Nov. 9, 1943. F. F. SMITH ET AL 2,333,826

GROUT EXPANDING ELASTIC SEAL

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Fig. 1.

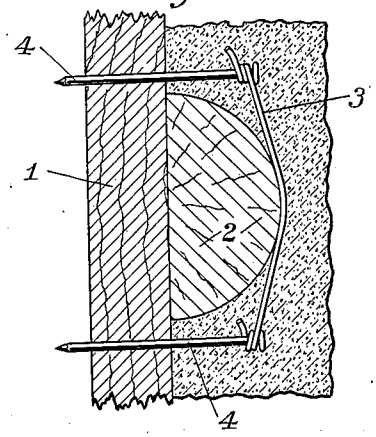


Fig. 2.

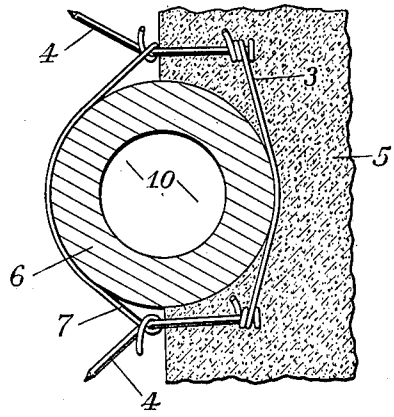


Fig. 3.

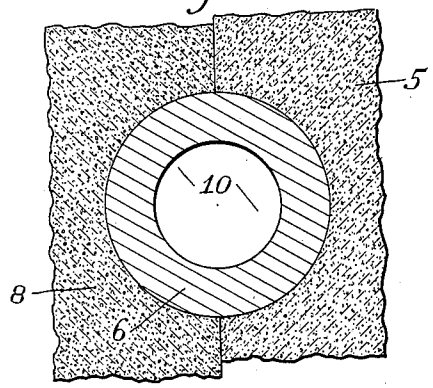


Fig. 4.

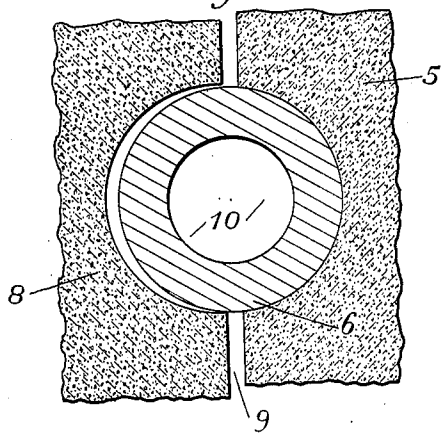
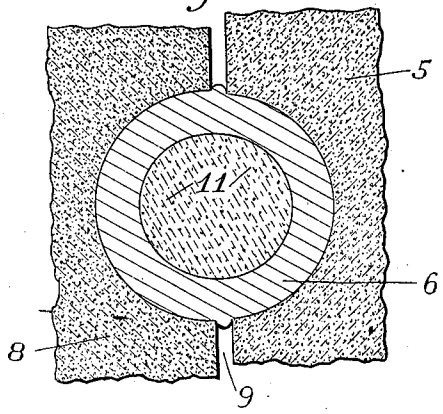


Fig. 5.



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Fig. 6.

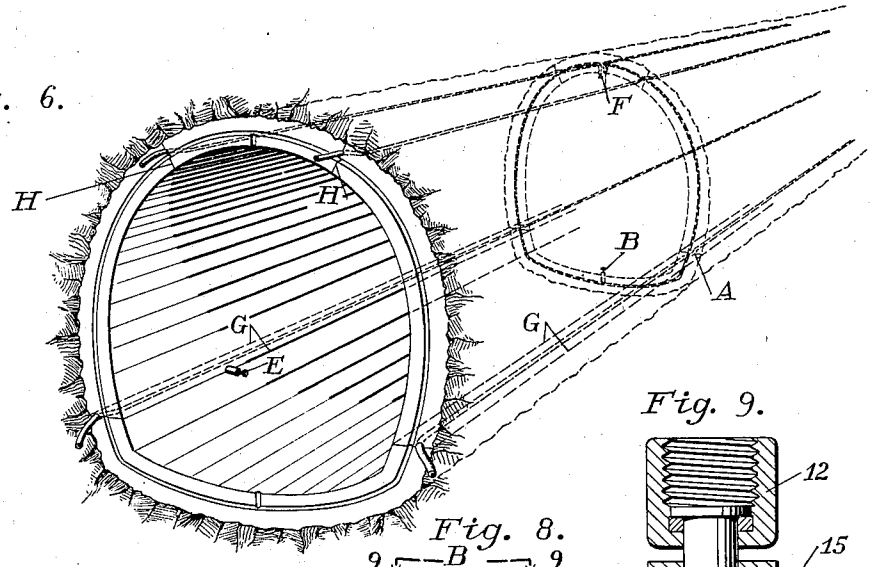


Fig. 9.

