ABSTRACT

A machine including a pair of spaced side frames movable towards and away from one another by suitable means, powered or manual, and adapted to support a plurality of chains hanging in a catenary curve until such time as the pipe to be deformed is placed in position on the chains for forming. Each of the chains is individually adjustable. The machine includes a top die movable vertically from its uppermost position downwards the required distance to properly deform the pipe or culvert previously placed in position on the plurality of chains. Downward movement of the top die may be controlled by an equalizing device to provide uniform forming from pipe end to pipe end in order to achieve the desired pipe-arch shape. Those side frames on which the chains are mounted also have means thereon to provide side confinement of the pipe while it is being deformed by movement of the top die. A track and trolley arrangement is provided to move pipe into the machine and to remove the formed pipe-arch from the machine.

13 Claims, 7 Drawing Figures
MACHINE FOR MAKING PIPE-ARCH FOR CULVERTS BY DEFORMING PIPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This machine has application in the manufacture of drainage pipe and related types of pipe in which pipe is deformed from a round structure to a pipe-arch or elliptical shape; pipe so shaped is particularly useful in culvert construction. The proposed machine may deform, for example, corrugated or smooth walled pipe; such pipe may be lock seamed, welded or riveted and may have a metallic or nonmetallic coating, or it may even be uncoated. Pipe having a more or less flat bottom and an integral arched top portion (pipe-arch) has load distributing characteristics and capabilities which make it especially satisfactory for use in constructing culverts, a further and particular advantage being that elevational space is also conserved. If properly designed and formed, light weight sheet metal may be used.

The machine of this invention enables cylindrical pipe to be deformed into pipe-arch without the necessity of using large, complicated special dies and presses. A relatively simple top die is adjusted according to the pipe diameter and a set of adjustable chains is employed to resist the pressure from the lowering of such top die.

2. Description of the Prior Art

It would appear that the most pertinent prior art is represented by U.S. Pat. No. 3,084,733 to A. A. Honeyman. The Honeyman machine employs a fixed top die to resist the pressure of moving chains attached to a moving top framework. A separate set of moving side members is employed by Honeyman to confine the pipe. Honeyman also employs a track and trolley arrangement to move pipe into the machine and to remove the formed pipe from the machine. There is no way in Honeyman, however, of varying the effective shape of the chains.

SUMMARY OF THE INVENTION

The instant machine for forming pipe culverts comprises an arrangement wherein there is relative movement between the die and the chains, with the shape of the chains being variable. Preferably the chains, and the side frames on which the chains are adjustably mounted, are moved to the desired position and then fixed in such selected position, the pipe is placed on the chains, and the top die is moved into contact with the top of the pipe so as to deform it into the particular pipe-arch desired. It is to be understood that in deforming cylindrical pipe in this manner, an end result is achieved which may be termed either "pipe-arch" or "elliptical shaping"; although these terms are considered synonymous, the particular term pipe-arch will be that generally employed throughout these descriptions.

The mounting means for the chains are located in such manner as to make it possible to change the effective shape of the chains, regardless of whether it is the upper die which moves or whether it is the set of chains which moves; the moving upper die, however, is preferred for this affords greater flexibility of product shape in the finished pipe-arch. Thus in the preferred arrangement the pipe is supported by a plurality of chains and the upper die is lowered into contact with the pipe whereby deformation occurs as occasioned by this contact and contact of the pipe with the side plates which provide lateral confinement of the pipe as downward movement of the upper die continues. As indicated, not only is the lateral position of the side plates variable, but also the effective shape of the chains is variable, by virtue of all of which desired variations in the shape of the finished pipe-arch may be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded sectional view with certain parts removed showing the working members of the pipe deforming machine.

FIG. 2 is an end elevation of the basic machine.

FIG. 2A is an enlarged fragmentary sectional view showing a modification which may be employed.

