

Dec. 26, 1944.

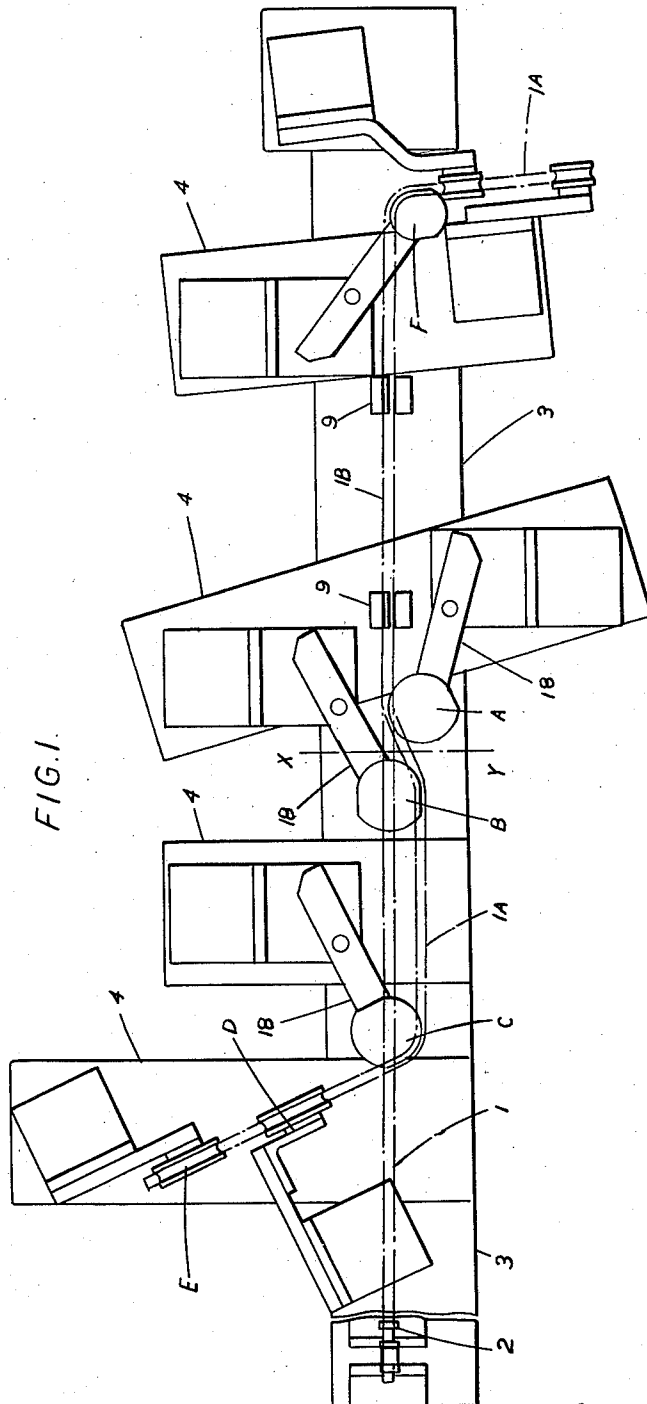
F. C. DRAPER ET AL

2,366,012

APPLIANCE FOR BENDING TUBES, RODS, AND THE LIKE

Filed Aug. 25, 1943

5 Sheets-Sheet 1



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