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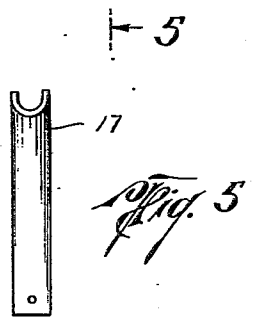
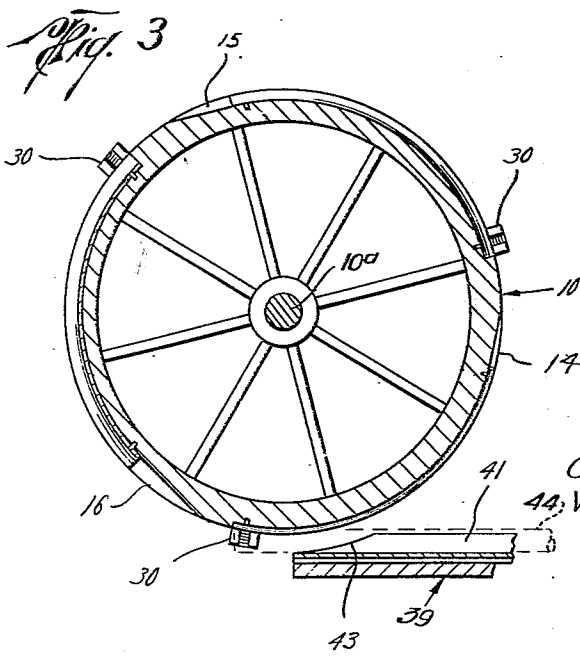
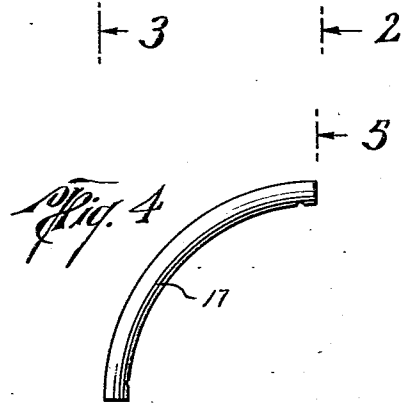
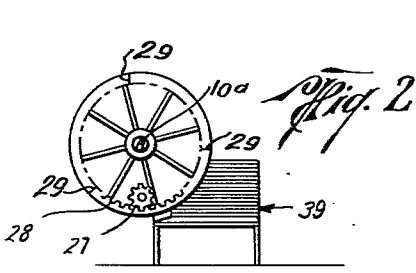
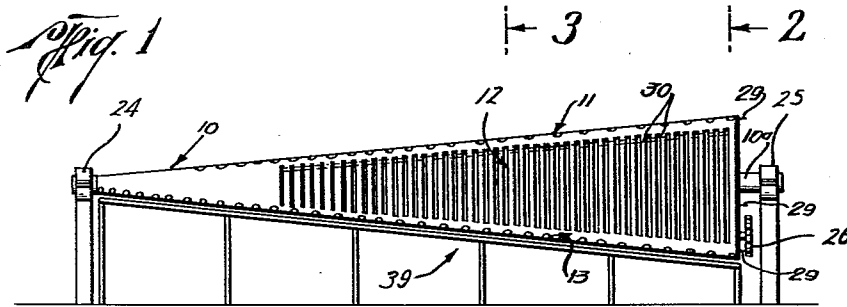
C. L. PARDUE, JR., ET AL

