970,805

PATENT SPECIFICATION

DRAWINGS ATTACHED

970,805

Date of Application and filing Complete Specification Oct. 25, 1963.

No. 42220/63.

Application made in Italy (No. 12908) on June 14, 1963.

Complete Specification Published Sept. 23, 1964.

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Index at acceptance: —E1 H12

International Classification: —E 02 b

COMPLETE SPECIFICATION

Improvements relating to Protective Linings for Watercourses and Other Exposed Surfaces

We, RIVER AND SEA GABIONS (LONDON) LIMITED, a British Company of 2 Swallow Place, Princes Street, London, W.1., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Wire mesh baskets known as "gabions" are used in sea, mountain and river defence works. The gabions are filled with stones of an appropriate nature and size and are used to build revetments and walls for protecting river banks and sea shores from erosion, for filling for embankments, for preventing land slips in sloping ground and so on. The ratio between the length, width and thickness of the gabions used for these purposes is comparatively low and may for example be that the length is twice the width and the width is equal to the thickness.

We have now found that wire mesh containers of a similar nature to gabions but of different proportions can be used to great advantage to reinforce protective stone linings grouted with bituminous or other similar flexible material, for water courses and other exposed soil surfaces.

Thus, according to this invention, such a lining comprises a series of closed rectangular wire mesh containers which are longer and wider than they are thick, jointed together side by side and packed with stones the interstices of which, at least on the exposed face of the lining, are partly or wholly filled with bituminous or other similar flexible material, which makes the lining at least partly impervious to water and also assists in protecting the top of the container and each filled container forms a mattress which is flexible and able to conform to the surface of the underlying soil.

The quantity of bituminous or like material in the wire mesh container can be such that all the interstices between the stones are completely filled and in this case the lining is completely impervious to water and there is also sufficient bituminous or like material to protect the whole of the wire mesh walls and top of the container. As an alternative to this however, the interstices of the stone in the container may be only partly filled with grout and then the lining may still be slightly porous and also only the wire mesh in the top of the container is covered with grout and is protected.

Preferably adjacent sides of the wire mesh containers are joined together by sewing with wire the adjacent edges of the containers so that the containers are firmly joined together and the joints are able to withstand tension. As an alternative to this however the joints between adjacent containers may just be filled with the bituminous or like material which then forms the connection between the adjacent mattress-like baskets.

Linings in accordance with the invention may be formed by a number of novel methods.

Two of the more common methods are as follows:—

In the first method which is used when the soil surface to be lined is either partly or totally immersed in water, the containers are prepared with their tops open and are filled with stone, the containers are then closed and placed side by side to cover the soil surface which is to be lined, and finally bituminous or like material in a liquid state is poured continuously and progressively over the containers, the rate of flow of the liquid material and the temperature being such that the material flows to the required extent into the interstices of the stone and there sets.

In the second method which is used

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when the surface to be lined is dry, the containers are arranged covering the surface side by side with their tops open, the containers are then filled with stone and are closed and finally liquid bituminous material or other flexible grout is poured over the containers, the rate of flow and the temperature of the material being such that it flows into the interstices of the stones and there sets as in the previous method.

With both methods further grout may be poured into the spaces between adjacent containers either to form the jointing between the containers by itself or to render the joints impervious after they have been made with wire tying the adjacent containers together.

Some linings in accordance with the invention and methods of making them will now be described by way of example only, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of a partly formed lining consisting of a series of containers arranged side by side with some of the containers filled with stone;

Figure 2 is a perspective view of another partly formed lining using a different form of container;

Figure 3 is a partly sectional perspective view showing a later stage in the construction of the lining shown in Figure 1 where this construction is in the dry;

Figure 4 is a partly sectional perspective view showing a later stage in the construction of the lining shown in Figure 1 where this is partly immersed in water;

Figure 5 is a partly sectional perspective view showing a stage in the construction of the lining of Figure 1 similar to that shown in Figure 4 but using a slightly different method; and,

Figure 6 is a cross-section to a larger scale of the lining in the stage of construction shown in Figure 5.

