

ARCHED PRECAST CONCRETE CULVERT

This invention relates to a group of arched culverts to be used for the construction of an aqueduct, a tunnel, a utility tunnel and other closed conduits, and such group can include a variety of arched concrete culverts ranging from type A to type L that will be described later, and selectively used depending upon circumstances. The arched culverts each comprises a bottom portion, two leg portions upstanding from opposed sides of the bottom portion and an arched ceiling portion spanning both leg portions.

Heretofore, there have been employed so-called box type concrete culverts of cross-sectionally rectangular shape, however, with such box type concrete culverts, there has been involved the drawback that, due to large bending moment applied to such culverts as shown in Fig. 28, each tube wall must be made relatively thick to cope with such bending moment, thereby increasing the cost of the concrete materials required in large quantities for the fabrication of the concrete culverts, and also making the transportation and installation works difficult due to the increased weight.

Accordingly, the main object of this invention is to solve such drawback involved in the box type culverts and to provide such a group of arched culverts ranging from type A to type L as described later that are capable of

coping with a wide variety of use.

The invention provides an arched culvert, to be used for constructing a closed conduit, which comprises a bottom portion, two leg portions upstanding from opposed sides of the bottom portion, an arched ceiling spanning both leg portions, and joining means for securely joining successive culverts with each other, said joining means comprising at least one guide spigot on one end face and respective guide socket on the other end face which guide spigot and guide socket serve to guide the mating culverts to properly engage with each other, and a recess provided in a face of said culvert which cooperates in use with a face of an adjacent culvert for retaining sealing means between said faces. Preferably the culverts are of precast concrete.

15 This invention will now be further described with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an example of closed conduit constructed in a straight line by use of arched culverts of type A, type E and type F<sub>1</sub>, except that a manhole member to be placed thereon is omitted;

20 Fig. 2 is a front view of an arched concrete culvert of type A;

Fig. 3 is a side view of the culvert of Fig. 2;

Fig. 4 is an enlarged sectional view of a socket and spigot joint of the arched culverts of Figs. 2 and 3;

25 Fig. 5 is an enlarged sectional view of an example of rubber ring applied on the joint of Fig. 4;

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Fig. 6 is a front view of a modification of type A culvert;

Fig. 7 is a horizontal sectional view illustrating an example of a closed conduit constructed in a curved  
5 line by the use of the arched culverts of type A;

Fig. 8 is a side view illustrating an example of a closed conduit constructed by the use of the arched culverts of type  $B_1$  and type  $B_2$  through vertically lowering method;

10 Fig. 9 is a front view of an arched culvert of type  $B_1$ ;

Fig. 10 is an enlarged side view of such portions of the arched culverts of type  $B_1$  and type  $B_2$  where a guide plug, a guide socket and a fastener receiving  
15 recession are respectively formed;

Fig. 11 is a partial sectional view of the joint of arched concrete culverts of type C on which a collar is provided;

Fig. 12 is a front view of an arched culvert of  
20 type D;

Fig. 13 is a front view of an arched concrete culvert of type E;

Fig. 14 is a front view of an arched concrete culvert of type  $F_1$ ;

25 Fig. 15 is a side view of the culvert of Fig. 14;

Fig. 16 is a front view of an arched concrete culvert of type  $F_2$ ;

Fig. 17 is a side view of the culvert of Fig. 16;

Fig. 18 is a front view of an arched concrete culvert of type  $G_1$ ;

Fig. 19 is a front view of an arched concrete culvert of type  $G_2$ ;

Fig. 20 is a front view of an arched culvert of type  $G_3$ ;

Fig. 21 is a perspective view illustrating an arched concrete culvert of type  $G_4$ ;

Fig. 22 is a front view of an arched concrete culvert of type H;

Figs. 23A and 23B are enlarged sectional views of arched concrete culverts of type  $I_1$  and type  $I_2$ , respectively whose center portions are bent leftward and rightward;

Figs. 24A and 24B are front views respectively of arched concrete culverts of type  $J_1$  and type  $J_2$ ;

Fig. 25 is a perspective view of an arched concrete culvert of type  $L_1$  in disassembled condition;

Fig. 26 is a perspective view of an arched concrete culvert of type  $L_2$  in disassembled condition;

Fig. 27 is a diagram showing the bending moment applied on the arched culvert of type A; and

Fig. 28 is a diagram showing the bending moment applied on the so-called box type concrete culvert of prior art.