2,796,910

PIPE BENDING MACHINE

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2 Sheets-Sheet 1



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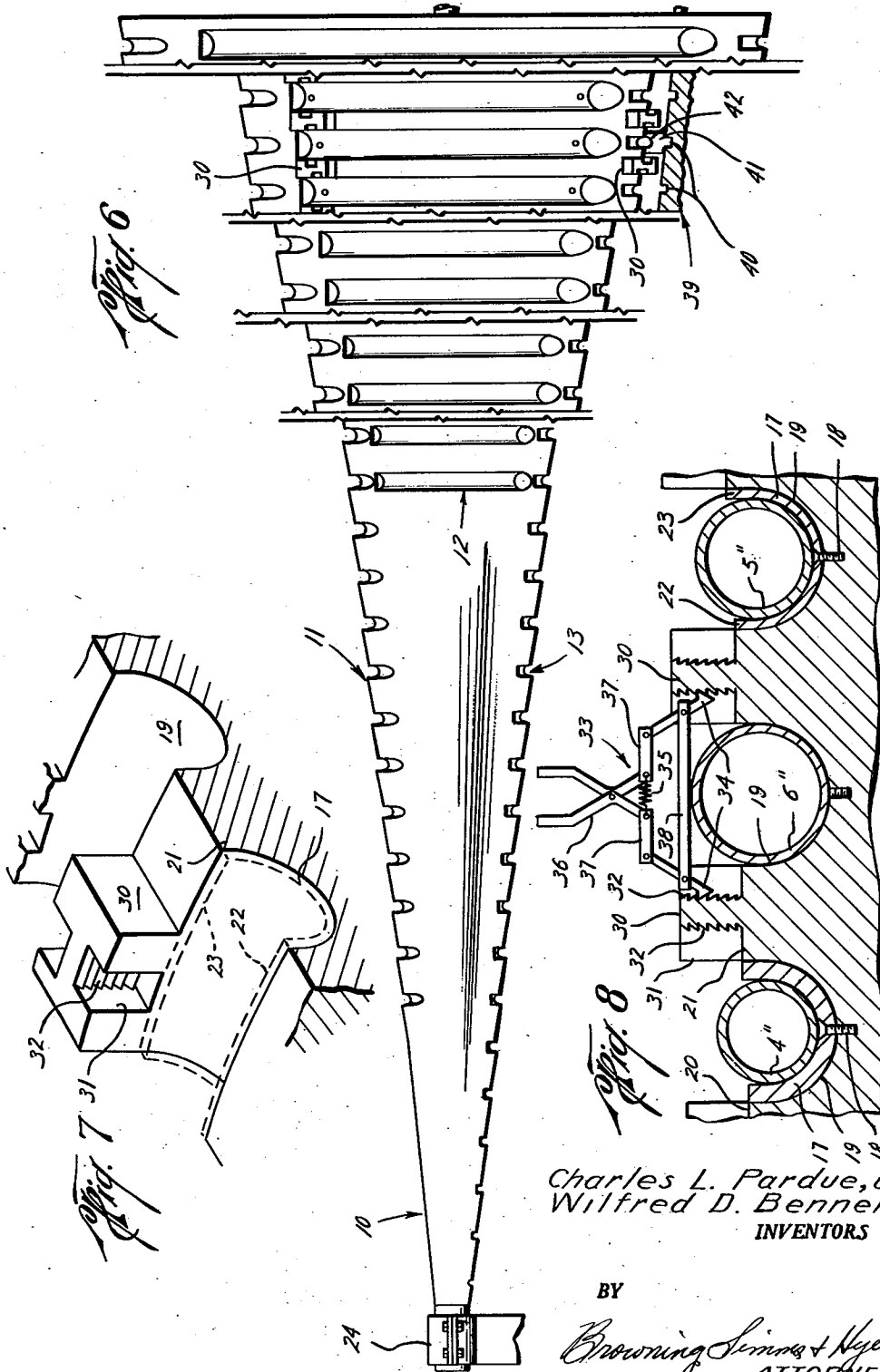
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PIPE BENDING MACHINE

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2 Sheets-Sheet 2



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1

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PIPE BENDING MACHINE

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5 Claims. (Cl. 153—40)

This invention relates to a pipe or tube bending machine and more particularly to a bender for simultaneously bending a number of lengths of pipe such as electrical conduits.

