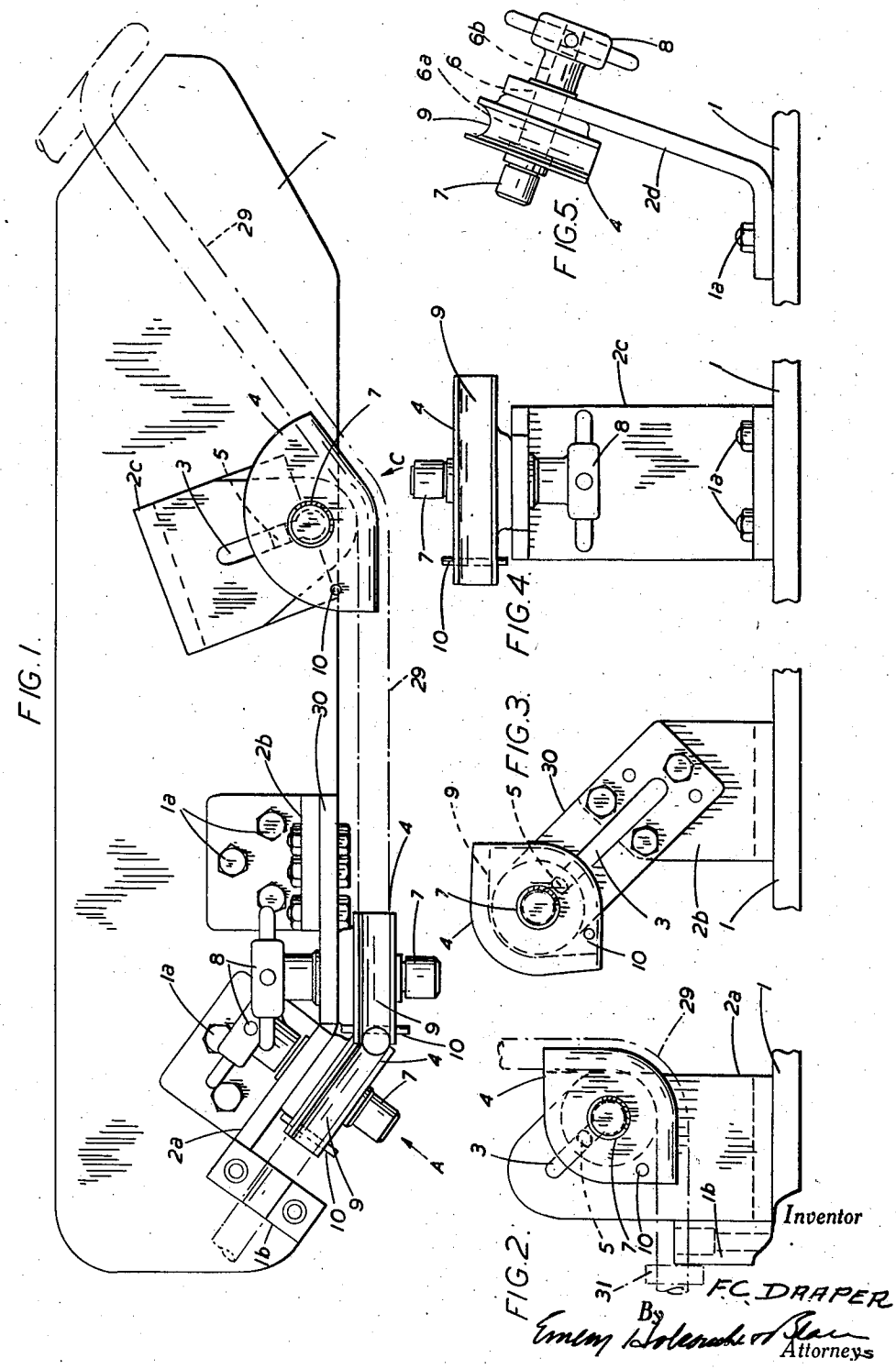
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APPLIANCE FOR BENDING TUBING

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APPLIANCE FOR BENDING TUBING

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FIG. 6.