Referring now to Fig. 1, there is illustrated a closed conduit 33 laid in a straight line and constructed of arched precast concrete culverts of type A, type E and type F<sub>1</sub>. The size of the arched culvert of type A ranges from 800mm to 3000mm in width, 5 from 560mm to 3000mm in height and from 1500mm to 2000mm in length. Such precast concrete culverts are fabricated each using concrete materials and a single-reinforcement cage or double-reinforcement 10 cage ( not shown ). As shown in Figs. 2 and 3, each main body 24 of the arched concrete culverts of type A has a bottom portion 1, two leg portions 2, 2' upstanding from opposed sides of the bottom portion and an arched ceiling portion 3 spanning both leg portions, 15 and is provided with an annular spigot 5 as a joint means on inner half of one open end periphery face 7 and with an annular socket 6 as a corresponding joint means on inner half of the other end periphery face 8; said annular spigot 5 and socket 6 are adapted to form 20 so-called socket and spigot joint. Also illustrated in Fig. 6 is a modification of the above type A culvert, wherein a large recess is formed on the lower face of the bottom portion 1 to provide good stability in setting thereof. As seen from Figs. 4 and 5, the annular 25 spigot 5 is provided with a stepped portion 5' for retaining a rubber ring 4.

A description will now be made of the types of culvert in alphabetical order, from type B illustrated in Figs. 8, 9 and 10. In place of the above socket and spigot joint, the arched concrete culvert of type B is provided in the main body 24 with four sheaths buried in and extending through the tube wall between both end faces at both sides of the bottom portion 1 and at both sides of the arched ceiling portion 3 so as to insert steel bars or steel strands 9 therethrough. The arched concrete culvert of type B is further assorted into two types, viz., type B<sub>1</sub> and type B<sub>2</sub>; the latter B<sub>2</sub> is described above, while, the former type B<sub>1</sub> is further provided with four recesses 12 each for inserting therein a fastener 11, and the lower inserting recesses 12a, 12b are formed with their upper faces opening upwardly of the bottom portion 1, while, the lower inserting recesses 12c, 12d are formed with their upper faces opening outwardly of the arched ceiling portion 3. Both type B<sub>1</sub> and type B<sub>2</sub> are each provided with a guide socket 25 on one end and with a guide spigot 25' on the other end corresponding to the lower sheath 10 extending through the bottom portion 1, and seal 4 in recess 5', as clearly seen from Fig. 10.

In Fig. 11, there are illustrated a pair of arched concrete culverts of type C. Also, in place of the socket and spigot joint of type A, the arched concrete culvert of type C is provided with a metallic collar 13

on outer periphery of one open end of the main body 24, in the same shape as the above type A, in such manner that a half length of the collar 13 projects so as to constitute a socket. The culvert C is  
5 also provided with a recess 14 on outer periphery of the other open end so as to receive the half length of the collar 13. In the figure, the reference numeral 26 denotes a buried stay for fixing the collar, the reference numerals 27, 28 are packings  
10 and the reference numerals 29, 30 denote packing receiving grooves.

Illustrated in Fig. 12 is an arched concrete culvert of type D mainly used in laterally press-joining method, and it is substantially the same as the above  
15 arched concrete culvert of type C, except that lower outside corners thereof where the bottom portion 1 and the leg portion 2, 2' intersect with each other are each formed with a round face R.

The arched concrete culvert of type E of Fig. 13  
20 is a modification of type A such that a flat face 15 is formed on the upper face of the arched ceiling portion 3 of the main body 24, with concrete material laid on and integrally shaped with the arched ceiling portion 3 so that there may be directly loaded automotive  
25 vehicles or installation machines and instruments.

Referring to Figs. 14-17, there are illustrated

arched concrete culverts of type F which are per se further assorted into two types, viz., type  $F_1$  and type  $F_2$ . The former type  $F_1$  which has been previously referred to in the description of Fig. 1 comprises a fitting 18 for a manhole 32 formed on one part of the flat face 15 of the above type E, a vertical passage 19 passing through the arched ceiling portion into the inside of the culvert and steps 20 mounted on one side of the manhole 32, the vertical passage 19 and the leg portion. While, as seen from Figs. 16, 17, the arched culvert of type  $F_2$  is a combined form of respective halves of the above type  $F_1$  and a manhole fitting 18, the passage 19 and the stairs 20 are formed over two arched culverts of the above type  $F_1$ .

Illustrated in Figs 18-21, are arched culverts of type G which is further assorted into 4 types, viz., type  $G_1$ , type  $G_2$ , type  $G_3$  and type  $G_4$  respectively in Figs. 18, 19, 20 and 21. In the arched culvert of type  $G_1$ , the bottom portion 1, and the arched ceiling portion 3 which is integral with the leg portions 2, 2', are fabricated separately and mutually engageable. In the type  $G_2$  of Fig. 19, the bottom portion 1 which is integral with the leg portions 2, 2', is fabricated separately from and mutually engageable with the arched ceiling portion 3. In the type  $G_3$  of Fig. 20, the bottom portion 1 is provided with outer holding projections

16 at both sides thereof to hold the leg portions 2, 2' from outside. In the arched culvert of type  $G_4$ , illustrated in Fig. 21, each bottom portion 1 is integral with holding projections 16 and is placed only under the end portion of the leg portions 2, 2'. With the arched culverts of type  $G_1$  to  $G_3$ , the bottom portion 1 is buried with concrete material to form a concave waterway 31 between both leg portions 2, 2' on the bottom portion 1, after the precast concrete culvert has been composed and laid at the construction site.

