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C. FRANCIS

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PIPE BENDING MACHINE

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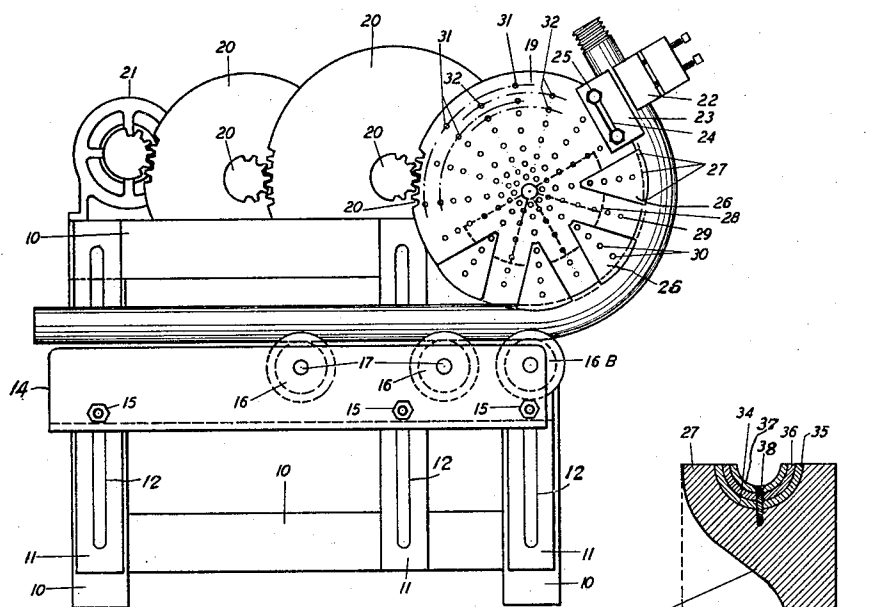


FIG. 1

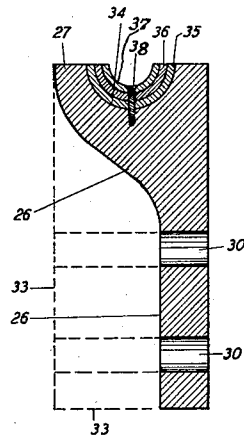


FIG. 3

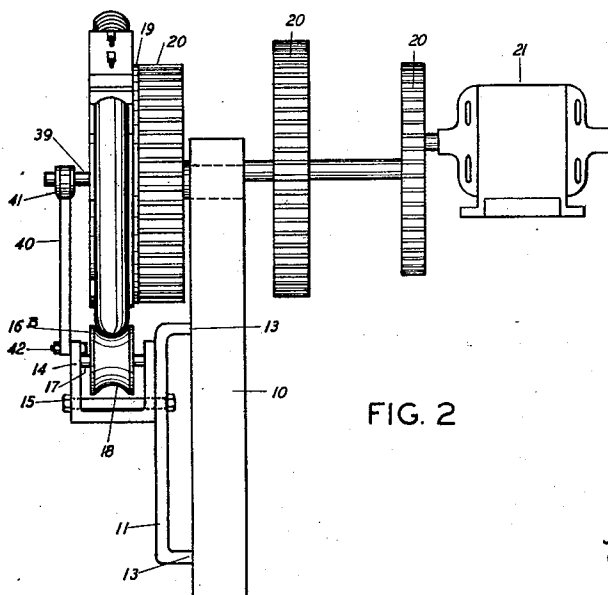


FIG. 2

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PIPE-BENDING MACHINE

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In forming bends from large and heavy pipe by power it has heretofore been known to support the pipe by means of idler rolls, to hold the free end of the pipe in a clamp attached to a rotatable head and, by rotating such head in a fixed position as regards the idler rolls, to bend the pipe to a desired radius by forcing it against blocks or dies also affixed to the head.

In the designs heretofore proposed the blocks or dies have either been unitary or have been made up of adjoining segments adapted to form a substantially continuous circumferential curve. It will be understood that these die blocks have two essential curvatures, one on the radius of the revolving head, corresponding to the radius of the bend to be formed, the other on the outer face of the block, at right angles to the first, and forming an arcuate groove having substantially the same radius as the outside of the pipe to be bent.