FIGS. 3 and 4 illustrate the effect of chain lengths on the pipe-arch geometry, in each case all parameters for forming the pipe-arch being the same except for chain lengths.

FIG. 5 is a side view of the basic machine of FIG. 2.

FIG. 6 is an enlarged fragmentary view, partly in section, of a portion of the machine illustrated in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 2 the base of the machine is illustrated as fabricated of structural beams 10 forming a platform to which the side columns 12 are attached.

The side columns 12 may be four in number, with longitudinal struts and bracing in the plane of the columns. These side columns 12 support the top frame structure generally indicated at 13. The top frame structure 13 provides support for a pair of hydraulic cylinders 14 which in turn are attached to the top die 15. The structure 13 may be comprised of a pair of sections, one for each of the hydraulic cylinders, connected by appropriate longitudinal struts and bracing. The top die 15 moves vertically from its uppermost position downward the required distance to properly deform the pipe.

The base 10 of the machine also supports laterally moving side frames 16, the side frames having suitable base plates and guides which allow them to slide laterally on cross members 17 (see also FIG. 1) of the base 10. Power for movement of the side frames 16 is provided by screws 18 which are attached to bearing points 19 on the base and which will have a screw nut (not shown) attached to the lowermost point of the side frame 16 as is well known in the art. Chains 20 may be attached to the topmost points of the side frames 16 by means of chain idlers 21 suitably supported adjacent the upper portions of the side frames 16 and chain hooks 22 thus allowing the chains to hang suspended between opposing chain idlers 21 in a catenary curve until such time as the pipe to be deformed is placed in position for forming. Such arrangement may be referred to generally as chain anchors.

FIG. 2A corresponds to a portion of the upper left-hand front of FIGS. 1 and 2 and illustrates a modification of the invention wherein the chain anchors comprise hooks 22a mounted directly on suitable frame members 25a, the chain idlers 21 and hooks 22 having been eliminated. With the anchor means 22a in this relocated position, a long length of chain hanging over the side of the frame structure is not so apt to pull the chain off the hook as might otherwise be the case with an arrangement like that shown in FIG. 1.
Top die 15 is provided with a slotted arrangement in its lower surface along the longitudinal center line of the machine which is designed to accommodate a trolley equipped with a hook 23.

In operation of the machine, the side frames 16 are positioned by the screws 18, which may be either powered or operated manually, to the proper lateral widths for the diameter of pipe to be deformed. The chains 20 are adjusted to the proper lengths for the diameter of the pipe to be deformed by manual movement of the chains on the chain anchors, whether they be the idlers 21 and chain hooks 22, or the hooks 22a on the members 25a. With the top die 15 raised to a convenient point to admit the pipe to be deformed, one end of such pipe is placed on the hook 23 while the opposite end is supported by an outside means, not shown. The pipe 30, schematically illustrated by the broken lines employed in FIGS. 3 and 4, is then rolled into deforming position where it rests on the plurality of chains 20, the outside supporting means then being removed. The hydraulic cylinders 14 are then actuated to move the top die 15 downwardly to perform the deforming of the pipe into the particular pipe-arch shape desired, resistance to forming forces being provided by the chains 20, and side confinement of the formed pipe shape being provided by the plates 24 which are attached to the top of the side frames 16 by members 24a or the like. Interlocking means generally indicated at 26 cooperate with the flanges 12a of the side columns 12 to function as guides for the top die 15 during its downward movement.

A suitable number of chain hooks 22, 22a are spaced along the frame members 25 or 25a as the case may be so that, depending on the pitch and depth of the pipe corrugations and the pipe metal thickness, a suitable number of supporting chains may be utilized. It may be that, for example, for three inch pitch by one inch deep corrugation on an annular pattern, it will be desirable to provide chains every 6 inches (or two pitches). For corrugated pipe of smaller pitch or shallower corrugations, it may be desirable to locate chains every eight inches or so, or three pitches. For any existing corrugated pipe, the number of desired corrugated pipe chains may be located on 6 or 8 inch centers depending upon the forming resistance required. For smooth wall pipes, various chain spacings may be used.