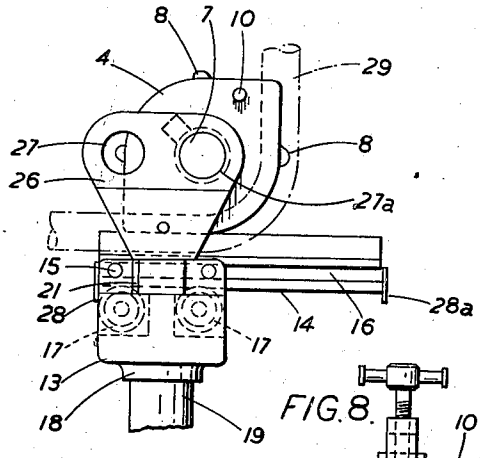


FIG. 7.

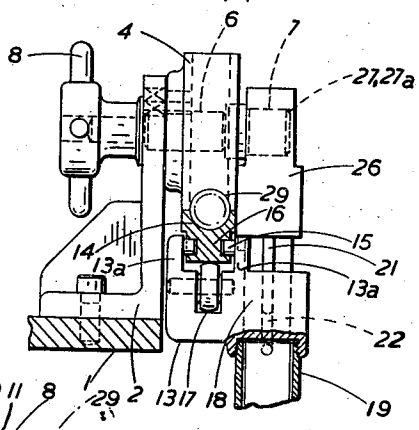
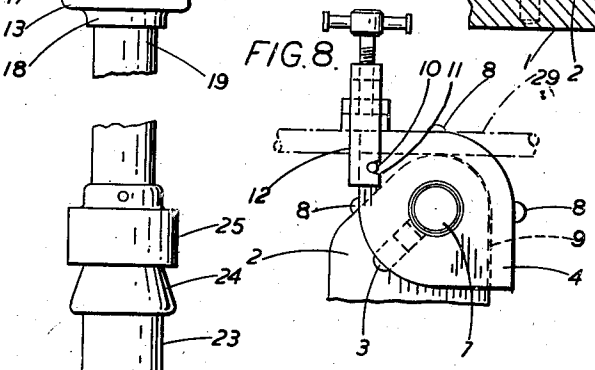
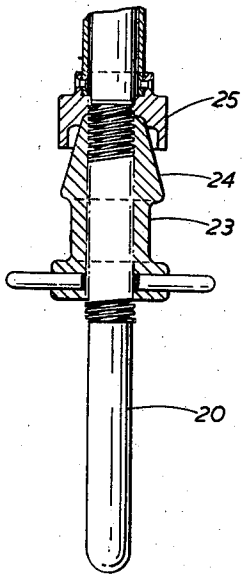


FIG. 8.





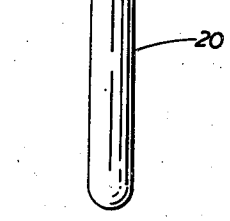
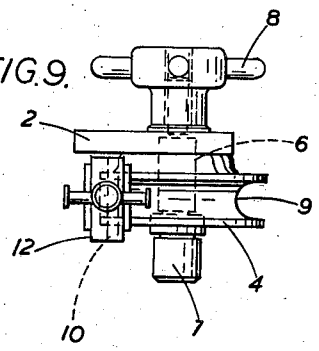


FIG. 9.



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UNITED STATES PATENT OFFICE

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APPLIANCE FOR BENDING TUBING

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Application January 27, 1943, Serial No. 473,737
In Great Britain April 22, 1941

6 Claims. (Cl. 153—45)

This invention relates to the bending of tubes and is particularly applicable to the formation of a number of bends in a length of tube of metal which can be bent in the cold and, for example, of metal such as annealed copper, mild steel or aluminium alloys which have been normalised.

The object of the invention is to provide bending appliances which enable bends to be formed in tubes expeditiously by means of unskilled labour and as free as possible from deformations of the cross-sections of the tubes such as may be occasioned by kinks, flattening on the outside of the bend and wrinkling on the inside of the bend.

The invention is in fact concerned with tools for use in the method of bending which is well known and in which profiled forming dies are employed, the tube to be bent being clamped at one point to the die and bent down into contact with the profile by a lever-like tool which can exert pressure on the outer surface of the tubes. In machines which have been proposed for that purpose, a handle or shaft to be used as the bending lever was to be pivoted to the forming die at the centre of the arc-shaped portion of the profile and a grooved slipper or block with a straight working surface, arranged in a part of the tool forming a housing for the slipper so as to be pressed into contact with the tube to be bent and so as to be capable of sliding in the housing, the pressure being applied by a roller on the back of the slipper at a point opposite the pivot of the handle.