These die blocks being unitary or substantially so it is necessary to provide such a block or set of blocks, not only for each size of pipe to be bent but also for each radius of bend to be made. Thus the equipment of dies required for a variety of pipe sizes and bend radii will often run into a great weight of metal and into a cost exceeding that of the bending machine itself.

I have discovered that it is not necessary to make the circumferential curvature of the segments of a divided die exactly correspond to the curvature of the desired bend but that, on the contrary, smooth bends free from kinks or flats may be made by using a plurality of dies having a much shorter radius than that of the desired bend, by radially advancing such dies until their high or center points coincide with the arc described by the bend to be made.

Giving this discovery practical application, I utilize it in a bending machine which may be constructed as in the attached drawings, in which my improvement is shown in detail while the bending machine itself, which is more or less conventional, is shown in a diagrammatic manner. In these drawings:

Fig. 1 is a side elevation of the complete machine, showing the dies in the same manner;

Fig. 2 is a right-end elevation of Fig. 1; and

Fig. 3 is a cross-section through a preferred form of segmental die.

Referring to Figs. 1 and 2, the members 10 form a frame on which the working parts are assembled and by which they are supported. This frame may desirably be built of channel or other suitable steel sections, and may be bolted or welded together, the latter construction giving great stiffness and strength. A cast-iron or other frame may be used if preferred.

11—11 are rigid plates having vertical slots 12 and attached to the frame as at 13. The U-channel 14 is held in contact with these plates by the bolts 15 and may be moved up or down, by loosening these bolts, to bring the idler rolls 16 and 16B into a tangent of the bend to be made.

These idler rolls are carried in the channels on pins 17, which should be readily removable, and are grooved as at 18 to substantially fit the size pipe to be bent.

A face plate 19, which will be further described, is arranged to be revolved slowly and powerfully, as by any train of gears 20 actuated by a source of power, as the electric motor 21. In Fig. 2 the face plate is shown as integral with the last gear in the train, but it may be supported and revolved in any suitable or preferred manner, this being no part of my present invention.

In forming a bend the strain on the idler roll 16B, which is situated directly below the center of revolution of the face plate, is exceedingly high and I propose to support this roll at its outer end by means of a stub shaft 39 projecting from the center of the face plate 19, a strap 40 carrying at its upper end a bearing box 41 adapted to slip freely over the end of the shaft, and bolts 42 attaching the lower end of this strap to a convenient part of the channel 14. This strap may be removed in case it interferes with placing the pipe in the idler rolls.

To the face plate is attached a clamp 22 for

holding the free end of the pipe. This clamp may be of any preferred design but it must be movably attached to the face of the plate, as for instance by the apron 23 having a slot 24 through which bolts 25 may be passed into holes formed in the face plate, the slot permitting the bolts to be given any required spacing. This clamp should hold the pipe at such distance from the face plate as to bring it into alignment with the groove in the dies about to be described.

To the face of the plate I attach a plurality of segmental dies 26, having a circumferential curvature 27 which is an arc of the closest bend for which the dies are to be used. Thus in Fig. 1 the curvature of the face 27 is an arc of the circle 28 described by the faces of the dies when they are fully retracted and brought into side contact.

The dies may be affixed to the face plate in any preferred manner, as for instance by bolts passed through holes 29 in the plate and holes 30 in the die. The holes in the plate may be radially arranged and the radii so spaced that when the dies are fully retracted toward the center of revolution they will be substantially in side contact. The arrangement of the holes is also such that they form circles about the center of revolution. Such radial and circular arrangement is indicated at 31—31 in Fig. 1. Intervening rows falling in circles of intermediate diameter as at 32—32 may also be formed to permit closer adjustment of the radius of the bend. If preferred, slots may be substituted for rows of holes as shown, though this is less desirable as requiring greater care in setting the dies and as materially weakening the face plate, as well as incurring danger of one or more of the dies slipping inward under the intense stress incident to the formation of a bend from heavy pipe.

