENTS

1,739	Great Britain	of 1867
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OTHER REFERENCES

The disclosure on page 208 of the book, Microwave Transmission Circuits, edited by George L. Ragan, published by the McGraw-Hill Book Company, Inc., in 1948 and copyrighted on May 21, 1948. (A copy of this book can be found in Division 69 of U.S. Patent Office.)