In present day building practice it is common in many instances to run within or on a wall or ceiling of a building a number of tubes in which the electrical wires for the building are run. These tubes are run side by side and vary in diameter from $\frac{1}{2}$ " to 6". It is frequently necessary for these tubes to make turns which parallel the wall on which they are run. In making these turns each tube must be bent to a different radius turn. In making a bend with a number of conduits, the minimum radius bend is controlled by the largest conduit as the minimum radius bend increases with conduit size. A successful bending machine must be capable of bending all sizes of conduits to any of a large number of different radius bends. If a group consists of five conduits with a 4" conduit in the middle and flanked on each side by 3" conduits and outwardly of the 3" conduits by 1" conduits, the bending machine must be capable of bending the 4" conduit about a minimum radius of 27" as prescribed by the N. E. code and must also be able to bend the 3" conduits about a lesser and a greater radius bend and the 1" conduits about a still lesser and still greater radius bend. The present day practice is to use a hand-operated machine and to bend each of these conduits on the job about the desired radius. This invention provides a machine with which a number of such pipes may be simultaneously bent so that the pipe for a particular job may be economically pre-bent at a central location and then transported to the site of the job if desired. On the other hand, if the size of the job justifies, the machine could be located on the site of the job.

It has previously been proposed to construct a pipe bending machine capable of bending pipe on more than one radius and of bending pipe of differing diameters on more than one radius. These machines have not been successfully used commercially probably for the reason that the weight of the inserts necessary to shim a 6" die bed to handle a $\frac{1}{2}$ " conduit making a large radius turn of, say, 40" or greater is prohibitive. That is, the weight of the die insert is so great that it is difficult to handle manually and thus the frequent setup changes for the machine require the frequent handling of very heavy die inserts and it is more economical to use the machines presently available.

This invention provides a machine in which this weight problem is overcome by spacing die beds circumferentially about a die and providing at a given radius of bend beds of stepped diameters so that the weight of the insert can be held to within reasonable limits.

It is a general object of this invention to provide a bending machine utilizing die inserts for bending pipe of a large number of diameters about a large number of radii in which the inserts are sufficiently light that they may be handled manually.

2

Another object is to provide a single die with a sufficient number of die beds at stepped radii and at stepped diameters at each given radii such that electrical conduits ranging from $\frac{1}{2}$ " to 6" in diameter as presently employed for running electrical wires in buildings may be bent to any desired radius of bend in which the die is of a practical size and weight.

Another object is to provide a single die with a sufficient number of die beds at stepped radii and at stepped diameters at each given radii such that electrical conduits ranging from $\frac{1}{2}$ " to 6" in diameter as presently employed for running electrical wires in buildings may be bent to any desired radius of bend utilizing die inserts in conjunction with the single die which are of a size and weight which may be handled manually.

Another object is to provide a single die for bending a larger number of conduits as specified in the preceding object in which a number of such conduits may be bent simultaneously.

Another object is to provide a workpiece supporting table for a bending die of the type specified in the two preceding objects in which the table is provided with adaptors which may be positioned on the table at any radius of bend and which have different diameter beds therein for supporting a pipe to be bent and for forcing it into the bed or insert of the die as the case may be during the bending operation.

Another object is to provide a pipe bender with means for preventing flattening or deforming of the pipe during the bending process.

Another object is to provide in a pipe bender having a bed adapted to receive inserts of various sizes to permit the bed to be used in bending various diameter pipe with a quick release clamp in which a single pin-up clamp is utilized for all diameter pipe bent about the same radius of turn.

Other objects, features and advantages of this invention will be apparent to one skilled in the art from a consideration of the drawings, specification and the appended claims.

In the drawings, wherein there is shown by way of illustration one embodiment of this invention and wherein like reference numerals indicate like parts:

Fig. 1 is a view in side elevation of a pipe bending machine constructed in accordance with this invention;

Fig. 2 is a view in end elevation of the machine of Fig. 1 taken along the lines 2—2 in the direction of the arrows;

Fig. 3 is a cross-sectional view of the machine of Fig. 1 on a greatly enlarged scale taken along the lines 3—3 in the direction of the arrows;

Fig. 4 is a view in side elevation of an insert adapted to be received in one of the beds of the pipe bending machine of Fig. 1;

Fig. 5 is a view in end elevation of the insert of Fig. 4 taken along the lines 5—5 in the direction of the arrows;

Fig. 6 is a view in side elevation on a greatly enlarged scale of the bending die of the machine of Fig. 1 and of a fragment of the bending table;

Fig. 7 is an isometric fragmentary view of the beds of the bending die and of one of the posts with which the pin-up clamp coacts to pin a pipe to the bending die; and

Fig. 8 is a fragmentary cross-sectional view through the pipe bending die on a greatly enlarged scale taken along a radius line of the die illustrating the use of the various size inserts in the die beds and showing the pin-up clamp used to pin the pipe to the die.