The dies may have the cross-section shown in Fig. 3, or they may be of the uniform section indicated by the dotted lines 33 or of any preferred section. In any case the curved face 27 is provided with a peripheral arcuate groove 34 adapted to fit the size of pipe to be bent. The depth of this groove must not be greater than its radius and may with advantage be slightly less, to avoid sticking of the pipe in the groove.

It is requisite that this groove fit the pipe to be bent as otherwise the section of the pipe will be distorted in bending. Thus a set of dies must be provided for each size pipe, and where the range of sizes is wide the cost of the dies is considerable, even though one set may be utilized for bends varying widely in radius. I have therefore provided a further improvement in the construction of the die which makes it available for any desired range of pipe sizes. This improvement comprises the provision of circumferential filler blocks or bushings, made

preferably of a tough and fairly hard metal, shaped on their lower side to fit into a relatively large groove and provided on their upper side with a groove adapted to receive a smaller pipe. One or more such bushings may be used, as indicated at 35, 36 and 37, and the step between the upper and lower face may be one or more pipe sizes. The length of the bushing should be substantially equal to that of the face 27 of the die. As the bushings are in compression during the formation of the bend they may be lightly retained in the die, as by the countersunk bolt indicated at 38 or even by spring clips.

The shortest bend which may be made with any one set of dies in fully retracted position has, obviously, a radius equal to the effective length of the die, measured from its face to the center of revolution of the face plate. In this position of the dies the root of the groove in adjoining segments describes a true arc.

On equally advancing the dies from the center of revolution the circle described by revolution of the dies increases and, as the arc of the groove is fixed, the root of the groove no longer lies in the circle but touches it only at the high or central point. At the same time, as the radii diverge the spacing of the high points which actually bear on the pipe is increased. For these reasons the enlargement of the radius of the bend by merely advancing the dies cannot be continued indefinitely as, if the space between the bearing points is too great, a smooth bend will not be produced. I have found, however, that in bending 4" pipe, for example, I can produce with a single set of dies, used in the above manner, perfect bends having radii varying from 13" up to 30" or more.

I claim as my invention:

1. A pipe-bending machine including a face plate; means for revolving said plate; a pipe clamp attached to said plate; a plurality of segmental dies attached to said plate, said dies having a peripheral arcuate groove parallel to said plate and in alignment with said clamp; means for holding said pipe in contact with said groove as said plate and dies are revolved, and means for varying the distance from the center of said face plate to the groove in said dies.

2. A pipe-bending machine including a face plate; means for revolving said plate; a pipe clamp movably attached to the face of said plate; a plurality of segmental dies adapted to be attached to the face of said plate, said dies having a peripheral arcuate groove parallel to said face, and means for arranging and maintaining said dies on said face in arcs of variable radius concentric with said face.

3. A pipe-bending machine including a face plate; means for revolving said plate; a plurality of dies adapted to be attached to

the face of said plate, said dies having a peripheral arcuate groove parallel to said face; means for arranging and maintaining said dies in said face in arcs of variable radius concentric with said face, and means for gripping the free end of said pipe adapted to be attached to said plate in a tangent to each of said arcs.

4. In a pipe bending machine having a revolvable face plate, a bending die attached thereto and an idler roll cooperating with said die to form a bend, means for holding said die and said roll in a fixed space relation comprising a support for said roll; a steel shaft centrally projecting from said plate, a strap having a bearing box engaging said shaft, and means for movably attaching the end of said shaft opposite said box to said support.

5. In a pipe bending machine; an arcuate die divided into segments, said segments having peripheral arcuate grooves adapted to register when said segments are assembled on a plane surface, means for rotating said die segments, and means for varying their radii of rotation.

6. In a pipe bending machine; a die having a peripheral arcuate groove; means for rotating said die; means for varying the radius of rotation of said die, and a filler adapted to fit within said groove, said filler being provided with a second groove parallel to said first groove but of smaller transverse radius.

In witness that I claim the foregoing I have hereunto subscribed by name this 22nd day of March, 1930.

CHARLES FRANCIS.