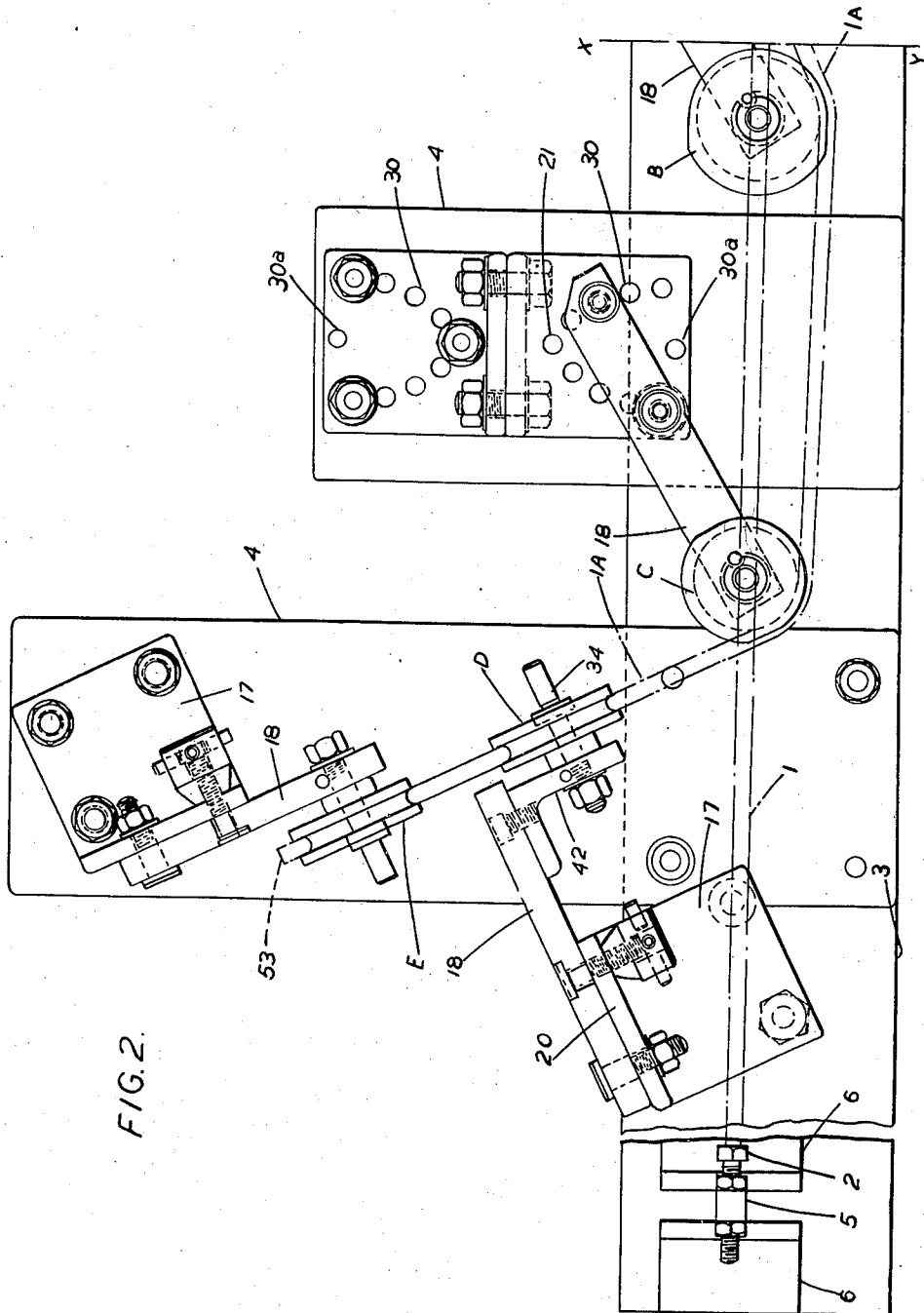


FIG. 2.

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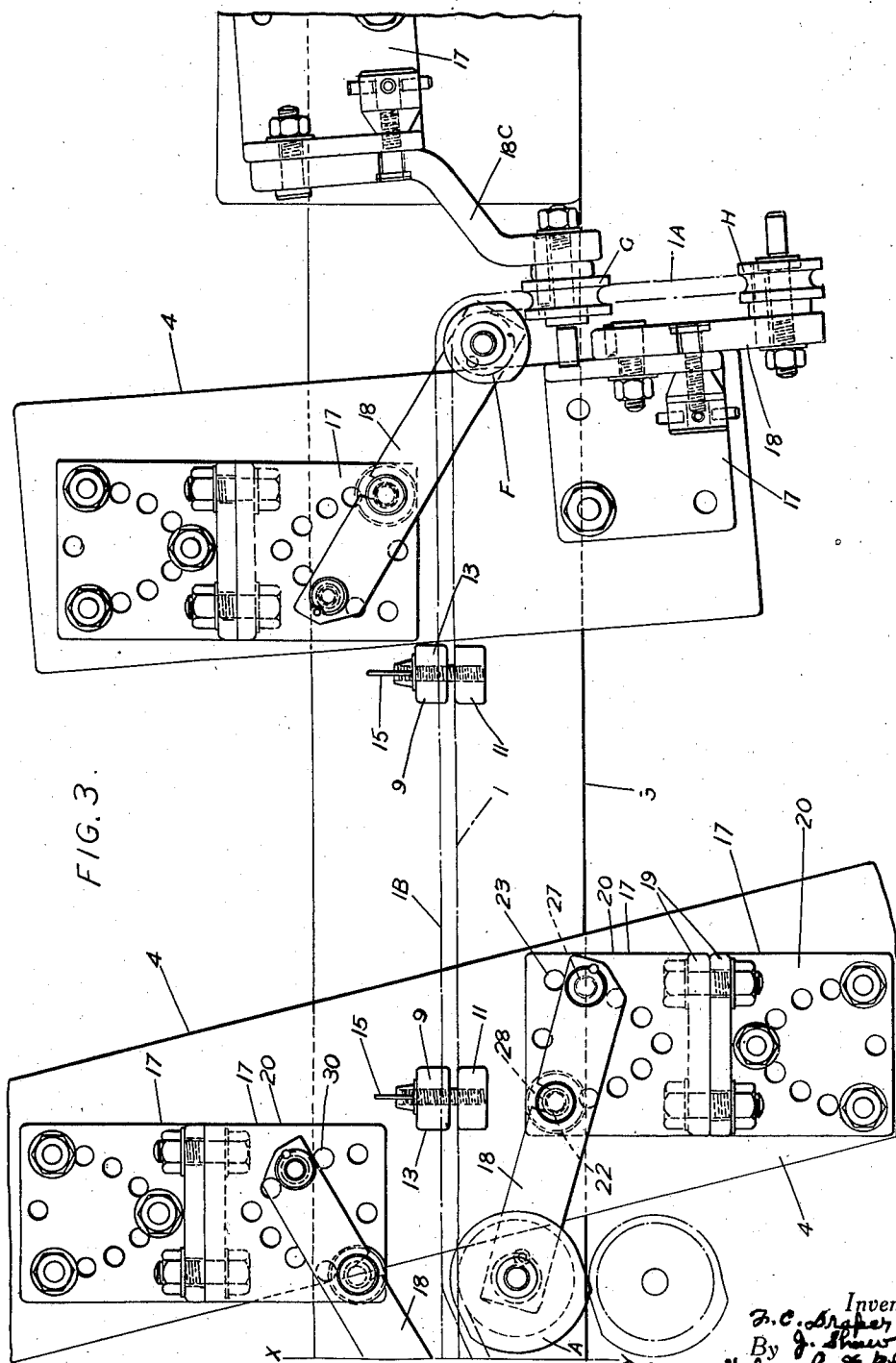
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5 Sheets-Sheet 3