In Fig. 22, there is illustrated an arched culvert of type H in which the bottom portion 1, the leg portions 2, 2' and the arched ceiling portion 3 are fabricated in separate parts, to be mutually engageable.

Arched culverts of type I are illustrated in Figs. 23A and 23B. They are further assorted into two types, viz.,  $I_1$  of Fig. 23A and type  $I_2$  of Fig. 23B. Both types  $I_1$  and type  $I_2$  are such variations of the type A that are each bent left and right respectively at their center portions and are used in constructing a closed conduit bent left or right.

Illustrated in Figs. 24A and 24B are arched culverts of type J which are further assorted into type  $J_1$  and type  $J_2$ . In the type  $J_1$ , of Fig. 24A, there is formed a subsided waterway 17 at the center of the bottom portion 1, while, in the type  $J_2$  of Fig. 24B, subsided

waterways 17,17 are formed at both sides of the bottom portion 1.

Additional culverts of type L usable with the previously described culverts are illustrated in Figs. 25 and 26, and are composites of the type F, viz., type  $L_1$  of Fig. 25 and type  $L_2$  of Fig. 26. The former type  $L_1$  is composed of a portal member 21 without the bottom portion, a pair of fitting plates 23, 23', each having an arched opening portion 22, to be fitted on the open end of the portal member 21, a manhole mounting 18 formed on the flat face 15, a passage hole 19 and steps 20. The latter type  $L_2$  has a pair of mutually engageable portal members 21, 21 spanning which the manhole mounting 18, the passage hole 19 and the steps 20 are formed.

In constructing a closed conduit using the arched culverts of one or more types among the above types A-L, they are conveyed to the construction site as a matter of course upon selection of the types and sizes considering the construction purpose, capacity and the like and then laid side by side and joined with each other.

There can be completely prevented any water leakage through the joint between culverts by the seals 4, 28 with the annular spigot 5 pressed into the annular socket 6, since the culverts are joined to each other in such manner that the rubber ring 4 is

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put and retained on the center stepped portion 5' of the annular spigot 5.

Further, the type A is suited to the construction of the closed conduit 34 that is curved left or right ( cf. Fig. 7 ), besides that of the closed conduit 33 of straight line. In this case, with the arched culverts of type E and type F or type L arranged at desired places and joined to the arched culverts of type A, it is possible to let the flat face 15 serve as a road surface, and not only the construction works can be efficiently carried out without occupying any particular space, with the installation instruments and materials loaded on the flat plane, but also the manhole 32 can be mounted thereon at a specified interval. Further, when the bent types  $I_1$  and  $I_2$  are employed, there can be constructed the bent closed conduit 35 which is bent left or right. Employment of the arched culverts of type C in construction of the closed conduit can reduce possible tube end damage since the collar 13 spans both tube ends of the interjoined culverts.

In the construction at difficult places to dig through, for example at a hillside, under a railway or a road or the like, there can be employed such a propulsion method that constructs the closed conduit while succesively pressing forward the arched culverts of

type D which has the collar 13 with round faces R at both sides of the bottom portion 1.

Further, in the construction of such a closed conduit that is larger in width and height than that of the type A, there can be employed the arched culverts of type G or type H, with the arched culverts conveyed in separate form to the construction site and assembled at the site. Thus, large size closed conduit can be constructed while overcoming difficulties in the transportation and handling.

While, in the case where the ground is not firm, the closed conduit can be prevented from partially sinking by using the arched culverts of type B in such construction manner as vertically lowers them from above, because the culverts are firmly held by inserting the four upper and lower steel bars of steel strands 9 through the sheaths 10 formed within the tube wall of the culverts of type B and by tensioning and fastening them by means of the fasteners 11 inserted in the insertion holes 12 formed on the culverts of type B<sub>1</sub> which are arranged at specified intervals. In this instance, the guide plugs 25 and the guide sockets 25' usefully serve to guide the mating culverts properly to engage with each other.

As described above, by using the arched culverts of one or more types selected from the types A-L, there

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can be constructed various forms of closed conduits,  
and as shown in the diagram of bending moment in  
Fig. 27, the arched culverts of types A-L are of such  
stable structure that has largely lowered bending  
5 moment which is applied to the upper portion and the  
tube wall compared to the box type culverts ( cf. Fig. 28 ).  
As a result, in accordance with the present invention,  
there can be provided such advantages that the thickness  
of the arched portion 3 and the leg portions 2, 2' can be  
10 reduced, and not only the quantity of concrete materials  
can be reduced so much to give economical profit but  
also the concrete culverts can be per se lightened to  
allow the transportation and installation works to be  
easily carried out.