As will be seen from the drawings, the bending die indicated generally at 10 is substantially conical in shape and is provided with three groups of circumferentially spaced die beds or grooves indicated generally at 11, 12

and 13. As best seen in Figs. 3 and 6, at any given radius of turn, that is, at any given point axially along the cone, the die bed of each group has a different diameter bed from the other two beds. By radius of turn, or radius of bend as used herein is meant, the distance from the rotational axis of the cone to the center of a circle which includes a die bed and lies in a plane extending axially of the cone. Each of the die beds extends circumferentially about the conical die 10 through an arc of 90° as best shown in Fig. 3. If a solid conical die is used, the die should be cut away from the trailing end of each die bed to the exterior of the conical die along the line tangent to the die bed at its trailing end as indicated at 14, 15 and 16 in Fig. 3. This will prevent the conical die from engaging the straight portion of the pipe being bent immediately adjacent the bent portion of the pipe as the bend is completed.

By way of example only and using as a basis the 1953 N. E. code which requires the following minimum radii,

Conduit, inches	Minimum Radius, inches
6	40
5	33
4	27
3½	23
3	20
2½	17
2	14
1½	10
1¼	9
1	7
¾	5
½	4

the conical die might be provided with beds for bending pipe at any desired radius of bend in whole inches as follows:

In die bed group 11 of cone 10 the radii from 20" to 66" would have a 3" bed and each radius would have its own reducing shoes 17 as indicated in Figs. 4 and 5 to reduce the diameter of pipe to be handled in these beds to 2½", 2" and 1½". The 17" to 19" radii would have a 2½" bed with reducing shoes reducing these beds to 2" and 1½". The 14", 15" and 16" radii would have 2" beds with reducing shoes to reduce these beds to ½". The 10" to 13" radii would have 1½" beds.

In die bed group 12 the radius from 40" to 66" would be 6" beds with reducing shoes 17 reducing the diameter of the beds to 5", 4" and 3½". The 33" to 40" radii would have 5" beds with reducing shoes to 4" and 3½". The 27" to 32" radii would have 4" beds with reducing shoes to 3½". The 23" to 26" radii would have 3½" beds.

In die bed group 13 the 9" to 66" radii would have 1¼" beds with reducing shoes to 1", ¾" and ½". The 7" and 8" radii would have 1" beds with reducing shoes to ¾" and ½". The 5" and 6" radii would have a ¾" bed and a reducing shoe to ½". The 4" radius would have a ½" bed.

From a study of the above exemplary die it will be seen that each size of pipe may be bent to any desired radius bend from the prescribed minimum radius to a maximum of 66" radius bend at stepped intervals of 1". At each radius of turn at the large end of the cone-shaped die there are provided stepped diameters. At the 66" radius a 5" pipe would be bent in the 6" bed, a 2" pipe in the 3" bed, and a ½" pipe in the 1¼" bed. Thus, the reducing inserts necessary to adapt the die beds at each radius of bend are not thick and heavy as would be the case if a single bed were used to make bends for all diameter pipe.

As best shown in Figs. 4, 5 and 8, the reducing shoes are semi-circular and have an arcuate dimension of 90°. The shoes are secured to the die 10 using fast lead screws 18 at each end of the die bend. As indicated in Fig. 8 and as set forth in the typical machine specified above,

the inserts 17 are of varying thickness so that different diameter pipe may be handled in a particular bed. As for instance in the Fig. 8 illustration, the central pipe might have a diameter of 6", the pipe to the right of the central figure a diameter of 5", and the pipe to the left of the central pipe a diameter of 4".

