April 20, 1943. H. S. CLAYBAUGH 2,316,839

METHOD OF MAKING ARCH-TYPE CULVERTS

Original Filed Nov. 10, 1939

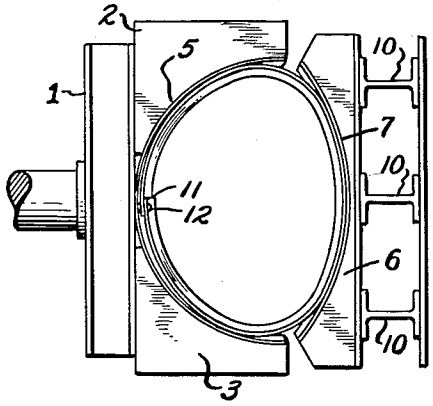


FIG. 1.

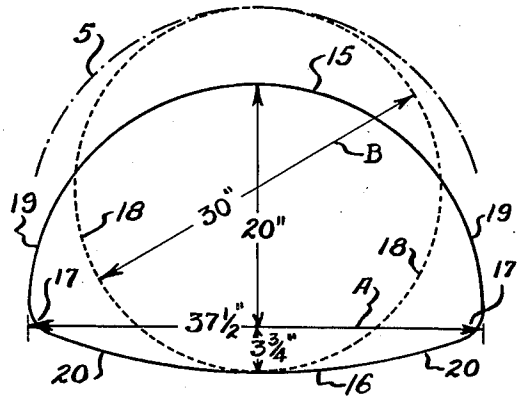


FIG. 2.

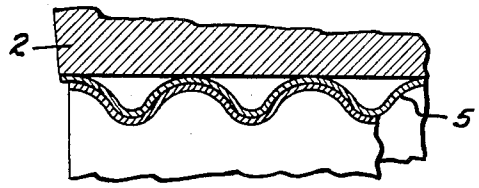


FIG. 3.

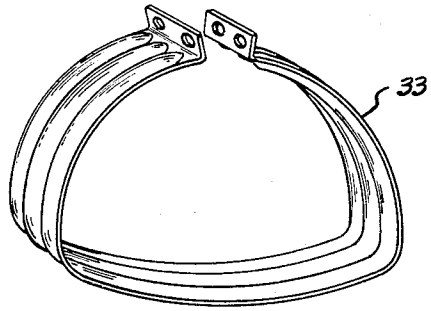


FIG. 4.

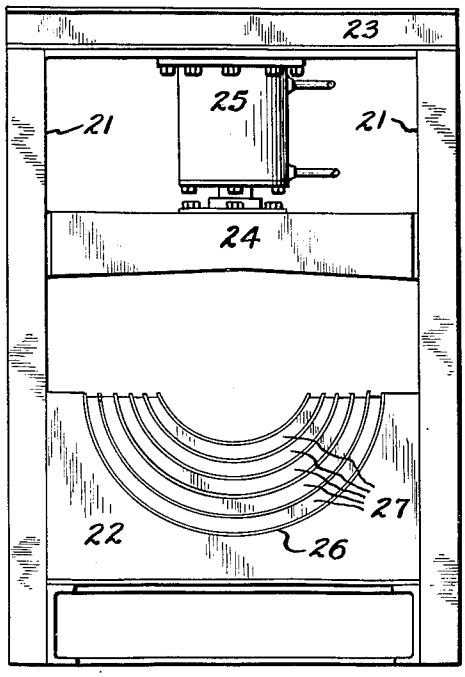


FIG. 7.

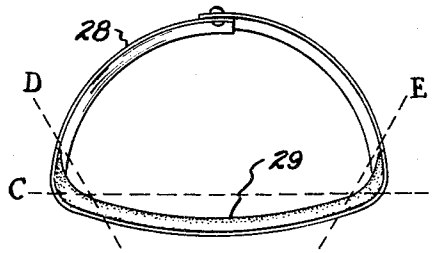


FIG. 5.

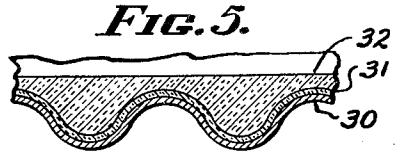


FIG. 6.