The containers shown in Figure 1 and Figures 3 to 5 of the drawings are the same as those described and claimed in our co-pending application No. 37812/62. (Serial No. 955,938).

In the lining shown in Figure 1, there are a number of wire mesh containers each of which is sub-divided into a number of compartments and has its length extending down the slope of the bank to be lined and the containers are placed closely together side by side. The length of each complete container measured down the sloping surface is at least three times the width of the container measured at right angles to the line of maximum slope. The thickness of each container is very much less than the length and the width and in this example is ten per cent of the width.

Each container has a bottom 1 formed by a rectangle of wire mesh with, projecting from it, two longitudinal edge walls 2 and 3 and two transverse edge walls 4 and 5. Each basket is sub-divided into a large number of compartments by intermediate transverse walls 6 each of which has rigidly fixed to it a cover 7.

After the compartments have been filled with stone 8, the covers 7 are bent downwards and their bottom edges are sewn with wire to the top edges of the intermediate transverse wall immediately below and the side edges of the covers are similarly sewn to the edge walls 2 and 3. This kind of compartmented container is referred to in our co-pending application No. 37812/62 (Serial No. 955,938), as a pocket mattress. Adjacent containers are joined together by sewing with wire so that they are connected to one another along the whole of their longitudinal edges.

The containers shown in Figure 2 of the drawings differ from those shown in Figure 1 in that there are no transverse partitions and there are therefore no separate compartments. Each container has a cover 10 which is in a single piece and is of the same extent as the bottom 1. Its edges are sewn with wire to the tops of the transverse and longitudinal edge walls of the container as the container is progressively filled with stone working from the bottom towards the top. A number of small wire ties 11 extend between the bottom 1 and the cover 10 to prevent the cover 10 from bulging and allowing too much of the stone to fall down to the bottom end of the container.

With the constructions shown in both Figures 1 and 2, provided that the bank on which the lining is constructed is completely dry, the containers can be erected and filled with stone *in situ* on the bank. If, however, the bank is partly or wholly immersed in water, the containers are erected and filled with stone in another position above the water and are then moved, for example by a crane or excavator into position on the bank. They may alternatively be erected and filled with stone on pontoons or barges and then be lowered into the water. When this is done, the most difficult step in forming the lining is to interconnect the adjacent containers by sewing them together with wire under water.

After the stone filled containers have been placed in position, the interstices of the stones are either completely or partly filled with bituminous material. The composition of the bituminous material must be selected for each particular lining and in particular the viscosity and penetration of the bitumen must be correctly related to the thickness of the lining, the sizes of the stone filling, and hence the sizes of the interstices which are to be filled, also the degree of water im-

perviousness which is required in the lining, the degree of consolidation of the lining which is required and also to the climatic conditions. A bituminous grout which is suitable under a number of circumstances consists of:—

Material	% by weight
Sand	65—70
Fillers	10—20
Bitumen	15—20

The filler should be a mainly calcareous material, such as cement, hydrated lime, or a calcareous powder produced by a stone crusher at least 70 per cent of which will pass an ASTM No. 200 screen or its equivalent.

Using a bituminous material of this kind together with the containers and stone filling shown in Figures 1 or 2, various forms of facing can be provided and the perviousness can be controlled by varying the amount of bitumen in the grout. The perviousness can also be controlled by the amount of grout used and the manner in which the grout is applied.

(a) To form a pervious protective facing, the containers are prepared either *in situ* or are lowered into position after filling. Bituminous material is poured into each container to such an extent that a complete seal is formed over the interstices of the stone near the outer face of the lining, but the joints between adjacent containers are not filled with bitumen. The containers may be sewn together with wire.