The present invention provides a form of bending appliance in which the bending is rendered more gradual by providing a second roller to press upon the back of the slipper at a point in advance, in the direction of bending, of the roller which is opposite the pivot and which thus acts at the point of maximum bending moment while the housing in which the slipper is arranged to slide is itself arranged to slide relatively to the head of the appliance and to be secured to the head when the slipper has been brought into contact with the tube to be bent. Such an appliance made in accordance with the invention may be readily arranged for making both clockwise and counterclockwise bends by forming in its head two alternative apertures for engagement with the pivot on the forming die, each having its axis in a plane at right-angles to the length of the slipper and containing the axis of one of the said two rollers; then if one of the apertures is utilised, the roller opposite it bears on the slipper at the point of maximum bending moment and, in effecting the bend, the appliance is turned about the pivot in the direction such that the other roller bears on the slipper at a point in advance of the point of maximum bending moment.

In a particular form of construction, the said housing is carried by a sleeve which is arranged to slide on but not to turn with respect to the shaft so that the slipper may be brought into contact with the tube to be bent and held by moving the sleeve along the shaft and securing it in position. The slipper may be arranged to slide in a channel between cheeks in the housing which is furnished with pins or projections engaging in grooves in the sides of the slipper. In order to prevent the slipper leaving the housing and to limit the amount of the relative displacement between the slipper and its housing, the slipper may be provided with a stop plate at each end in position to be engaged by one or other of the rollers.

The forming die has to be fixed rigidly in position and, for that purpose, a bracket with a seating or bedding surface for the die may be provided with a key-hole slot to receive a bolt by means of which the forming die is secured and which also constitutes the pivot for the bending appliance; the forming die may then be prevented from rotation by providing a projection integral with it which also engages the slot in the bracket. The tube to be bent may be held against the forming die to prevent springback by a screw cramp which is secured to the die by a pin fixed to the latter engaging a notch in the side of the body of the cramp.

The invention obviously can be utilised in bending machines in which a number of forming dies having arcuate profiles of different radii are secured to brackets mounted on a bed in such positions that a number of successive bends can be made conveniently in a single length of tubing. Such supporting brackets can be made of appropriate shapes and with their seating surfaces set at appropriate angles in order that bends may be easily made in planes at any desired relative angles and at any desired points along the length of tubing.

In order that the invention may be clearly understood and readily carried into effect, an example of a bending appliance and examples of forming dies with which it may be employed will now be more fully described with reference to the accompanying drawings in which:

Figure 1 is a plan of a bending machine ac-

cording to the invention equipped with a number of forming dies having profiles of different radii for use in forming a number of bends in succession, in different planes, in a length of tube;

Figure 2 is an elevation as seen in the direction of the arrow A in Figure 1, of one of the forming dies and its supporting bracket;

Figure 3 is a similar view of a second forming die and bracket as seen in the direction of the arrow B in Figure 1;

Figure 4 is a similar view of a third form of forming die and bracket as seen in the direction of the arrow C in Figure 1; while

Figure 5 is a similar elevation of a fourth embodiment of forming die and bracket for forming bends in a plane intersecting those of the bends formed by the dies shown in Figures 2 to 4;

Figure 6 is a side elevation of a bending tool or appliance adapted for use in bending tubes on the forming dies shown in Figures 2 to 5, the appliance being shown in co-operation with a forming die according to Figure 2 or Figure 3;

Figure 7 is an elevation of the appliance seen at right-angles to Figure 6, with certain parts in section;

Figure 8 is an elevation of a forming die with a cramp in position for holding the tube to be bent to the forming die at the entering point of the latter; and

Figure 9 is a plan view of the device shown in Figure 8;

In Figures 1 to 5 of the drawings, 1 is the bed-plate of the bending machine to which four brackets 2*a*, 2*b*, 2*c*, and 2*d* of different configurations are secured by screws 1*a*. The brackets serve for anchoring in position the four forming dies 4 so as to enable four bends to be formed in succession in a single length of tube 29 in different planes.

