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FLOW INCREASING ATTACHMENT FOR CULVERTS

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Fig. 1.

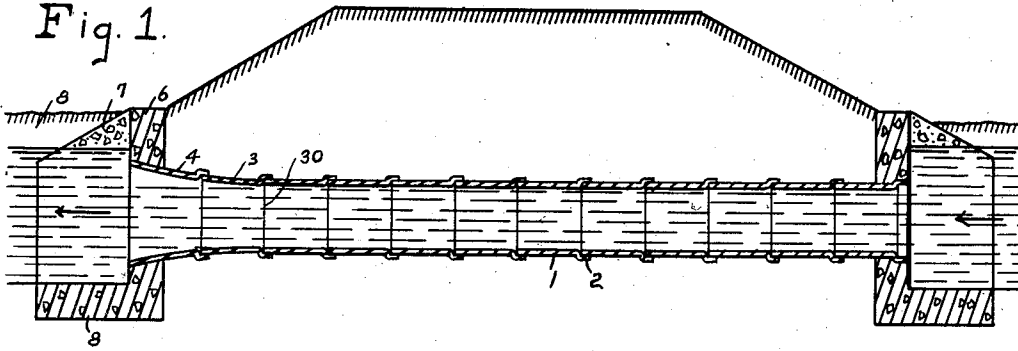


Fig. 2.

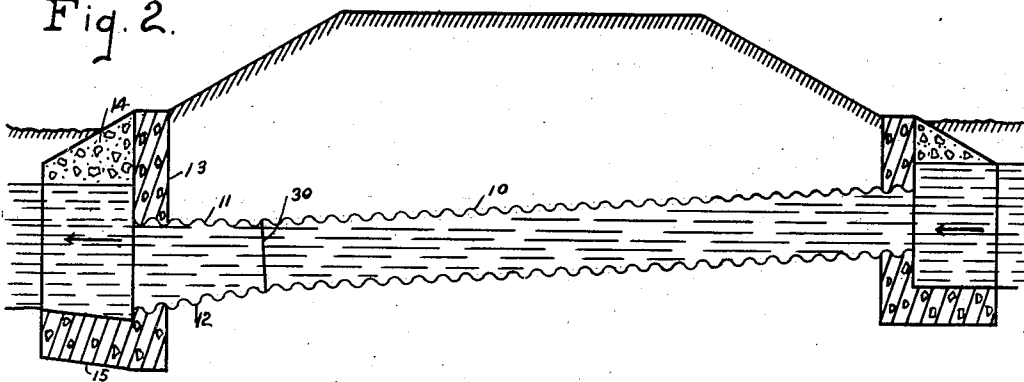


Fig. 3.

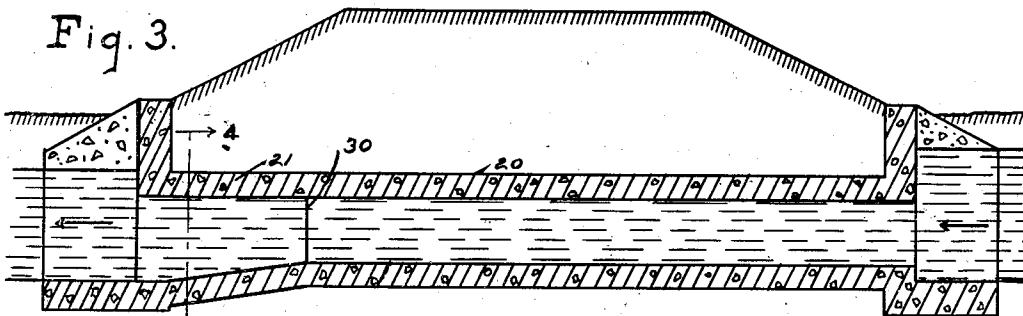
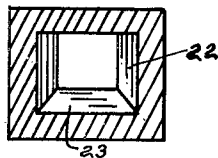


Fig. 4.



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FLOW-INCREASING ATTACHMENT FOR CULVERTS.

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My invention relates to improvements in flow increasing attachments for culverts.

The object of my invention is to utilize the kinetic energy of the water flowing through the culvert to increase the rate of flow therein instead of permitting such energy to be wasted or allowing it to be destructively exerted upon the banks of the stream at the outlet.