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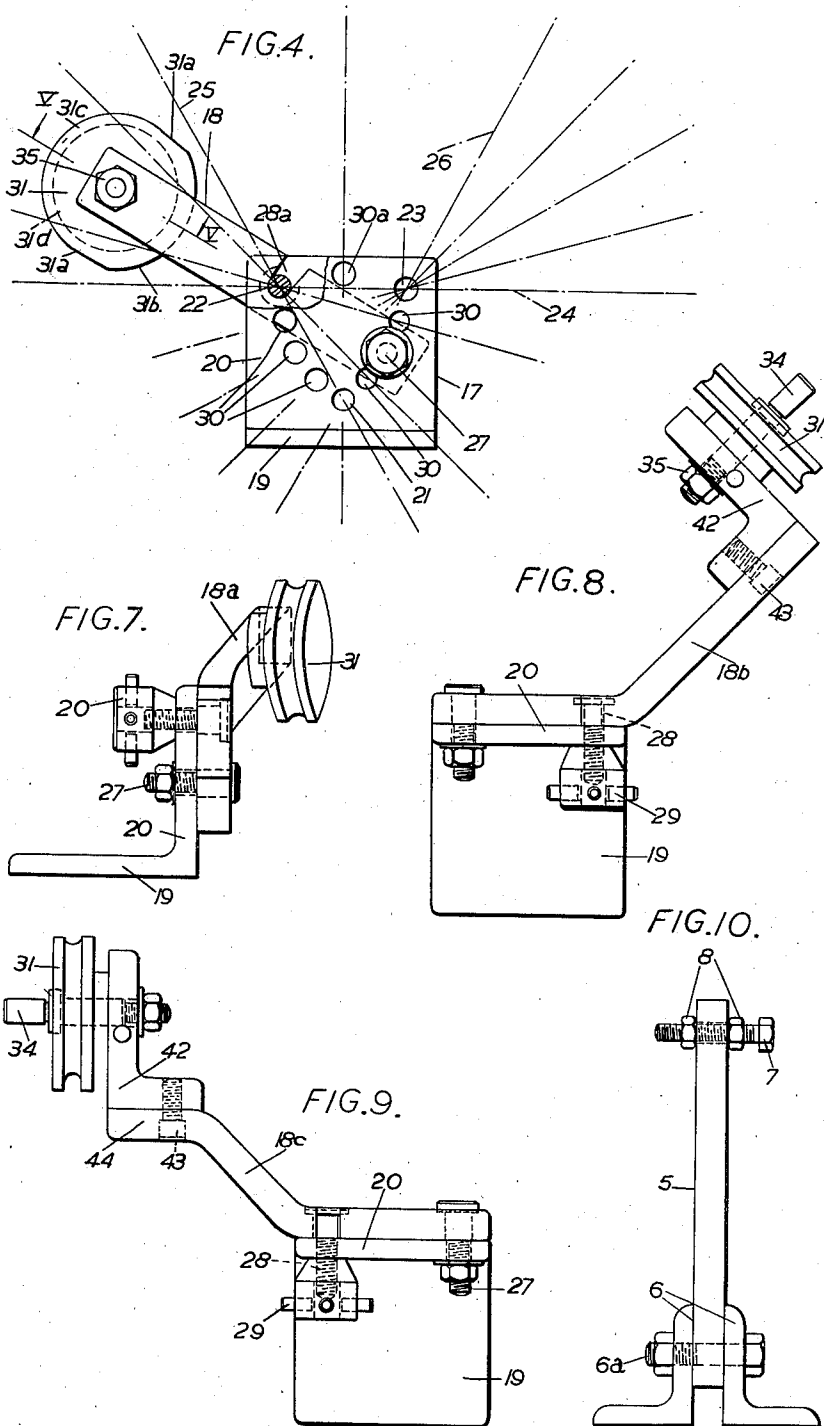
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APPLIANCE FOR BENDING TUBES, RODS, AND THE LIKE

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5 Sheets-Sheet 4



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APPLIANCE FOR BENDING TUBES, RODS, AND THE LIKE

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FIG. 11.

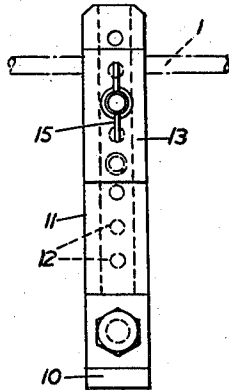


FIG. 12.