It will be seen that each of the forming dies 4 consists of a steel plate with a profiled periphery of a shape to give the desired shape to the bend; the profile consists of an arc-shaped portion with a straight or flat portion to either side, to limit the amount of overbend. However, the shape of the forming die is usually not the final shape of the tube desired but is made to allow for a slight spring-back of the tube when the latter is released from engagement with the die. The periphery of each forming die 4 is formed with a groove 9 having a cross-section conforming to one half of the outside of the tube to be bent.

Each forming die is bedded on to a flat surface of its bracket 2*a*, 2*b*, 2*c*, or 2*d*, which is shaped to lie in a plane parallel to that in which the respective bend is to be made. Thus, the bedding surfaces of the brackets 2*a* and 2*b* are vertical, while that of the bracket 2*c* is horizontal and that of the bracket 2*d* is inclined. The bracket 2*b* is furnished with a cranked part 30 on which its bedding surface is formed.

Each forming die 4 is fixed on the bedding surface of the bracket 2*a*, 2*b*, 2*c*, 2*d* and secured in position by the following means. A slot 3 of key-hole form is provided in each of the brackets and a bolt 6 engages a hole in the forming die, the axis of which lies at the centre of the arc-shaped portion of the profile of the forming die 4. The shank of the bolt 6 has a part 6*a* which fits the enlarged end of the key-hole slot 3 and a screw-threaded part 6*b* of smaller diameter which can slide in the narrower part of the key-hole slot 3. The forming die 4 is locked in position by tightening up a nut 8 on to the bolt 6 so as to draw the larger part 6*a* of its shank into the enlarged end of the key-hole slot 3. In this way, the parts are prevented from sliding in the slot 3 and rotation of the forming die 4 is prevented by engagement of a pin 5 integral with the forming die 4 in the narrow part of the slot 3. The forming dies 4 can be readily moved out of the way when necessary to avoid obstructing the sweep of the tube being bent on a previous die. This is effected by loosening the nut 8 sufficiently and pushing the bolt 6 axially until the smaller part 6*b* of its shank engages in the slot 3 when the whole can slide along the slot 3. Then when it is desired to position the forming die 4 accurately and lock it in position, the bolt 6 is caused to slide along the slot 3 until it engages the enlarged end of the slot, whereupon the nut 8 is tightened to draw the larger part 6*a* of the bolt 6 into the slot 3. The bolt 6 is formed with a cheese head 7 which also serves as a pivot for the bending tool or appliance as will be explained below.

In making a bend in the tube 29, the part of the tube where it enters the groove 9 in the forming die 4 has to be held firmly against the die so as to prevent it from being sprung away from the die 3 during the bending operation. A simple arrangement for this purpose is shown in Figures 8 and 9. A further pin 10 projects from the face of the forming die 4 in position to engage a notch 11 in the body of a screw cramp 12. When this cramp 12 is tightened, it effectively holds the tube 29 at the entering point in the groove 9 in the forming die 4.

The tube 29, thus held in position, is bent into contact with the profile of the forming die 4 by means of the tool or appliance shown in Figures 6 and 7. In those figures, the appliance is shown in position engaging the head 7 of the bolt 6 which thus forms the pivot for the appliance to turn with respect to the forming die 4 which is locked to the bracket 2*a* in the manner already described.

The appliance consists of a handle or shaft 20 having at its upper end a head 26 provided with two holes 27, 27*a*, either of which can be made to engage over the pivot 7, and a block comprising a sleeve 19 screwed into a housing 13 for a shoe or slipper 14. The sleeve 19 is prevented from turning on the handle 20 by a key 21 engaging a keyway 22 in the part 18 of the housing 13, but the sleeve can slide over the handle 20 to bring the slipper 14 towards or away from the tube 29 to be bent and, in order to hold the slipper 14 in contact with the tube 29, a nut 23 with a conical nose 24 entering a socket 25 on the sleeve 19 is arranged to screw on the handle 20 so that when tightened up, it maintains the slipper 14 in contact with the tube 29. In this way, the hand appliance is arranged to effect bends on forming dies of different radii with the minimum of readjustment. The slipper 14 is a bar with a straight upper working surface but with its upper surface shaped to conform with the cross-section of the tube 29; it is housed between cheeks 13*a* of the housing 13 to slide in the channel between those cheeks. The cheeks 13*a* are provided with pins 15 engaging in channels 16 in the slipper 14. Below the slipper 14, a pair of thrust rollers 17 are journalled in the housing 13 and it will be observed that the axis of each of the rollers 17 lies in a plane at right-angles to the slipper 14 which also passes through the axis of one of the holes 27, 27*a*. The pur-