INVENTOR.
HOWARD S. CLAYBAUGH.
BY Allen & Allen
ATTORNEYS.

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METHOD OF MAKING ARCH-TYPE CULVERTS

Howard S. Claybaugh, Minneapolis, Minn., assignor to The American Rolling Mill Company, Middletown, Ohio, a corporation of Ohio

Original application November 10, 1939, Serial No. 303,846, now Patent No. 2,286,197, June 16, 1942. Divided and this application November 10, 1939, Serial No. 303,845

4 Claims. (Cl. 153—48)

This application is a continuation in part of my application Serial No. 135,555, filed April 7, 1937, and entitled Pipe or culvert and method for making, and is a divisional of my copending application Serial No. 303,846 filed November 10, 1939, and now Patent No. 2,286,197 and entitled Pipe or culvert.

This invention relates to improvement in pipes and culverts or the like, and to the method for making same, and has among its objects to provide a one-piece tubular structure in which more flow efficiency from a hydraulic standpoint is obtained, in which less head room is obtained with better placement of flow and in which the arch strength is increased, and in which a desirable flexibility is obtained which is of advantage in supporting the load which the structure must carry.

The invention is applicable to hydraulic piping in general, and although the invention has found a valuable application in culverts, it is not limited entirely to such application.

In the last few years metal culverts have come more and more into use, but in all arch-type culvert structures known to me the arches are arranged upon some fabricated base of wood or metal, are assembled on the job, and are either bolted to angle irons on a cement or other base, or a flat metal base is used and has turned up ends to which the feet of the arch are riveted.

Flat bases of metal have a disadvantage in that, due to thrust of the feet of the arches at the outer sides of the base, the same buckles upwardly centrally. In case of buckling there is likely to be foundation undermining due to washout. It is an object of my invention to avoid this.

Another and important object of this invention is to provide a structure having a relatively wide bottom with a relatively low vertical height and to use as a starting material, the ordinary cylindrical pipe, and to deform and shape the pipe so as to obtain all of the advantages hereinafter set forth and to avoid the disadvantages of former structures.

Another object of my invention is the provision of an arch type culvert or pipe having inherent advantages both in the manufacture and in installation and use over any arch type culvert heretofore produced, as will be set forth.

Still another object of my invention is the provision of arch type culverts in sizes comparable to the smaller sizes of culverts which hitherto could not be produced in arch form.

Still another object of my invention is the provision of integral, unitary arch type culverts in all sizes, which can be handled and installed like ordinary culvert units and do not require fabrication in the field or during installation.

Still another object of my invention is the provision of integral arch type units which embody all of the protective features which contribute to the wear resistance and prolongation of the life of conventional culvert units, and especially the provision of paved, arch-type culverts.

These and other objects of my invention which will be set forth hereinafter or will be apparent to the skilled worker in the art upon reading this specification, I accomplish by that certain construction and arrangement of parts of which I shall now describe exemplary embodiments. In this application I claim the method, and the product is claimed in a copending divisional application entitled Pipe or culvert.

Features of the invention include the culvert as an article of manufacture; the method by which it is made; and the scheme of operating on a long cylindrical tube and applying pressure at points spaced axially of the tube to bring the total length of the tubing to the required form; along with all the broader ideas of means inherent in the drawing or specification or claims.

Features, objects, and advantages of the invention will appear in the description of the drawing; and in said drawing:

Figure 1 is a side elevation showing the essential elements of the press and their action in deforming the cylindrical tube and showing the tube in end view;

Fig. 2 is a diagram showing the relation of the cylindrical tube, to the contour of the improved culvert made therefrom, as a result of controlled deformation; and

Fig. 3 is a longitudinal section taken through one of the pressing elements and tube being deformed thereby, and illustrating the corrugated liner or conformation of the mold and its relation to the corrugations of the tubular element during deformation of the same.

Fig. 4 is a perspective view of a band which may be employed in fastening culvert sections together.

Fig. 5 is an elevational view of paved culvert.

Fig. 6 is a partial longitudinal view of a culvert having a modified form of paving.

Fig. 7 is a front elevation of another form of press.