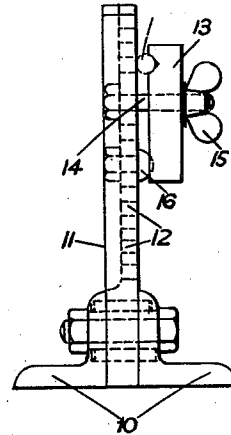


FIG. 13.

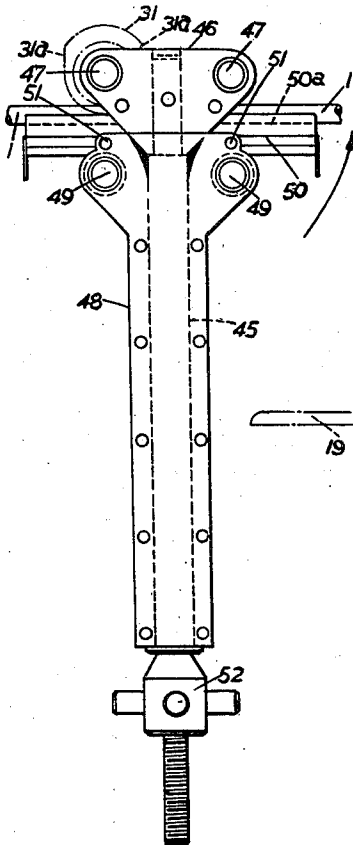


FIG. 14.

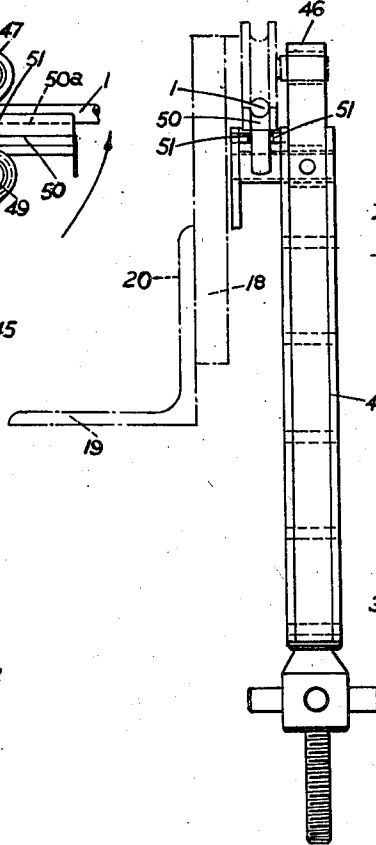


FIG. 5.

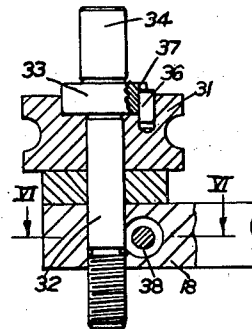
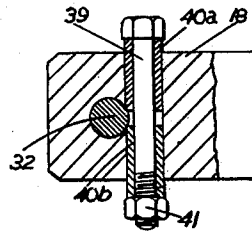


FIG. 6.



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UNITED STATES PATENT OFFICE

2,366,012

APPLIANCE FOR BENDING TUBES, RODS,
AND THE LIKE

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Application August 25, 1943, Serial No. 499,990
In Great Britain October 20, 1942

8 Claims. (Cl. 153—32)

This invention relates to appliances for bending tubes, rods and the like. The invention is particularly concerned with apparatus for forming a number of bends in a length of metal tube which can be bent in the cold, such as tubes of annealed copper, mild steel, or aluminum alloys which have been normalised.

It is often necessary to provide a length of metal tubing with a comparatively complicated set of bends which may be irregularly spaced along the length of the tube and not only may have to be made about axes at right-angles, but also on occasion about oblique axes, and indeed bends of different radii may have to be made in the same length of tubing. An example of such bends is set out in the specification of patent application Serial No. 473,737, filed 27th January 1943; an example of the application of such tubes occurs in hydraulic systems, such as, for example, tubes supplying hydraulic pressure to the turrets of aircraft. It is evident from the said prior patent specification that when a complicated set of bends has to be made by bending the tube around a series of forming dies, the dies have to be set up with various spacings between neighbouring dies and the dies have to be set up in various angular positions, and that if separate supporting brackets and jigs are employed for each bend, these fixings involve a very considerable number of parts for a single job and in addition, the same parts are not easily adaptable for different jobs.

The object of the present invention is to provide a set of fixings for such bending dies which can deal with bends of the different kinds encountered in practice and for which a minimum number of standardised parts only is necessary.