pose of that arrangement is as follows. When one of the holes, for example, as shown in Figure 6, the hole 27*a*, engages the pivot 7, one of the rollers 17 is immediately opposite the pivot 7 while the other roller 17 is laterally offset. In Figure 6, the bend has just been completed by a clockwise turning of the handle 20 about the pivot 7. Therefore, during the bending, the right-hand roller 17 maintains contact between the slipper 14 and the forming die at the point of maximum bending moment, while the left-hand roller 17 is in advance of that point in the direction of bending and thrusts on the slipper 14 to effect the first stage in bending the tube 29. If a counterclockwise bend is to be made, the hole 27 is engaged with the pivot 7 and the functions of the two rollers 17 are interchanged, the right-hand roller 17 then being in advance of the point of maximum bending moment in the direction of bending. During the bending operation, the slipper 14 slides in the housing 13 but does not slide relatively to the tube 29. The slipper 14 is furnished with stop plates 28, 28*a* at its ends to prevent the slipper leaving the housing and to limit the displacement of the slipper 14 with respect to the rollers 17 and consequently with respect to the housing 13.

The course of an operation consisting in making a number of bends in a length of tube 29 can be described with reference to Figures 1 to 5. In the case of a thin-walled tube, it is first filled with a material which will prevent the tube walls from collapsing or becoming distorted in the neighbourhood of the bends. For this purpose, a powdered material may be used or a material which can be introduced in the molten condition and allowed to solidify within the tube. The tube 29 is then set by bringing a collar or union 31 clamped to it against a setting stop 1*b* fixed by screws to the bed-plate 1 and the tube is next clamped at the point to be bent to the left-hand side of the first forming die 4 as seen in Figures 1 and 2. The appliance shown in Figures 6 and 7 with the nut 23 slacked back is applied to the pivot 7, the hole 27 being used as a counterclockwise bend is to be made. The second forming die 4 shown in Figure 3 is moved out of the way by loosening the nut 8 and sliding the bolt 6 down the slot 3 as already described. The slipper 14 is located below the tube 29 and brought up into contact with it by tightening the nut 23 and the bend effected by a counterclockwise movement of the handle 20 so that the tube 29 is given the shape seen in Figure 2, the slipper 14 "ironing out" the tube on the straight profile of the forming die to ensure the correct bend. The tube 29 is next clamped at the appropriate point to the second forming die 4 shown in Figure 3 after that die has been locked in its correct position. While the first forming die 4 supports the part of the tube 29 which has been bent, a second bend is then made in a similar way to the first except that, as it is a clockwise bend, the hole 27*a* is brought into engagement with the pivot 7. Successive bends may then be made around the forming dies 4 shown in Figures 4 and 5 in a similar way to the first bends, whereupon all cramps as shown in Figures 8 and 9 are removed, the forming dies 4 withdrawn and the tube 29 is removed in the finished state. The forming die 4 and its bracket 2*d* shown in Figure 5 are not, of course, shown in position on the bed-plate 1 in Figure 1.

I claim:

1. An appliance for bending tubing to conform to the profile of a forming die comprising, a shaft with an integral head formed with a pair of alternative apertures for engaging a pivot on the forming die and relatively displaced perpendicular to the axis of said shaft, a housing slidably mounted on said shaft, a bearing slipper slidably mounted in said housing to be moved with the latter into contact with the tubing to be bent, a roller mounted in said housing to bear upon the rear face of said slipper and journaled about an axis lying substantially in a plane perpendicular to the length of said slipper and passing through the axis of one of said apertures and a second roller also mounted in said housing to bear upon the rear face of said slipper and journalled about an axis lying substantially in a second plane perpendicular to the length of said slipper and passing through the axis of the second of said apertures.