More specifically stated, it is the object of my invention to provide means whereby the flow of water through a culvert may be automatically accelerated when the culvert is filled with water, whereby the capacity of the culvert under a given surface elevation of water at the inlet end may be materially increased as compared with that of ordinary culverts of the same diameter.

My invention is based upon the discovery that by providing a culvert with an extension which will be submerged when the culvert is filled and which progressively increases in cross sectional area in the direction of the outlet, it is possible to utilize the kinetic energy of water passing through the culvert to maintain a velocity in the progressively enlarging extension sufficient to not only reduce the resistance at the junction of the extension with the culvert, but to actually develop a tendency toward a vacuum at that point, whereby the rate of flow through the culvert may be accelerated, notwithstanding a reduction in the velocity of the water at the outlet end of the attachment.

I have further discovered that the results possible to obtain by my invention are not only dependent upon an installation which ensures the submergence of the outlet during periods when the culvert is filled with water, but that the best results are also dependent upon the rate of divergence of the walls of the attachment, the best efficiencies under ordinary conditions being shown where the opposing walls diverge substantially at the rate of one to ten, i. e., one foot for every ten feet in length as measured along the axis. A less divergence requires an increased length of the attachment and a greater divergence will ordinarily be found to reduce the efficiency by absorbing a portion of the energy. Tests of my improved attachment, under actual working conditions encountered in the installation of road culverts, have

demonstrated that it is possible by the use of my invention to increase the capacity of such culverts about fifty per cent.

I am aware of the fact that culverts have been provided with conical or converging walls at the inlet end and with divergent walls at the outlet end designed to prevent erosion of the banks and to prevent the destructive effects of cross currents and eddies, and in some instances to reduce the tendency for debris to clog the culvert. But so far as I am aware no regard has been paid in such instances to the requirements necessary for increasing the capacity of the culvert, the expanding outlet ends being provided for substantially the same reason which led to the use of a contracting inlet, i. e., an inlet having converging walls, and without reference to the degree of divergence of the walls at the outlet, nor to the provision of means for ensuring a submergence of the outlet under capacity conditions. Unless these factors are taken into consideration and the culvert accordingly designed in accordance with my invention the desired object cannot be attained.

In the drawings:—

Figure 1 is a vertical sectional view of a roadway provided with a culvert constructed in accordance with my invention.

Figures 2 and 3 are similar views showing modified forms of construction and arrangement.

Figure 4 is a cross sectional view of my improved attachment or extension member of the culvert, drawn to line 4—4 of Fig. 3.

Like parts are identified by the same reference characters throughout the several views.

In Fig. 1 the culvert proper comprises a series of tile members 1, each having at one end an enlarged portion 2 which serves as an overlapping, annular flange for the next section. The attachment embodying my invention comprises the two conically tapered members 3 and 4 at the outlet end, the outer member 4 being preferably slightly bell-shaped at the discharge end. The degree of expansion in the conical portion is in the ratio of substantially one to ten as above described and at the outlet end the cross sectional area is more than double that of the cylindrical portion of the culvert, i. e., that of the members 1. At the outlet an abutment 6 is provided which is flanked by

walls 7 which with the bottom wall 8, are adapted to prevent erosion at the sides of the abutment 6 and are also adapted to co-operate with the banks 8 of the stream to ensure the retention of sufficient water at the outlet to keep the surface level above all portions of the member 4 when the culvert is filled with water, although somewhat below the level of the water at the inlet.

Where the conditions are such that a horizontally disposed culvert would not have the outlet end of the attachment submerged under ordinary conditions of capacity flow, I employ the construction illustrated in Fig. 2, in which the culvert tube 10 is downwardly inclined in the direction of the outlet, and my improved attachment 11 will, in such case, be preferably formed with its top portion substantially a continuation of the top of the tube 10, but with the sides and also the bottom 12 diverging, respectively, from each other and from the wall 11.

The abutment 13 is formed with flanking walls 14 and a bottom wall 15 similar to the walls 7 and 8 shown in Fig. 1, but with the bottom wall 15 preferably upwardly and outwardly inclined to counteract the erosion which would otherwise result in the bed of the stream from the impact of the downwardly moving current of water.