According to the present invention, a jig or fixing bracket for supporting the dies or formers enables the latter to be fixed in position for carrying out all the varieties of bending operation which are needed with the use of relatively few parts; the bracket is of right-angled section with two flat plates at right-angles, one utilised for securing the bracket in position and the other drilled with a number of holes consisting of a line of holes lying along a circular arc struck about another hole as centre. An arm which carries the forming die directly or indirectly is fixed to the drilled bracket plate in one of a number of possible angular positions merely by the use of a pair of securing bolts which engage one of the holes in the line and the hole at the centre of the arc on which the line of holes lies. In a convenient arrangement, three holes are drilled in

one of the plates of the bracket, each lying at the corner of an equilateral triangle with its apex near the edge of the drilled plate and with two series of further holes lying on circular arcs which extend from the apex of the triangle to the other two corners, each being struck about one of the other corners as centre. If two of the corner holes lie on a line parallel to the plate used for fixing, if those two holes are used for securing the former arm, then the latter lies with its centre line parallel to the plate used for fixing. That plate can be secured to a horizontal support or to a vertical support. In the former case, the centre line of the former arm is horizontal, but it can be placed in any of a number of angular positions in a vertical plane if a corner hole is employed to receive one bolt and one of the holes lying in the circular arc is used for the other bolt. In the latter case, the former arm can be secured in various angular positions in a horizontal plane.

It will be appreciated that two of the fixing brackets can be used fixed back to back. The drilled plate of one of them is used for fixing to the support and then the drilled plate of the other one can be used for securing the former arm in various angular positions parallel to the supporting surface.

It has been indicated that the forming die need not be secured directly to the former arm. A right-angle piece may be secured to the former arm and the forming die secured to that angle piece in various oblique positions.

The former arm may be a steel bar of rectangular cross-section drilled near one end with a hole to receive one of the securing bolts which can be fixed by an ordinary nut. Further along the former arm, another bolt passing through another hole in the fixing bracket may be provided with a finger nut. In the former arm it may pass through a slot opening to one side of the arm, in which case by loosening the finger nut, the former arm may be swung out of the way, which is convenient in some cases since otherwise it might interfere with the formation of a previous bend in the pipe.

Other positions for the forming die may be obtained by employing former arms which are not straight bars but are cranked either to the left or to the right, and the forming die may be offset by using a former arm which is cranked twice, that is to say, which has an inclined portion proceeding from the part secured to the fixing bracket, and a further end portion turned parallel again to the part secured to the fixing bracket.

The forming die itself is a flat plate with a portion of its periphery curved to correspond to the arc of the bend and running into two opposite flat portions which are parallel. These flat portions serve to limit the extent of the bending but usually allow slight over-bend in order to allow for elastic recovery due to inherent springiness of the tube to be bent. The periphery of the die is formed with a groove of a size just to receive the pipe to be bent.

Generally speaking, in bending a length of pipe, the latter is cut off to a predetermined length and the bending is started after the end of the pipe has been registered against an adjustable stop. This may consist of a vertical bar standing up from the base of the jig to which the brackets are fixed and having projecting from it a horizontal screw which is adjustable and locked in the adjusted position by nuts. If the pipe is to be bent in both directions from an intermediate point, it needs to be supported near that point in clamps, each of which consists of a vertical bar upstanding from the base of the jig with horizontal holes at different heights to receive a bolt provided with a finger nut for holding a clamping jaw against the pipe at any desired height.

In order to illustrate how a few standardised parts can be used in carrying out a relatively complicated series of bends in a length of metal pipe, an example of a set-up in accordance with the invention, together with the necessary parts for use in it, will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a general plan view of the complete jig employed;

Figure 2 is a plan to an enlarged scale and showing more detail of the parts of the jig to the left of the line X—Y in Figure 1; and

Figure 3 is a similar plan of the parts of the jig to the right of the line X—Y in Figure 1;

Figure 4 is an elevation of the fixing bracket employed showing a simple rectangular former arm secured in position;

Figure 5 is a section on the line V—V in Figure 4 showing the method of securing the forming die to the former arm;

Figure 6 is a section on the line VI—VI in Figure 5;

Figure 7 is an end elevation showing a cranked former arm secured to a fixing bracket;

Figure 8 is a plan view showing a cranked former arm fixed to the fixing bracket with an angle member for holding the forming die;

Figure 9 is a plan view of an arrangement in which a double cranked former arm and angle member are employed;

Figure 10 is an elevation of the setting stop employed;

Figures 11 and 12 are two elevations at right-angles of a suitable form of clamp for the pipe in the neighbourhood of the first bend;

Figure 13 is a front elevation, and

Figure 14 a side elevation of a simple form of bending tool shown in position at the commencement of a counter-clockwise bend.

The example taken for the purpose of illustration involves eight bends in a length of pipe shown at 1 in Figures 1 to 3. The shape of the bent pipe is shown at 1A in those figures, and it will be noted that it is to have a straight length 1B near its middle portion. It is convenient in such a case to start bending from a point near the middle towards one end, which is towards the

left in the drawings, and then to complete the bends by proceeding in the other direction towards the right in the drawings. The pipe 1 is cut to the predetermined length and has its left-hand end, or in the case in which hydraulic pressure is maintained within the pipe during the bending, a plug closing the end of the pipe, brought against a setting stop 2. This setting stop is shown in detail in Figure 10 and like the other parts of the jig, it is fixed to a bed or base consisting for simplicity of a straight section 3 of reinforced moulded synthetic resin to which are fixed a number of branching portions 4 of the same material.