Briefly, in the practice of my invention, I first form a culvert section in the conventional way. Preferably the culvert is formed circumferen-

tially from a single metal sheet the ends of which are lapped and riveted or otherwise fastened as is usual. This is possible in all but the larger sizes; but it is not without the spirit of my invention to employ a section which is formed circumferentially of more than one sheet. Then I deform the completed culvert section to arch shape as will hereinafter be described. In the deformation, the upper section is given a wider curve than the original, and the bottom section is not formed flat but somewhat convex outwardly; and the two sections are joined by curved portions at the side edges of the arch. In the deformation, provision is made for retaining the contour and continuity of the corrugations in the culvert or pipe where corrugations are employed. A paving may be installed in the culvert or pipe either before or after the deformation, or partly before and partly after the deformation, all as will be fully explained hereinafter.

Referring first to Figure 1, numeral 1 indicates a vertically disposed I-beam of a pair, having attached thereto in spaced relation a pair of die-forming elements respectively indicated at 2, 3; and the said elements may be faced by what I term a liner of corrugated metal 5, the liner being suitably secured as by riveting or welding (not shown) to the metal elements 2 and 3.

The arc of contour of this liner is not circular but has substantially the curvature desired for the arch of the final product, which is preferably parabolic. In any event the curvature is such as to properly form the arch portion of the culvert. A second die element is indicated at 6 and this also may have a corrugated liner 7 similar to that at 5. The die element 6 is suitably backed in this case by horizontally arranged I-beams 10, and in one form of the press, now used, the I-beams are moved by suitable mechanism toward the element 6. The elements thus far described constitute parts of a press which will include a suitable framework and pressure applying means (not shown in Fig. 1).

It is to be noted that the tubular element being acted upon is formed from a single sheet of corrugated metal with the end portions overlapped as at 11, and riveted by a series of rivets 12 spaced lengthwise of the tube.

In Fig. 7 I have shown a modified form of press comprising a frame 21, a base 22, a top beam 23 and a movable platen 24 which may be actuated by hydraulic mechanism 25 or other suitable mechanical or fluid means. The base 22 is hollowed out to the desired arch shape for a large size culvert or pipe as at 26; and I provide a series of nesting die members 27 which may be stacked in groups of varying number to adapt the press for the formation of culvert or pipe of different smaller sizes.

Different die members may be attached to the platen 24 to form arch bottoms of different curvatures, if desired; but I have not found this necessary in practice. The bottom of the culvert should be convex outwardly; but it is sufficient to form the bottom surface of the platen 24 to a curve of large radius, or to form it of meeting angularly related planes as shown so as to give it a desired concavity which may be the same for all sizes of culvert.

It will be noted that the dies shown in Figure 7 are not provided with corrugated surfaces. Corrugated members conforming to the corrugations of the cylindrical culvert are sometimes of assistance in maintaining the corrugations during deformation; but with culverts of properly defined corrugations and normal thicknesses of metal in proportion to the diameter of the culvert are usually not necessary, and successful commercial operation is being carried on with dies having smooth surfaces.

A feature of the invention is the operation of deformation by pressures successively applied at points spaced axially of the tube. In this way the result can be obtained by the use of relatively narrow dies. Action is first had on the end of the tube and then the tube is moved axially step-by-step so that pressure is successively applied, until the whole tube has been deformed in the manner contemplated herein. In this way the dimension of the dies is not controlling as to the length of sections which can be formed. In Fig. 2 the arch is shown as partly circular, while in Fig. 1 the arch is non-circular. Both configurations are contemplated herein. Although in Fig. 1 the press is shown in its final position it will be understood, by an inspection of Fig. 2, that the tubular element originally had a cylindrical form. Of course, the main feature herein is the deformation of this hollow cylindrical element, to provide a mechanically improved pipe or culvert, which may or may not have substantially the same cross sectional area or water-carrying capacity as the cylindrical tube from which it is made, but which gives greater flow capacity in the bottom portion and which provides a base which will not buckle upwardly, and which acts in a self-tamping manner as the load is applied to the arch.