Referring particularly to Fig. 8, it will be noted that both the die beds 19 and the inserts 17 as viewed in cross section are semi-circular below a diametrical plane through each bed which planes are parallel to the axis of rotation of the die 10. Spaced outwardly from this point there are provided parallel walls 20 and 21 which are continuations of the semi-circular portion of the die bed 19. These walls will support the pipe while it is being bent and prevent it from flattening out or being deformed in any way. It will also be noted that the inserts are constructed in like manner with walls 22 and 23 serving the same function when the inserts are used.

The cone-shaped die is mounted for rotation about an axial shaft 10a in spaced bearings 24 and 25. Power for rotating the cone is provided from a prime mover, not shown, and is transmitted to the cone through a gear 26 which rotates pinion 27. Pinion 27 engages a rack 28 carried internally of the cone die 10 to rotate the cone-shaped die. If desired, the die may be provided with limit switches, not shown, which engage pegs 29 (Figs. 1 and 2) to stop the prime mover and stop rotation of the cone-shaped die after it has rotated through an arc of 90°. If desired, additional pins may be provided to stop the die after it has rotated a lesser number of degrees to provide 45° or 60° turns or the like.

In order for the cone-shaped die in rotating to bend a length of pipe, it is necessary to pin the pipe to the forward end of a die bed. As it is desired to use this machine for mass production, there is provided a quick releasable pin-up clamp which may be utilized with any diameter pipe at a given radius of bend to pin the pipe to the cone-shaped die. To provide this quick release pin-up, there is provided a radially extending post 30 on each side of each die bed. For simplicity only one set of posts is shown. However, it will be understood that a post 30 is provided on both sides of each die bed. Each post 30 is provided with an outwardly or radially extending slot or groove 31. The bottom of the groove is provided with teeth 32 which face toward the die bed. Pin-up clamp indicated generally at 33 is provided with latch means 34 adapted to engage teeth 32 with the latch means being resiliently biased into engagement with teeth 32 by a spring 35. Means are provided for retracting the latch means 34 and preferably this is provided by a handle 36 with arms secured to the latch means 34 through suitable linkage 37 so that upon squeezing the arms of the handle together, the latch members 34 will be retracted and disengaged from the teeth within grooves 31. The pin-up clamp is provided with a bar 38 to which said linkage 37 is pivoted and which engages the side of a pipe on the side opposite the die bed as shown in Fig. 8. It will be appreciated that bar 38 will engage any diameter pipe and hold the pipe in place inasmuch as latches 34 would move down further into grooves 31 and engage teeth 32 at a level closer to the die bed with a smaller diameter pipe in the bed.

It will be appreciated that as the diameter of the die beds change, the die beds may be positioned closer or farther away from each other and that different size clamps might be provided for different groups of die beds so that the cone-shaped die could be as small as commensurate with the space necessary for the several die beds. In other words, posts 30 would be positioned closer together at the small end of die 10 than at the large end of die 10 and hence the pin-up clamp 33 would be smaller.

As best shown in Figs. 7 and 8, the longitudinal dimension of the die beds increases with increasing diameter of the cone die 10. Thus, each pair of posts 30 are staggered and grooves 31 on a single post are staggered by the same amount so that they will be directly opposite

each other at each die bed. A single post has a groove 31 in opposite faces of the post so that each post serves as an anchor for the pin-up clamp 33 on opposite sides of the post.

To support the pipes to be bent and to force the pipe into the die bed or insert as the case may be as the conical die 10 is rotated, there is provided a table indicated generally at 39. As best shown in Fig. 1, table 39 extends parallel to a plane tangent to the cone-shaped die 10. Preferably, the table underlies the cone-shaped die and in its dimension extending away from the cone-shaped die is substantially horizontal. As the diameter of pipe to be bent will vary throughout the length of the cone, it is preferred that the table be provided with adapters which support the pipe to prevent their being flattened or being deformed in any manner during the bending process. Preferably, the table is provided with elongate slots 40 in which there is positioned adaptors 41 for supporting pipe to be bent. The upper surface of adaptor 41 is semi-circular in end view as at 42 to receive and support a length of pipe to be bent. The forward end of each adaptor 41 is cut on a curved bias as at 43 so that the adaptor and table may underlie the die 10 without interfering with rotation of die 10 and posts 30.