CLAIMS

1. An arched culvert, to be used for constructing a closed conduit, which comprises a bottom portion, two leg portions upstanding from opposed sides of the bottom  
5 portion, an arched ceiling spanning both leg portions, and joining means for securely joining successive culverts with each other, said joining means comprising at least one guide spigot on one end face and respective guide socket on the other end face which guide spigot and guide socket serve  
10 to guide the mating culverts to properly engage with each other, and a recess provided in a face of said culvert which cooperates in use with a face of an adjacent culvert for retaining sealing means between said faces.
2. A culvert according to claim 1, wherein said guide  
15 spigot comprises an annular spigot formed on an inner half of one end face of the culvert and said guide socket comprises an annular socket formed on an inner half of the other end face thereof.
3. A culvert according to claim 2, wherein said recess  
20 is provided by a center stepped portion of said annular spigot and said sealing means comprises a rubber ring retained by said stepped portion to prevent water leakage through a joint between adjacent culverts.
4. A culvert according to claim 1 of precast concrete,  
25 wherein said joining means also comprises a plurality of sheaths buried in and extending through the culvert wall between both end faces thereof and adapted to receive



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therethrough bars to be tensioned and fastened by means of a fastener.

5. A culvert according to claim 4, wherein fastener inserting recesses are formed on the tube wall with each  
5 sheath cut away at that portion.

6. A culvert according to claim 1, wherein said joining means comprise a collar, which is mounted on the outer periphery of one open end of the culvert in such manner that  
10 a half length thereof projects therefrom to constitute said socket, and a recess formed on the other open end so as to receive a projecting half length, and form said spigot.

7. A culvert according to claim 6, wherein lower outside corners thereof where the bottom portion and the leg portions intersect are each formed with a round face.

15 8. A culvert according to any one of claims 1 to 7, wherein a flat face is formed on the upper face of the ceiling portion, by means of concrete material placed on and integrally shaped with the arched ceiling portion.

9. A culvert according to claim 1, wherein the  
20 bottom portion, the leg portions and the arched ceiling portion are fabricated in separate parts to be mutually engageable.

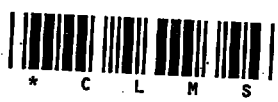
10. A culvert according to claim 1, wherein the bottom portion is provided with outer holding projections  
25 at both sides thereof to hold the leg portions from outside.

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11. A culvert according to claim 1, wherein the bottom portion, and the arched ceiling portion which is integral with the leg portions, are fabricated separately and mutually engageable.
- 5 12. A culvert according to claim 1, wherein the bottom portion is integral with the leg portions and is fabricated separately from and mutually engageable with the arched ceiling portion.
- 10 13. A culvert according to claim 1, wherein a bottom portion which is integral with outer holding projections is placed under each end portion of the leg portions.
- 15 14. A culvert according to claim 1, wherein at least one subsided waterway is formed in the bottom portion.
- 20 15. A culvert according to claim 8, wherein a manhole fitting is formed on one part of the flat face, a passage is provided passing through the arched ceiling portion into the inside of the culvert and steps are mounted on one side of the manhole fitting, the passage and a leg portion.
- 25 16. A culvert according to claim 1, wherein two culverts are provided of composite form whereby a manhole fitting, a passage and steps are formed spanning two culverts.
17. A culvert according to claim 1, wherein said culvert



is bent left or right at center portion thereof so that there may be constructed a bent closed conduit.

- 18. A culvert according to claim 1, and a second culvert coupled therewith, wherein said second culvert is composite  
5 with a portal member without bottom portion, and includes a pair of fitting plates having arched opening portion fitted on the open end of the portal member, a manhole mounting formed on a flat face of the ceiling portion of the culvert, a passage therein and steps mounted therein.
  - 10 19. A culvert and second culvert according to claim 18, wherein said second culvert and said portal member are composite spanning which the manhole mounting, the passage and the steps are formed respectively.
  - 20. An arched culvert substantially as hereinbefore  
15 described with reference to and as illustrated in Figs. 2 to 5, Fig. 6, Fig. 7, Figs. 8 to 10, Fig. 11, Fig. 12, Fig. 13, Figs. 14 and 15, Figs. 16 and 17, Fig. 18, Fig. 19, Fig. 20, Fig. 21, Fig. 22, Figs. 23A and B, and Figs. 24A and B, of the accompanying drawings.
  - 20 21. An arched culvert according to claim 20 and coupled therewith a second culvert substantially as hereinbefore described with reference to and as illustrated in Fig. 25 or Fig. 26 of the accompanying drawings.
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