Referring now to Fig. 2 this figure is given by way of example only, and there is no intention to be limited to the exact shape or capacity other than that a pipe is provided which has a maximum of bed area and flow capacity with a minimum of head space. As an example only, the dimensions have been given for a culvert produced by deformation of a cylindrical metal tube having a diameter of 30 inches. The cross-sectional area of the cylinder is about 4.91 square feet, and the cross-sectional area of the improved pipe (in this instance a culvert) is about 4.69 square feet. This ratio of the cylindrical to the deformed pipe may be varied, so that greater bed capacity is obtained as a result of deformation, but so that cross-sectional area is proportionately less than in the above example. An important feature is the relatively large flow capacity in the bottom portion of the improved pipe.

The total head room in this particular improved culvert is about 23¾ inches, 20 inches of this amount lying above a line A which approximately represents the level of the connecting zone of the feet of the arch 15 with the base 16. The width of the base, as measured by this horizontal line A, is substantially greater than the diameter of the cylinder represented by line B, said original diameter being 30 inches, and the width of the base of the improved culvert being about 37½ inches. The feet of the arch merge into the base by curved portions 17 of relatively small curvilinear extent or area. Of course there is no intention to be rigidly limited to the exact areas of these curved portions, but they are all of relatively small extent as compared with the base and arch portions and in all instances the base although relatively flat and concaved upwardly, is substantially of greater width than the diameter of the original cylindrical element from which the improved culvert is produced.

An important point is that the width of the bed flow has been increased, and insofar as the flow volume is concerned the added and efficient area lies between the portion 18 of the dotted line representing the outline of the cylinder, and the portions 19 and 20 respectively at the lower portion of the base area which extends from the vertical middle of the culvert to the point of connection at the foot of the arch.

The curved portions of the improved arch are generally non-circular and the arch is preferably of parabolic form. The curved bottom is preferably non-circular and has more of an elliptical configuration, but in any event is preferably convex outwardly. The dies may be riveted to channel irons and compression action is obtained by any suitable means.

The tubular sections can be from two to four feet long, and the span as measured horizontally can be 18 inches to 67 inches. Good proportions are: 18 inch span with a rise (vertical height) of 10 inches; or up to 67 inch span with a 37 inch rise, etc. The invention is not limited to or by the above dimensions. The device is particularly valuable for cross drains, and for storm sewers to give large flow capacity to low head room. In the highway field for side culverts, or under-the-road culverts, especially where beautification is a factor, these culverts are more attractive as drain structures.

In carrying out the invention, a cylindrical pipe is made and is riveted together in the usual manner by standard fabricating methods. This pipe is then placed in a machine and is deformed or collapsed preferably by dies, the dies being shaped to hold the pipe (as collapse occurs) as to obtain a final configuration substantially like that shown in the drawing, including a base which is slightly upwardly concave.

The advantages are valuable ones. The total cross sectional or flow capacity area is not substantially changed, but there is a very substantial increase of flow capacity at the bottom portion of the pipe. This greater flow capacity at the bottom is desirable because under ordinary conditions water remains at this lower level. The pipe is rarely more than three-fourths full, and this relatively very much larger flow capacity is at the bottom where it should be.

The improved culvert therefore spreads the water over a larger base area and for a given volume reduces the velocity which is a particular advantage when placing the culvert in ditches or especially on a sand foundation because lessened velocity decreases the amount of "under wash." Another important advantage is that substantially greater normal cross-sectional area is obtained with substantially less head room, and the culvert can be installed with very few inches of cover.

Another important advantage is that the supporting strength of the arch is substantially increased since the method of formation has taken out or annulled most of what may be termed the initial flexibility. The resistance to load has been substantially increased. The upwardly concave base, or downwardly convex base, allows the proper amount of flexibility but increases the dead load and live load needed to appreciably deflect the arch.

In cases where an end of a culvert projects beyond an embankment, greater strength is provided by the culvert of this invention against sagging.