This machine utilizes the chains 20 suspended in a selected, fixed position from the side frames 16 via the chain anchors (idlers 21, hooks 22 and frame members 25, or the hooks 22a on the frame members 25a) to function as the lower die element. Such chains will resist the pressure of a vertically moving top die 15. Side confinement of the pipe on this machine is performed by the members 24 which are an integral part of the same side frame 16 which supports the chains 20.

Referring now to FIGS. 5 and 6 there is depicted an equipping device to insure precise control of the top die 15 during is downward, deforming movement. The device consists of two identical assemblies, each controlling the movement of one end of the top die 15. Each assembly is comprised of a slide 29 carrying a cam 29a and slideable on track 33. Slide 29 is attached to the track 33 with provision for lateral movement. A flexible member generally indicated at 27, and which may be a chain or other flexible member running over idlers 28 to accommodate direction change of the flexible member 27, is attached to the end of the top die 15.

Tension for the flexible member 27 is provided by the counter weight 35.

Slide 29 and cam 29a are positioned to actuate limit switches 31 or 36 during either upward or downward travel of top die 15. It will be understood by those skilled in the art that movement of the top die 15 will be limited to within the preferred limits within the selected set of parameters for the making of the pipe-arch desired. Limit switches 31 and 36 are attached to clamps 32 which may be positioned manually, or by powered means, on member 34 to the desired position.

These equalizing device assemblies are attached to the strut members located in the plane of the side columns 12.

The flexibility of this invention is perhaps best illustrated with reference to FIGS. 3 and 4. In order to demonstrate the variable geometry which may be accomplished by the machine of this invention, certain parameters are given. In the illustrations of FIGS. 3 and 4 the dimensions indicated at 40 between the side restraints 24 are the same. In each case pipe of the same beginning diameter 30a is employed. It is also assumed that pipe-arch of the same height 30b will be achieved in the final product. Thus, the only thing to differ in the setups illustrated in these FIGS. 3 and 4 is the effective lengths of the chain employed. The amount of chain from point A to point B in FIG. 4 is only approximately 94% of the amount of chain measured between these same points in FIG. 3. The curve of chain 20 in FIG. 4 is flatter than that of FIG. 3.

It will be apparent to those skilled in the art that there are some limits of a practical nature on the chain length variations employed in this machine. If the chain, for example, is set either too long or too short, the widest part of the pipe-arch may strike below or above the side restraint member 24 and the forming which then takes place may be undesirable. Within the workable parameters selected, however, it will readily be apparent that simply by changing only the length of the chain 20, pipe-arch of different shapes may be finalized. In these examples, therefore, it is assumed that a given starting diameter 30a will be employed and that distortion will in fact occur sufficient to get the finished height 30b in both cases. Assuming these dimensions and the fact of distortion, the two shapes resulting from the arrangements of FIGS. 3 and 4 will be different from one another. Such variations in shape are achieved simply by changing the effective lengths of the chains employed.

The prior art does not disclose an arrangement which will achieve this result. Thus, in the arrangement of the said Honeyman patent earlier mentioned, wherein the chains are employed simply to pull the pipe into contact with a fixed upper die, the chains originating well above the die, for any given set of parameters a single shape will be realized regardless of how much chain length was started with initially.

To obtain the results of the instant invention in a modification wherein the chains are employed to move the pipe into contact with a fixed upper die, and to differentiate such a modification from that of the said Honeyman patent, the structure utilized would have to be such that the chains 20 would first be arranged between the points A and B so as to begin with the particular chain curve desired, and then, while maintaining this chain curve, the points A and B, in effect, would be moved upwardly so that the chains would bring the pipe 30 into deforming contact with the die 15 so as to
get one of the shapes 61, 62 of FIGS. 3 and 4. This modification, although not shown, is one which will be appreciated by those skilled in the art. The difference between such modification and that of the said Honeyman patent is that the effective curvature of the pipe supporting chains is different in the two examples mentioned, a fact which is not available in the prior art structure as shown.