(b) To form an impervious protective facing, containers are prepared in a manner similar to that described in (a) above. Bituminous grouting material is applied to all the containers until all the interstices between the stones in the containers are completely filled. Further bituminous grouting material is then poured into the spaces between the adjacent containers. If the containers are filled with stone away from the site on which they are eventually placed, the bituminous grouting material may be applied to the stone away from the site as well. It may alternatively be applied *in situ*. With this form of impervious lining, the bitumen grout poured into the spaces between adjacent containers may form the only connection between them and this is simpler and quicker than sewing the baskets together with wire especially under water.

An example of the application of bituminous grout to the stone lining where this is in the dry is shown in Figure 3 of the drawings. The bituminous grout is allowed to flow from a tank 12 mounted on a motor truck 13 through a channel or pipe on to the surface of the stone lining. The truck 13 moves along slowly above the top of the lining and the pipe is moved up and down to distribute the grout over the whole surface of the stone.

Where the bituminous grout has to be applied to the stone lining below water, either the technique shown in Figure 4 or the technique shown in Figures 5 and 6 of the drawings is used. The equipment shown in Figure 4 of the drawings is used for applying grout to that part of the lining which is above the water and that part which is immersed to a depth of about 6 feet. The part of the lining which is immersed to a depth greater than 6 feet is carried out by the equipment illustrated in Figures 5 and 6. Some of the equipment illustrated in these drawings is described and claimed in specification No. 903,980. The equipment illustrated also comprises a trolley 14 which is movable along a track 15 laid along the top of the bank which is being lined. The trolley 14 has a tank 16 from which a long tube 17 is supplied with bituminous material. The tube 17 has at its immersed end, a valve 18 through which the material flows out below the water. The tank 16 is supplied with bituminous material continuously from a main tank 12 on a motor truck 13 similar to the truck 13 shown in Figure 4 of the drawings.

The grouted stone facings described with reference to the drawings have a considerably longer working life than plain unreinforced stone linings grouted with bituminous material because of their elastic and plastic characteristics and because of the strength imparted to the lining by the wire mesh containers.

WHAT WE CLAIM IS:—

1. A protective stone lining for water courses and other exposed soil surfaces, the lining comprising a series of closed rectangular wire mesh containers which are longer and wider than they are thick, jointed together side by side and packed with stones the interstices of which, at least on the exposed face of the lining, are partly or wholly filled with bituminous or other similar flexible material, which makes the lining at least partly impervious to water and also assists in protecting the top of the container, and each filled container forming a mattress which is flexible and able to conform to the surface of the underlying soil.

2. A lining according to claim 1, in which all the interstices between the stones are completely filled with the bituminous or other similar material so that the lining is completely impervious to water and the material protects the whole of the walls and top of the container.

3. A lining according to claim 1 or claim 2, in which adjacent edges of the wire mesh containers are joined together by wire which is sewn around the edges of the containers so that the containers are firmly

perviousness which is required in the lining, the degree of consolidation of the lining which is required and also to the climatic conditions. A bituminous grout which is suitable under a number of circumstances consists of:—

Material	% by weight
Sand	65—70
Fillers	10—20
Bitumen	15—20

The filler should be a mainly calcareous material, such as cement, hydrated lime, or a calcareous powder produced by a stone crusher at least 70 per cent of which will pass an ASTM No. 200 screen or its equivalent.

Using a bituminous material of this kind together with the containers and stone filling shown in Figures 1 or 2, various forms of facing can be provided and the perviousness can be controlled by varying the amount of bitumen in the grout. The perviousness can also be controlled by the amount of grout used and the manner in which the grout is applied.

(a) To form a pervious protective facing, the containers are prepared either *in situ* or are lowered into position after filling. Bituminous material is poured into each container to such an extent that a complete seal is formed over the interstices of the stone near the outer face of the lining, but the joints between adjacent containers are not filled with bitumen. The containers may be sewn together with wire.