The bottom or base of the culvert is curved but is relatively flatly curved and is upwardly concave for several reasons. One is to keep it as flat as possible to obtain large bottom area. Another is to provide a bottom which will flatten to some extent as the load is applied, and will act as a self-tamper, yet will still retain its curved form, and will not buckle upwardly, whereby to allow space for underflow of water to undermine its foundation. For ordinary installation a flat bottom ditch or one with a slightly concave bottom is excavated. The culvert is then laid in the ditch bottom and the back-filling is placed. This fill is tamped solidly at the sides and as far back beneath the bottom as is practicable. When the load is applied to the arch and the curved bottom springs slightly or flattens slightly it will cause the loose fill back under the outside ends of the culvert to be tamped and become compact, which adds greatly to the strength of the culvert.

In this invention the cylindrical pipe is so acted upon and its shape is so changed that the resistance to deformation of the final article by load is substantially increased, the vertical height is decreased (which is required more and more in road work), and due to the broader horizontal base with its lower level, increased flow capacity is provided.

The culvert or pipe of my invention may be given a paving in accordance with the teachings of the Cushman Patent No. 1,735,732. This may be accomplished by dipping and draining the structure in a horizontal position, using a fluid bath of suitable bituminous or other paving material. Pavings may be made without filling up the corrugations level full, and will contribute to the life of the structure. I prefer, however, completely to fill up the corrugations so as to make a level floor over the paved portion. I prefer also to cause the paving to cover the whole bottom of the structure and to extend part way up the sides of the arch, thus providing a paving which may be formed by dipping the culvert structure 28 of Fig. 5 in directions normal to the planes indicated by dotted lines C, D, and E. Depending upon the configuration of the bottom, a greater number of dips may be employed if desired. In the dipping process the arch wall portions may be partially or completely given a thin coating of the bituminous paving material.

Or the paving 29 may take the form of a preformed pad of bituminous material with or without fibrous reinforcement, which pad may be placed in a culvert, caused to conform to the inside configuration thereof, and caused to adhere by heat and pressure, or by the use of a cement.

In Fig. 6, I have shown the metal body 30 of the culvert, which in this case is a galvanized body, carrying an inwardly disposed sheet of asbestos or the like 31 which was applied to it prior to the solidification of the molten galvanizing metal so as to become imbedded therein. This may be done before the sheets are formed into the original round culvert. A paving 32 of bituminous or like substance, which may either be formed by dipping or may be formed as a pad, is in adhesive contact with the asbestos sheet 31.

My culvert sections are handled in the field as ordinary culvert sections, and may be fastened together in endwise relationship by means of bands such as that shown at 33 in Fig. 4, or may be otherwise fastened together as desired.

Modifications may be made in my invention without departing from the spirit of it. Having

thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of making a corrugated arch-type conduit, which comprises first forming a cylindrical, continuous metal tube, said tube being circumferentially corrugated substantially throughout its length, applying pressure to opposite sides of the tube by means of dies, both of which are concave and one of which is characterized by substantially greater concavity than the other, moving the dies relatively toward each other with the tube between them to exert pressure radially of the dies on the outer portions of the corrugations along substantially diametrically opposite longitudinal parts of the tube whereby to deform the tube, the tube during deformation having portions extending freely between areas of pressure, the said deformation occurring primarily in said freely extending portions, applying the substantially diametrical pressure adjacent each side of each such area of deformation, and progressively extending the areas of diametrical pressure toward each other circumferentially of the tube as the pressure is applied, to deform and draw the corrugations of said tube in said freely extending portions without collapsing the said corrugations, the corrugations as so drawn serving to maintain the deformed condition of the metal tube as a whole, whereby to produce a corrugated conduit having an arch and a relatively flat but slightly outwardly convex base together with connecting portions between the arch and the base of greater curvature than the arch, the corrugations maintaining their integrity and continuity in the final conduit.

2. The process claimed in claim 1 including the step of progressively deforming the said corrugated tube by the application of pressure thereto successively in contiguous areas from end to end of the tube.

3. The process claimed in claim 1 including the step of positioning the corrugated tube so as to relate axial riveted joints therein to said initial pressure areas to cause said joints to lie at portions of the deformed tube remote from those portions connecting the arch and base thereof.

4. The process claimed in claim 1 including the step of limiting pressure in said pressure areas to the crests of the corrugations of the corrugated tube.

HOWARD S. CLAYBAUGH.