The present invention relates to concrete dam construction and more particularly to a concrete dam having a drainage system on its downstream face covered by a facing of suitable material, such as "Gunite," either where such systems were installed in connection with the repair of the dam or in connection with the original construction thereof. The surfaces of concrete structures often, under the conditions to which they are subjected, deteriorate and pieces of the concrete break away, thereby leaving surfaces which deteriorate much more readily than the original surfaces. Deterioration of such surfaces results from many causes, for example seepage of water through the concrete of a water dam and more particularly such seepage in connection with freezing. Surfaces of concrete structures which have become damaged due to such deterioration cannot be satisfactorily repaired by the use of concrete but may be by the use of "Gunite" which is formed by a mixture of cement and sand blown from a "cement gun" through a hose to a nozzle, where water is added in just sufficient quantity to hydrate the mixture, and then is blown against a suitable form or backing in a dense layer. When thoroughly set, the "Gunite" is substantially waterproof.

In repairing the face of a concrete dam where there is no substantial seepage, entirely satisfactory results may be attained by merely covering the surface of the dam with a suitable layer or facing of "Gunite." However, if there be seepage of a substantial amount of water through the concrete of a dam, water would collect back of the "Gunite" facing and might eventually cause cracking of the "Gunite" due to freezing or even to hydrostatic pressure. At more-or-less frequent intervals particularly at points where seepage of water through the concrete is substantial, weep pipes may be installed in the concrete and, in the event that a "Gunite" facing be applied to the downstream side of the dam, these weep pipes would extend through said "Gunite" facing. This arrangement would prevent the collection of water behind the facing at such wet spots but, as has been found in practice, does not provide sufficient protection against the accumulation of water back of the water-resisting facing or blanket of "Gunite." As a matter of fact, even where the downstream of the concrete appears to be dry, it is not safe to assume that there is no seepage through the concrete of water which would collect back of such a facing and tend to cause destruction thereof. For example, some parts of the exposed concrete may give the impression of no seepage, in that the seepage water may be evaporated substantially as soon as it appears at the exposed concrete surface, but such evaporation might be prevented by the application of a "Gunite" facing thus causing the objectionable collection of the seepage water back of the facing.

An object of the present invention is to provide a concrete dam with a facing of "Gunite" or the like in such a manner as to avoid any cracking of the facing due to collection of water back of the same. Another objection of the invention is to provide an improved method of repairing the downstream faces of concrete dams. A further object is to provide a concrete dam having a facing of dense cementitious material and a drainage system between the facing and the concrete adapted to carry off substantially all of the water seeping through the concrete, and thereby prevent cracking of the facing which might otherwise occur due to freezing of the water or to hydrostatic pressure.

According to one way of carrying out the present invention, the downstream face of the concrete dam is first provided with a suitable drainage system adapted to drain substantially the entire surface thereof. To this end the dam may be provided at said downstream face with substantially parallel main drainage troughs extending downwardly from the upper part of the wall. At the sides of the main troughs, there may be provided branch troughs inclined toward the main troughs into which they discharge and arranged to drain substantially the entire downstream face of the concrete. Where the dam has upright construction or expansion joints, certain of the main troughs may conveniently be formed along these joints. In connection with the repair work, loose material is removed as by chipping, from the downstream face of the dam, and the main and branch troughs may be formed in any suitable manner as by chipping.

After all these troughs have been formed, the troughs may be covered with plates of suitable material, such as "Elastite," to serve as a backing against which the "Gunite" may be shot. After the backing plates are in position over the troughs, this forming enclosed ducts, there may be placed over the plates covering the main expansion joints or strips of suitable material, such as copper. Then, after placing reinforcing mesh over the entire surface except at the expansion strips, the "Gunite" is blown into place to cover the mesh and form a layer of substantially suf-
cient thickness, except over the expansion strips where grooves may be provided at the outer face of the "Gunite" layer.