The setting stop, as seen particularly in Figure 10, consists of a vertical bar 5 which extends up from between two angle brackets 6 fixed by bolts to the bed 3. A bolt 6a is tightened up to hold the bar 5 in the desired position from which it may easily be swung by hand when it is necessary to move the setting stop out of the way. The stop member proper consists of a stud 7 projecting from the vertical bar 5 and capable of precise adjustment by means of nuts 8 which also serve to fix it in the adjusted position. The pipe 1 is supported in a pair of clamps 9 which engage the straight middle part 1B. The construction of clamp employed is shown in detail in Figures 11 and 12. Each consists of a pair of angle brackets 10 fixed by bolts to the base 3 and a vertical bar 11 standing up from the brackets 10. The bar 11 is drilled with holes spaced a short distance apart along the length of the bar, as shown at 12. This enables the pipe 1 to be supported at any desired height from the bed 3. The pipe 1 is held against the bar 11 by a clamping jaw 13 of rectangular shape and held by a bolt 14 placed through an appropriate hole 12 to hold the pipe 1 at the desired height. The jaw 13 is held in position by a finger nut 15, and in order to maintain it parallel to the bar 11, it also engages the rounded head 16 of a short bolt passed through the hole 12 lower down as seen in Figure 12. Bolts with different sizes of head 16 can be employed to suit pipes 1 of different diameters. The pipe 1 is led between the bar 11 and the jaw 13 of each clamp and the finger nut 15 tightened to hold the pipe.

In the example taken, the first bend is a horizontal bend about a forming die A. This die has to be clamped in a horizontal plane, and in that particular case, a pair of fixing brackets 17 are employed together with a plain rectangular former arm 18. These parts are shown in greater detail in Figure 4. The bracket 17 consists of two plates at right angles, viz. a plate 19 for fixing the bracket in position, and a plate 20 which is drilled to enable the former arm to be fixed in any of a number of angular positions. For this purpose, the plate 20 has three drilled holes 21, 22, 23, which lie at the corners of an equi-lateral triangle. These holes alone allow the arm 18 to be set with its centre line lying in the direction 24 which, if the plate 20 is vertical, is a horizontal direction, so they allow the arm 18 to be set in either of the directions 25, 26, which are at 60° to the direction 24. This is because the three holes are equi-distant and can receive two bolts 27, 28 which pass through the former arm 18. These bolts are more clearly shown in Figures 7 to 9 in which modified forms of the fixing arrangement are illustrated. The bolt 27 is a plain bolt with a shallow head secured by an ordinary hexagonal nut. The bolt 28 clears the hole in the plate 20 and is fixed by

tightening up the nut. The bolt 28 also has a shallow head but is provided with a finger nut 29 which is a spin fit on the screw thread of the bolt 28 and the friction of the head of the bolt 28 in the countersink in the hole in the arm 18, 18a, 18b, or 18c is sufficient to prevent the bolt 28 turning when the nut 29 is tightened or loosened. The former arm 18 is formed with a slot 28a running from the countersunk hole which receives the bolt 28 to one edge of the arm 18. The result is that if the finger nut 29 is slackened, the former arm 18 can be swung about the bolt 27 out of the path which the pipe 1 may have to take in a subsequent bend.

It will be noticed that the plate 20 is drilled with additional holes 30 which lie along arcs between the holes 21 and 22 on the one hand, and the holes 21 and 23 on the other hand, the arcs being struck about the holes 23 and 22 respectively as centres. There are three such holes in each set spaced 15° apart along each arc, and by selecting one of the holes 22, 23 and any one of the holes in the opposite arc at 30, the arm 18 can be set at any angular position from the direction 24 to the direction 25 or 26 at any spacing of 15° between them, as indicated by the chain lines in Figure 4. Actually, the arm 18 is shown as fixed in the hole 22, and the middle hole 30 of the opposite series, so that in the position shown its centre line makes an angle of 30° with the direction 24. There is an additional hole 30a allowing the arm 18 to be set vertically and, in fact, as an alternative, a series of holes like the holes 30 may be provided along an arc extending between the holes 22, 23 and struck about the centre of the hole 21.

In Figures 4, 5 and 6, the forming die 31 is shown secured to the outer end of the arm 18, by means of a bolt 32 which has a collar 33 near one end, and at this end formed with an extension 34 to serve as the pivot of the bending tool, as will be explained below. The other end of the bolt 32 is screw-threaded to receive a securing nut 35. The forming die 31 is fixed to the bolt 32 and prevented from angular turning on it by a pin 36 engaging a hole in the face of the die 31, and also one of a number of notches or flutes 37 spaced around the circumference of the collar 33. The forming die 31 is formed, for convenience, from a circular flat blank with a groove of U-section formed in its periphery. Two opposite parallel flat portions 31a (Figure 4) are milled from the original periphery which remains over the part 31b. Then the arc contour of the bending part of the die is turned at 31c, the amount of metal removed being such that the groove shown at 31d becomes semi-circular over the arc 31c to fit the outside surface of the pipe to be bent. It is necessary to be able to set the angular position of the die 31 to set the bending contour 31c of the die correctly. The pipe is bent to the contour of the arc 31c and one of the flat portions 31a serves to limit the bend, although as already mentioned, when the pipe is bent against a flat 31a, a certain amount has to be allowed for elastic recovery of the pipe. The flats 31a must, however, be set at the correct angle to determine the desired amount of bend, and that is effected by causing the pin 36 to engage the appropriate notch or flute 37 in the collar 33. However, it may also be arranged for the bolt 32 to be set in any desired angular position in the former arm 18 and to be locked in the position in which it is set. This may be arranged as shown in Fig-