It will also be apparent to those skilled in the art that other modifications may be made in this invention. Furthermore, while the invention has been illustrated with reference to certain structures and arrangements, the invention is not to be limited to these particular arrangements and structures except insofar as they are specifically set forth in the subjoined claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A machine for deforming pipe into pipe-arch which comprises: a base; side columns fixed to said base; a top frame fixed to said side columns; a top die mounted on said top frame; side frames on said base movable towards one another; restraining means on said side frames adapted to be engaged by pipe such as pipe is deformed; a plurality of chains suspended from said side frames so as to form a curve, said chains being adapted to receive pipe to be deformed; means to change the effective curve of said suspended chains relative to the selected position of said restraining means; and means to effect relative movement between said top die and said chains so as to deform the pipe into pipe-arch.

2. The machine of claim 1 in which said last mentioned means includes operative means to move said top die vertically downward into contact with pipe positioned on said chains.

3. The machine of claim 2 in which the means to change the effective curve of said chains includes chain anchors.

4. The machine of claim 3 in which said chain anchors are located outside of said restraining means so that said chains are free thereof.

5. The machine of claim 2 including screw means to effect movement of said side frames.

6. The machine of claim 2 in which said restraining means comprises a pair of horizontal parallel plates spaced from one another a distance sufficient to permit pipe to be placed on said chains and against which said pipe will abut when deformed by downward movement of said top die.

7. The machine of claim 6 in which said chains are free of said plates so that pipe supported thereon will engage said plates directly when deformation takes place.

8. A machine for forming pipe-arch from cylindrical pipe which comprises: a pair of side frames; a plurality of chains adapted to be suspended between said side frames, said chains lying in a catenary curve; parallel pipe restricting means arranged along said side frames and between which pipe is to be disposed when said pipe is placed on said chains, said pipe restricting means being arranged to be engaged by said pipe when said pipe is formed into pipe-arch; means to adjust the lengths of said chains between said side frames relative to said restricting means whereby to effect changes in said curve; a top die located above said chains; and means to move said top die into contact with pipe supported on said chains whereby to form said pipe into pipe-arch; the said chains supporting said pipe and preventing downward movement thereof, and the said restricting means regulating outward movement of said pipe as it is formed by downward movement of said top die.

9. The machine of claim 8 in which said pipe restricting means comprises a pair of parallel plates; the said means for adjusting the lengths of said chains comprising chain anchors located to the outside of each of said plates.

10. The machine of claim 9 in which said chain anchors comprise a pair of chain idlers and a plurality of hook means to which the chains are engaged, a said plate and a said idler being closely spaced, said chains passing therebetween, and means to move a set comprised of one said plate and one said idler towards another set comprised of another said plate and another said idler.

11. A machine for deforming pipe into pipe-arch which comprises: a base; side columns fixed to said base; a top frame fixed to said side columns; an hydraulic cylinder actuating means attached to said top frame; a top die mounted on said actuating means; side frames mounted on said base and movable towards one another; restraining means on said side frames adapted to be engaged by pipe such as pipe is deformed; a plurality of chains suspended from said side frames so as to form a curve, said chains being adapted to receive pipe to be deformed; means to change the effective curve of said suspended chains relative to the selected position of said restraining means; and means to effect relative movement between said top die and said chains so as to deform the pipe into pipe-arch.

12. The machine of claim 11 including an equalizing device for said actuating means.

13. A method of forming pipe-arch from pipe which comprises the steps of supporting pipe on a plurality of chains hanging in a catenary curve, providing a die spaced from said pipe, providing means to limit outward deformation of the pipe, providing means to change the effective curve of said chains relative to the selected position of the outward limiting means, and effecting relative movement between said chains and said die to deform said pipe.

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