In operation the number and size of conduits being known, the radius of turn of each conduit is calculated in the conventional manner for each turn to be encountered in a building. Then as many of these bends as can be made at one time with one group of die beds are set up and made. The necessary adaptors 41 are positioned on table 39 and pipe to be bent supported upon the table. The necessary inserts 17 are secured in the die beds. The ends of the pipe to be bent (shown in dashed outline at 44 in Fig. 3) are placed between posts 30 and the pin-up clamps 33 utilized to clamp the pipes to the bending die. The die is then rotated through the desired arc to bend these sections of pipe. After the pipe is bent, the pin-up clamps are removed and the pipe pulled through underneath the die to the side of the die opposite the table and stored for transportation to the job.

From the above it will be seen that all of the objects of this invention have been accomplished. The size insert necessary to make the desired bends has been held to a minimum by providing different diameter die beds at each radius of turn, thus reducing the thickness of the insert necessary to make the desired bend. The pipe is supported against deformation during the making of the bend and is pinned to the conical die with a quick-action pin-up clamp which may be utilized with any diameter pipe.

The machine is fully capable of rapidly handling a large number of conduits and of making any radius bends of any diameter pipe which are required in present day building construction for the running of electrical wires.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A pipe bending machine comprising, a cone-shaped bending die, circumferentially spaced groups of die beds

in the peripheral face of the die, each group including beds spaced axially of the cone-shaped die to permit different radius bends; said circumferentially spaced groups having different diameter beds at a given radius bend permitting each of said groups of beds at said radius of bend to accommodate pipe of a different range of outside diameter with insert shoes releasably secured in the beds, and means for forcing a pipe to be bent into a die bed or insert therein to bend pipe.

2. A pipe bending machine comprising, a rotatably mounted cone-shaped bending die, circumferentially spaced groups of die beds in the peripheral face of the die, each group including beds spaced axially of the cone-shaped die to permit different radius bends, said circumferentially spaced groups having different diameter beds at a given radius bend permitting each of said groups of beds at said radius of bend to accommodate pipe of a different range of outside diameter with insert shoes releasably secured in the beds, and means for forcing a pipe to be bent into a die bed or insert therein as the cone-shaped die is rotated.

3. A pipe bending machine comprising, a rotatably mounted cone-shaped bending die, circumferentially spaced groups of die beds in the peripheral face of the die, each group including beds spaced axially of the cone-shaped die to permit different radius bends, said circumferentially spaced groups having different diameter beds at a given radius bend permitting each of said groups of beds at said radius of bend to accommodate pipe of a different range of outside diameter with insert shoes releasably secured in the beds, and a table for supporting pipe to be bent and forcing a pipe into a die bed or insert therein as the cone-shaped die is rotated.

4. A pipe bending machine comprising, a rotatably mounted cone-shaped bending die, circumferentially spaced groups of die beds in the peripheral face of the die, each group including beds spaced axially of the cone-shaped die to permit different radius bends, said circumferentially spaced groups having different diameter beds at a given radius bend permitting each of said groups of beds at said radius of bend to accommodate pipe of a different range of outside diameter with insert shoes releasably secured in the beds, and a table for supporting pipe to be bent and forcing a pipe into a die bed or insert therein as the cone-shaped die is rotated, said table extending parallel with a plane tangent to the periphery of the cone-shaped die.

5. A pipe bending machine comprising, a rotatably mounted cone-shaped bending die, circumferentially spaced groups of die beds in the peripheral face of the die, each group including beds spaced axially of the cone-shaped die to permit different radius bends, said circumferentially spaced groups having different diameter beds at a given radius bend permitting each of said groups of beds at said radius of bend to accommodate pipe of a different range of diameter with insert shoes releasably secured in the beds, and a table for supporting pipe to be bent and forcing a pipe into a die bed or insert therein as the cone-shaped die is rotated, said table extending parallel with a plane tangent to the periphery of the cone-shaped die and having means for receiving and supporting semi-cylindrical adaptors having an internal diameter approximating the outer diameter of the pipe to be bent so that the adaptor supports the pipe against deforming or flattening as it is pulled across the table and bent by the bending die.

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