Other objects, features and advantages will appear upon consideration of the following detailed description and of the drawing in which:

Fig. 1 is an elevation of the downstream face of a dam showing substantially parallel main drainage troughs extending downwardly to carry off seepage water and branch troughs in panels between the main troughs to drain into the main troughs at the sides of the panels, and showing a panel in which the troughs have been covered with "Gunite" and an adjacent panel before the application of the "Gunite."

Fig. 2 is a vertical section on the line 2—2 of Fig. 2;

Fig. 3 is a section on the line 3—3 of Fig. 1; and

Fig. 4 is a section on the line 4—4 of Fig. 1.

Referring to the drawing, there is illustrated a dam 10 comprising a concrete body 11 and a facing 12 of any suitable material such as "gunite."

As illustrated in Fig. 1 the dam is divided at its downstream face into panels 13 of substantially equal widths by main drainage troughs 14 which, where convenient are located over construction joints.

As illustrated in Fig. 1, and in greater detail in Figs. 3 and 4, the surface of the concrete is chipped to provide a suitable backing on which to apply the "Gunite," the main troughs 14 are arranged to cut out the concrete body 11 preferably as above stated along construction joints separating panels 13, and branch troughs 15 draining into the main troughs 14 are cut or chipped out of the concrete in the various panels. Preferably the branch troughs 15 extend at least half way across a panel and in some instances the high ends of inclined branch troughs at corresponding heights may meet at the middle of the panels.

After their formation, main troughs 15 and branch troughs 15 may be covered respectively by backing plates 16 and 17 of suitable material such as "Elastite." Then at the main troughs 14, suitable expansion strips 18 may be placed over the plates 16. Each strip 18 may be of standard construction and consist of a metal strip formed into an inverted U at its center and provided at its edges with flanges extending to substantially two-thirds the height of the inverted U. Then a layer of metal mesh 19 is placed over the concrete and spaced therefrom at a convenient height. The mesh 19 may extend over the flanges at the edges of the expansion strip to the inverted U central portion, where the mesh may be secured in any suitable manner.

The "Gunite" may then be applied to the concrete until it reaches a suitable thickness. The layer or facing of "Gunite" is continuous over the branch troughs 15 but is formed over the inverted U portion of each expansion strip with a groove 20. Although it is not necessary, each groove 20 may be filled with any suitable plastic 21.

It will be evident that with a drainage system such as disclosed, there will be no tendency of the outside coating to crack due to the freezing of water at the rear thereof, or to hydrostatic pressure. The main troughs may drain into a pool at the foot of the dam.

It should be understood that various features may be changed and that certain features may be used without others, without departing from the true spirit and scope of the invention.

What I claim is:

1. A concrete dam built with upright constructional joints dividing the downstream face into panels, water collecting main troughs over said joints, branch troughs collecting water from said panels and discharging it into said main troughs, coverings over said main troughs, expansion strips over the coverings of said main troughs, and a "Gunite" facing covering said downstream face without a break except above the middle portions of the expansion strips where grooves are provided.

2. A dam comprising a concrete body provided at its downstream face with substantially upright main troughs leading down said face at suitable intervals and setting off panels therebetween and with inclined branch troughs collecting water from said panels and discharging it into said main troughs; coverings over all said troughs; expansion devices over the coverings of said main troughs; and a facing of dense cementitious material for said downstream face.

3. The combination of a concrete dam having a system of drainage troughs at the downstream face of the concrete adapted to receive and carry away seepage water from substantially all of said face, and a waterproof covering coat for said downstream face and drainage system, whereby the destructive action of frost either in the main body of the dam or in the covering coat will be eliminated.

4. The combination of a concrete dam having at its downstream face a drainage system comprising troughs to receive and carry away seepage water from substantially all of its face and coverings over said troughs to form closed ducts, and a waterproof coat of cementitious material covering said downstream face and drainage system, whereby the destructive action of frost will be eliminated.

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