ures 5 and 6. A hole is drilled through the arm 18 at 38 or through the bracket 42 (Figure 9) at right-angles to the hole which receives the bolt 32 and breaking into that hole. The hole 38 receives a bolt 39 and a pair of hardened bushes 40a and 40b. When these bushes are loose, the bolt 32 is turned into the desired position in the former arm 18, and then the nut 41 on the bolt 39 is tightened up, forcing the sharp edges at the inner ends of the bushes 40a, 40b to bite slightly into the bolt 32. Then the upper bush 40a prevents counter-clockwise rotation of the bolt 32 and the lower bush 40b prevents clockwise rotation of it.

Figure 7 shows a cranked former arm 18a used instead of the straight arm 18 shown in Figure 4. This enables the forming die 31 to be secured at an angle as illustrated in Figure 7. In Figure 8, a cranked former arm 18b is provided, but the forming die 31 is not fixed directly to the arm 18b, but to an angle member 42 secured to the former arm 18b by studs 43, the forming die 31 being fixed in the desired angular position to the angle member 42 in the same way as in Figure 4, it is secured to the former arm 18.

In Figure 9, the former arm 18c is cranked twice as shown so as to bring its outer end 44 parallel to the bracket plate 20. In this case also an angle member 42 secured by a stud 43 serves to carry the forming die 31.

The die A for effecting the first bend which is in a horizontal plane has to be set horizontally, and as shown, the centre line of the former arm 18 is set at 15° to the length of the bed 3 by employing a corner hole 22 and a hole in the opposite series next to the corner hole 23. In this case, two fixing brackets 17 are employed bolted back to back, the fixing plate 19 of the one bracket being in contact with the fixing plate 19 of the other bracket, and the drilled plate 20 of the first bracket being used for bolting it to the branch 4 of the bed. The drilled plate 20 of the second bracket is used for fixing the former arm 18 as described.

The actual bending is effected by a lever bending tool and a simple form of the tool which may be used is shown in Figures 13 and 14. The tool consists of a stem 45 to which a head 46 is welded. The head 46 is formed with alternative holes 47 for engaging the pivot 34 of the forming die. A housing 48 can slide on the stem 45 and carries a pair of rollers 49 which are opposite the holes 47 in the sense that a line passing through the centre of a roller 49 and the corresponding hole 47 is parallel to the axis of the stem 45. A straight slipper 50 with a semi-circular groove 50a in its upper surface to fit the pipe 1, is mounted in the housing 48, resting upon the rollers 49 and guided by pins 51 in the housing 48 engaging grooves in the opposite sides of the slipper 50. The lower end of the stem 45 is screw-threaded and receives a nut 52. By screwing down this nut, the housing 48 can slide away from the head 46 so that the latter can engage the pivot 34 with the pipe 1 to be bent threaded between the slipper 50 and the bending die 31, whereupon by tightening the nut 52, the housing 48 can be pushed up until the slipper 50 is in contact with the pipe and the rollers 49 bear on the rear face of the slipper 50. As shown in Figures 13 and 14, the parts are in position for starting a counter-clockwise bend, the left-hand roller 49 effecting the nip between the pipe and the forming die 31, and as the bending tool is turned counter-clockwise about the pivot 34, the

right-hand roller 49 which is in advance, pushes up the slipper 50 to commence the bending of the pipe which is completed against the flat 31a of the die 31. In the case of a clockwise bend, the right-hand hole 47 is engaged with the pivot 34 and the right-hand roller 49 then takes the nip against the pipe and the tool is turned clockwise.

Referring again to Figures 1 to 3, the second bend is a horizontal bend to be made about the forming die B close to it in the opposite direction to the first bend. It will be noted that the die B is mounted on a former arm 18 fixed to a pair of brackets 17 in a manner very similar to the die A except that the former arm in this case is set at an angle of 30° to the length of the bed 3 by selecting a hole 30 in the plate 20, which is in the middle of the series. It will also be noted that the former B has set up interference with the placing of the pipe 1 between the clamps 9 and the setting stop 2, so that in the first setting, the die B and indeed also the die C which will be referred to later, have to be moved out of the way, and this is done by swinging the former arms 18 in the manner already described about the bolts 27. It will be noticed that for convenience the brackets for the die B are fixed to the base 3 on the opposite side of the general run of the pipe 1 from those used for the first bend.

The third bend is made at the die C which is fixed in position in a manner similar to the die B, but it will be noticed that owing to the amount desired for the bend at the die C, this die is set in a different angular position with respect to its former arm 18 from the position of the die B with respect to its former arm.