(b) To form an impervious protective facing, containers are prepared in a manner similar to that described in (a) above. Bituminous grouting material is applied to all the containers until all the interstices between the stones in the containers are completely filled. Further bituminous grouting material is then poured into the spaces between the adjacent containers. If the containers are filled with stone away from the site on which they are eventually placed, the bituminous grouting material may be applied to the stone away from the site as well. It may alternatively be applied *in situ*. With this form of impervious lining, the bitumen grout poured into the spaces between adjacent containers may form the only connection between them and this is simpler and quicker than sewing the baskets together with wire especially under water.

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Where the bituminous grout has to be applied to the stone lining below water, either the technique shown in Figure 4 or the technique shown in Figures 5 and 6 of the drawings is used. The equipment shown in Figure 4 of the drawings is used for applying grout to that part of the lining which is above the water and that part which is immersed to a depth of about 6 feet. The part of the lining which is immersed to a depth greater than 6 feet is carried out by the equipment illustrated in Figures 5 and 6. Some of the equipment illustrated in these drawings is described and claimed in specification No. 903,980. The equipment illustrated also comprises a trolley 14 which is movable along a track 15 laid along the top of the bank which is being lined. The trolley 14 has a tank 16 from which a long tube 17 is supplied with bituminous material. The tube 17 has at its immersed end, a valve 18 through which the material flows out below the water. The tank 16 is supplied with bituminous material continuously from a main tank 12 on a motor truck 13 similar to the truck 13 shown in Figure 4 of the drawings.

The grouted stone facings described with reference to the drawings have a considerably longer working life than plain unreinforced stone linings grouted with bituminous material because of their elastic and plastic characteristics and because of the strength imparted to the lining by the wire mesh containers.

WHAT WE CLAIM IS:—

1. A protective stone lining for water courses and other exposed soil surfaces, the lining comprising a series of closed rectangular wire mesh containers which are longer and wider than they are thick, jointed together side by side and packed with stones the interstices of which, at least on the exposed face of the lining, are partly or wholly filled with bituminous or other similar flexible material, which makes the lining at least partly impervious to water and also assists in protecting the top of the container, and each filled container forming a mattress which is flexible and able to conform to the surface of the underlying soil.

2. A lining according to claim 1, in which all the interstices between the stones are completely filled with the bituminous or other similar material so that the lining is completely impervious to water and the material protects the whole of the walls and top of the container.

3. A lining according to claim 1 or claim 2, in which adjacent edges of the wire mesh containers are joined together by wire which is sewn around the edges of the containers so that the containers are firmly

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joined together and the joints are able to withstand tension.

4. A lining according to claim 1 or claim 2, in which the joints between adjacent containers are filled with the material which then forms the connection between the adjacent containers.

5. A method of forming a lining according to claim 1, on a soil surface which is partly or totally immersed in water, wherein the containers are prepared with their tops open and are filled with stone, the containers are closed and placed side by side to cover the soil surface which is to be lined, and finally bituminous or other similar flexible material in a liquid state is poured continuously and progressively over the containers, the rate of flow of the liquid material and the temperature being such that the material flows to the required extent into the interstices of the stone and there sets.

6. A method of forming a lining according to claim 1 on a soil surface which is dry, wherein the containers are arranged covering the surface side by side with their tops open, the containers are filled with stone and are closed and finally liquid-bituminous or other similar flexible material is poured over the containers, the rate of flow and the temperature of the material being such that it flows into the interstices of the stones and there sets.

7. A method according to claim 5 or claim 6, in which further bituminous or like material is poured into the spaces between adjacent containers to render the joints impervious to water.

8. A method according to claim 7, in which adjacent edges of the containers are tied together with wire before the further material is poured into the spaces between them.

9. A lining according to any one of claims 1 to 4, or a method according to any one of claims 5 to 8, in which the bituminous material has the following composition made as percentages by weight:— Sand 65 per cent to 70 per cent; bitumen 15 per cent to 20 per cent; fillers 10 per cent to 20 per cent.

10. A lining according to claim 1, constructed substantially as described with reference to Figure 1 or Figure 2 of the accompanying drawings.

11. A method of constructing a lining according to claim 5, substantially as described with reference to the accompanying drawings.

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Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1964.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