2. An appliance for bending tubing to conform to the profile of a forming die comprising, a shaft with an integral head formed with a pair of alternative apertures for engaging a pivot on the forming die and relatively displaced perpendicular to the axis of said shaft, a housing slidably mounted on said shaft and formed with a channel directed transversely to said shaft, a bearing slipper mounted to slide in said channel and to move with said housing into contact with the tubing to be bent, a plurality of projections directed inwardly from each of the side walls of said channel to engage in longitudinal grooves in the sides of said slipper, a roller mounted in said housing to bear upon the rear face of said slipper and journalled about an axis lying substantially in a plane perpendicular to the length of said slipper and passing through the axis of one of said apertures and a second roller also mounted in said housing to bear upon the rear face of said slipper and journalled about an axis lying substantially in a second plane perpendicular to the length of said slipper and passing through the axis of the second of said apertures.

3. An appliance for bending tubing to conform to the profile of a forming die comprising, a shaft with an integral head formed with a pair of alternative apertures for engaging a pivot on the forming die and relatively displaced perpendicular to the axis of said shaft, a housing slidably mounted on said shaft, a bearing slipper slidably mounted in said housing to be moved with the latter into contact with the tubing to be bent, a roller mounted in said housing to bear upon the rear face of said slipper and journalled about an axis lying substantially in a plane perpendicular to the length of said slipper and passing through the axis of one of said apertures, a second roller also mounted in said housing to bear upon the rear face of said slipper and journalled about an axis lying substantially in a second plane perpendicular to the length of said slipper and passing through the axis of the second of said apertures, and a stop plate secured to said slipper at each end thereof in position to be contacted by one of said rollers in each of the limiting positions of said housing relatively to said slipper.

4. An appliance for bending tubing comprising, a die-supporting bracket plate formed with a key-hole slot, a profiled plate constituting a forming die, a bolt passing through said profiled plate and engaging said key-hole slot to form a pivot for a bending tool, said bolt having a portion of larger diameter to fit the enlarged end of said

key-hole slot and a portion of smaller diameter to slide in said key-hole slot, a nut in threaded engagement with said bolt to draw the portion of larger diameter thereof into the enlarged end of said key-hole slot to position and secure said profiled plate to said supporting bracket plate and, on being slackened, to permit the portion of said bolt of smaller diameter to slide in said key-hole slot and a projection integral with said profiled plate to engage said key-hole slot and prevent rotation of said profiled plate when same is secured to said supporting bracket plate.

5. An appliance for bending tubing comprising, a die-supporting bracket plate formed with a key-hole slot, a profiled plate constituting a forming die, a bolt passing through said profiled plate and engaging said key-hole slot to form a pivot for a bending tool, a nut in threaded engagement with said bolt for clamping said profiled plate to said die-supporting bracket plate, a projection integral with said profiled plate and engaging said key-hole slot to prevent rotation of said profiled plate relatively to said supporting bracket plate, a peg projecting from the face of said profiled plate in the neighbourhood of the entering end of the profile thereof, and a screw-cramp formed with a notch engaged by said peg to enable the tubing to be bent to be held against the profile of said profiled plate at the entering end thereof.

6. An appliance for bending tubing comprising, a die-supporting bracket plate formed with a key-hole slot, a profiled plate constituting a forming die, a bolt passing through said profiled plate and engaging said key-hole slot to form a pivot for a bending tool, said bolt having a portion of larger diameter to fit the enlarged end of said key-hole slot and a portion of smaller diameter to slide in said key-hole slot, a nut in threaded engagement with said bolt to draw the portion of larger diameter thereof into the enlarged end of said key-hole slot to position and secure said profiled plate to said supporting bracket plate and, on being slackened, to permit the portion of said bolt of smaller diameter to slide in said key-hole slot, a projection integral with said profiled plate to engage said key-hole slot and prevent rotation of said profiled plate when same is secured to said supporting bracket plate, a peg projecting from the face of said profiled plate in the neighbourhood of the entering end of the profile thereof, and a screw-clamp formed with a notch engaged by said peg to enable the tubing to be bent to be held against the profile of said profiled plate at the entering end thereof.

FREDERICK CECIL DRAPER.