The fourth bend is effected at the die D and the bend is such that the pipe 1A has to pass below the die D and to be bent upwardly from the base 3. Therefore, the die D is set at the desired angle by the use of a bracket 17 as already described, a plain straight former arm 18, and an angle member 42 secured as already described with reference to Figures 8 and 9. Then, in order to finish this end of the pipe, a bend has to be made over the die E so that the end of the tube finally projects vertically downwards as indicated at 53. In this case, therefore, the die E is fixed directly to a former arm 18 secured to a bracket 17 at the desired angle to give the proper position for the die E.

The sixth bend is made on the other end of the pipe 1 to the right of the clamps 9, as shown best in Figure 3. In fact, a right-angle bend in a horizontal plane is made around the die F. The fixing of this die on its former arm 18 is very similar to a fixing of the die B except, of course, that the arm 18 projects in the opposite direction from the bracket 17, and as a right-angle bend has to be made, the die F is set in a different angular position on the arm 18.

The seventh bend is made about the die G which is fixed to a double cranked former arm 18c similar to that shown in Figure 9 except that the die G is secured direct to the arm 18c without interposing one of the angle members 42. The arm 18c is fixed at the desired angle to one of the standardised brackets 17. The pipe is bent down and under the die G, and then the eighth or final bend is made around a die H, bringing the end of the pipe 1A so as to extend vertically upwards. The die H is parallel to and in the same plane as the die G to produce a right-angle bend, and it is mounted on a simple rectangular

former arm 18 secured to the standardised fixing brackets 17 in the manner already described.

Generally speaking, the pipe has to be held down to each forming die at the commencement of a bend to prevent it springing away, and any suitable cramp may be used for that purpose, such as that described in patent application Serial No. 473,737 already referred to.

We claim:

1. A fixing jig for dies for bending metal tubes or rods comprising an angle bracket consisting of a pair of integral flat plates at right-angles to each other, one of said plates being perforated with three holes each lying at a corner of an equilateral triangle and with series of holes lying on circular arcs each of which extends from one corner of said triangle to another corner thereof and which is struck about the third corner of said triangle as center, a die-carrying arm, a pair of bolts passing through spaced holes in said arm and through one corner hole in said plate and through one of the holes of the opposite series to fix said arm to said plate and a profiled bending die secured to the free end of said arm and formed as a flat plate with a rim grooved to receive the bent tube or rod.

2. A fixing jig for dies for bending metal tubes or rods comprising an angle bracket consisting of a pair of integral flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, an arm contacting said plate, a pair of bolts passing through spaced holes in said arm and through said other hole in said plate and through one of the holes of the arcuate series to fix said arm to said plate, a right-angle die-carrying member bolted to the free end of said arm and a profiled bending die plate secured to said die-carrying member and formed as a flat plate with a rim grooved to receive the bent metal tube or rod.

3. A fixing jig for dies for bending metal tubes or rods comprising an angle bracket consisting of a pair of integral flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, a die-carrying arm, a pair of bolts passing through spaced holes in said arm and through said other hole in said plate and through one of the holes of the arcuate series to fix said arm to said plate, a profiled bending die plate, and a bolt securing said die plate to the free end of said arm and extending to form a pivot for a lever-like bending tool.

4. A fixing jig for dies for bending metal tubes or rods comprising an angle bracket consisting of a pair of integral flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, an arm contacting said plate, a pair of bolts passing through spaced holes in said arm and through said other holes in said plate and through one of the holes of the arcuate series to fix said arm to said plate, a right-angle die-carrying member bolted to the free end of said arm, a profiled bending die plate, and a bolt securing said die plate to the free end of said arm and extending to form a pivot for a lever-like bending tool.

5. A fixing jig for dies for bending metal tubes or rods comprising a die-carrying member, a profiled bending die plate, a bolt passing through said die plate and said die-carrying member to secure same together, a further bolt passing

through said member at right-angles to the axis of said first-named bolt, a pair of hardened bushes surrounding said further bolt and means for tightening said bushes to cause same to lock said first-named bolt in adjusted angular position.

6. A jig for spacing and mounting dies for bending metal tubes or rods comprising a mounting bed, a plurality of fixing brackets secured in spaced relationship to said bed and each comprising a pair of flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, and a plurality of die-carrying arms each fastened to one of said fixing brackets.

7. A jig for spacing and mounting dies for bending metal tubes or rods comprising a mounting bed, a plurality of fixing brackets secured in spaced relationship to said bed and each comprising a pair of flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, a plurality of die-carrying arms each fastened to one of said

fixing brackets, and a setting stop also secured to said bed and comprising an upstanding bar and an adjustable set-screw threaded in said bar to be engaged before the commencement of bending by the end of the metal tube or bar to be bent.

8. A jig for spacing and mounting dies for bending metal tubes or rods comprising a mounting bed, a plurality of fixing brackets secured in spaced relationship to said bed and each comprising a pair of flat plates at right-angles to each other, one of said plates being perforated with a series of holes lying on a circular arc struck about another hole in the plate as center, a plurality of die-carrying arms each fastened to one of said fixing brackets, and at least one clamp for supporting the tube or rod to be bent at an intermediate point also secured to said bed and comprising an upstanding bar with spaced perforations, a jaw for gripping the tube or rod to be bent, and a bolt passing through said jaw and the appropriate perforation in said bar for fixing said jaw to said bar.

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