In Fig. 2 the culvert and also the attachment are illustrated as composed of corrugated metal, but the character of the material used is not essential to the invention herein claimed. In cases where the culvert is composed of concrete, the culvert tube 20 and the expanding attachment 21 may be formed integrally as a monolithic structure, (Fig. 3), and may, if desired, be rectangular in cross section. The side walls 22 of the extension diverge as clearly shown in Fig. 4 and the bottom wall 23 is also downwardly inclined to a greater extent than the top wall 21, the latter being continuous in a straight line with the top of the culvert tube or passage 20. The flanking walls and floor of the abutment extension are similar to those disclosed in Fig. 1, the conditions assumed being such that it is not necessary to provide an inclined floor similar to the floor 15 in Fig. 2. It will be understood that in forming these flanking walls on the abutment consideration should be given, not only to the prevention of erosion, but also the problem of maintaining the surface level of the stream at a horizontal plane above the top of the expanding attachment or extension member of the culvert.

In operation, there is no material difference in the results attained by my improved culvert over those of an ordinary culvert until the flow of water becomes sufficient to fill the culvert and the expanding attachment at the outlet end thereof. But when the flow is such as to fill the culvert tube

and raise the level of the water at the outlet above the expanding attachment, the water tends to maintain by inertia the velocity which it has when entering the attachment, and actually maintains a sufficient velocity within the increasing cross sectional areas, to enable the attachment to carry progressively greater quantities of water at the maintained velocity than that which the culvert tube would normally supply. Therefore, there is a constant tendency for the water in the attachment to move away from that which follows it, and this causes an acceleration of the flow in the smaller cross sectional areas, the effect being that of an increase in head at the inlet end of the culvert.

In a glazed tile culvert twenty-four inches in diameter and twenty feet long, operating under a normal head of one foot, with a discharging capacity of 23.4 cubic feet per second, I have found that by attaching my improved extension member the capacity can be increased to 33.6 cubic feet per second. A similar test with a culvert thirty inches in diameter and twenty feet long under one foot head of water showed a capacity without my improved attachment of 33.3 cubic feet per second and a capacity with the attachment added of 50.2 cubic feet per second. The tests in both cases were made under conditions which were otherwise alike and with the outlet submerged.

Similar tests made with culverts of varying length and diameters indicate that there is a variation in the results secured which is dependent upon the length and diameter of the culvert tube, the length of the attachment and the ratio of expansion, but that, in all cases where the above described conditions of installation are observed, a very marked increase in the capacity of the culvert is attained by the use of my invention.

By the use of my invention the momentum energy of the water in the culvert is exerted against the body of water in the attachment which is necessarily moving more slowly because of the enlarged cross section and which, therefore, serves as a water piston to absorb the difference in the kinetic energy of a given volume of water at the inlet end of the attachment and that of an equal volume at the outlet end or point of final discharge. In absorbing this momentum energy the water piston in the attachment is somewhat accelerated, but at the outlet, if the cross sectional area is double that of the culvert, the velocity will be about one half that of the accelerated culvert water and considerably less than it would be at the outlet of the culvert if constructed in the ordinary manner.

My invention, therefore, serves the double purpose of utilizing the kinetic energy of the water flowing through the culvert to re-

duce the resistance, thus increasing the effective head, and of proportionately reducing the velocity of the water at the point of final delivery to prevent destructive erosion.

6 I claim:—

1. A culvert provided with divergent walls at its discharge end forming a progressively enlarging water passage and positioned for complete submergence of such
10 passage below the level of the stream of water when the culvert is filled.

2. The combination with the walls of a culvert, of an extension member at the outlet end thereof, of progressively increasing
15 capacity in the direction of the outlet, said extension member being disposed for a complete submersion of its water-carrying por-

tion beneath the level of the stream at the outlet when the culvert is filled.

3. A culvert having a main portion of
20 substantially equal capacity throughout, and a submerged outlet portion, which progressively increases in cross sectional area in the direction of the point of discharge in such a ratio as to provide an expanding water
25 piston capable of substantially absorbing the difference in the kinetic energy of the water delivered from the main portion and that of an equal quantity of water delivered from the outlet portion, to accelerate the flow in
30 the main portion while reducing its velocity at the point of discharge.

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