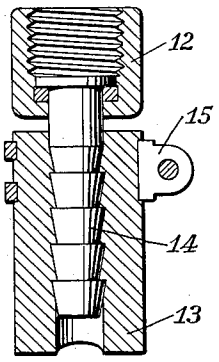


Fig. 8.

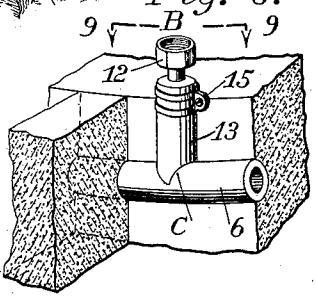


Fig. 7.

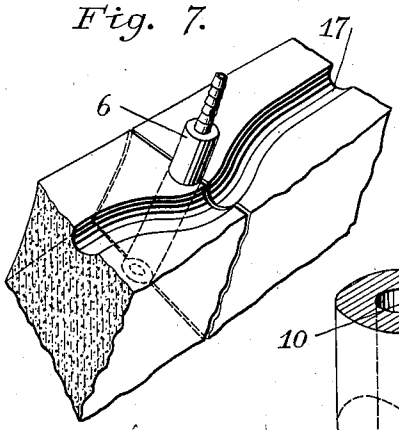


Fig. 10.

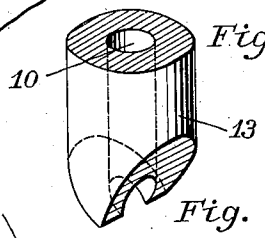


Fig. 12.

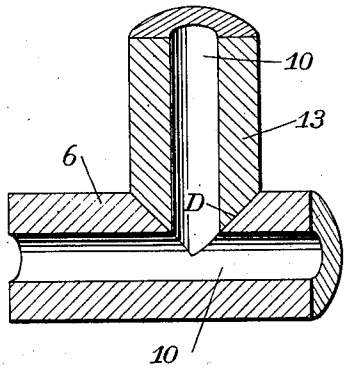


Fig. 11.

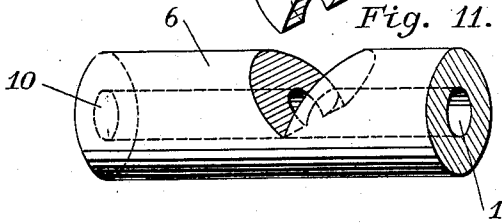
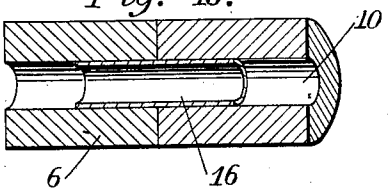


Fig. 13.



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Fig. 14.

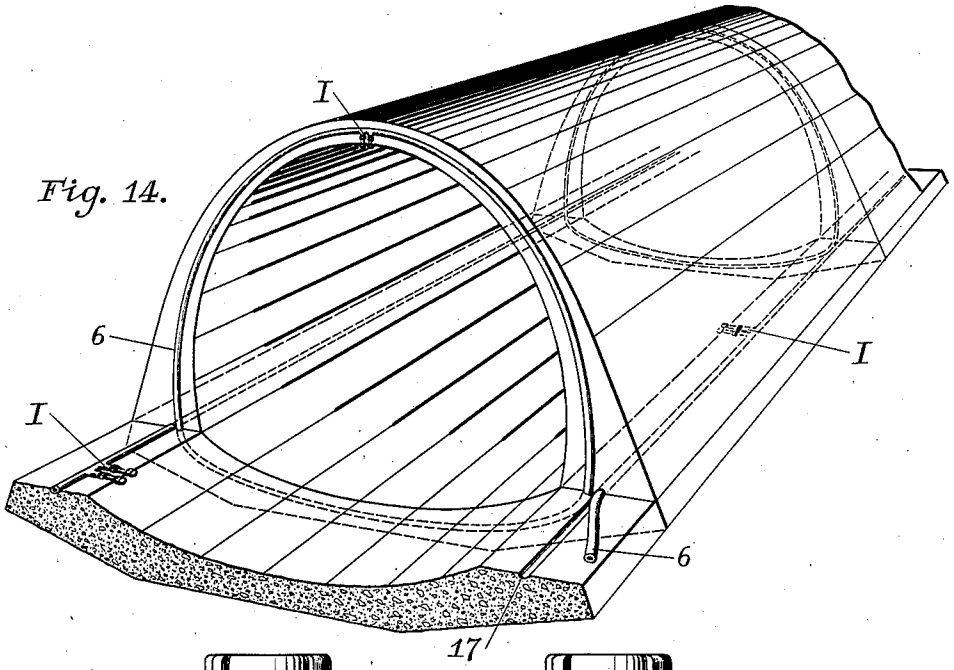
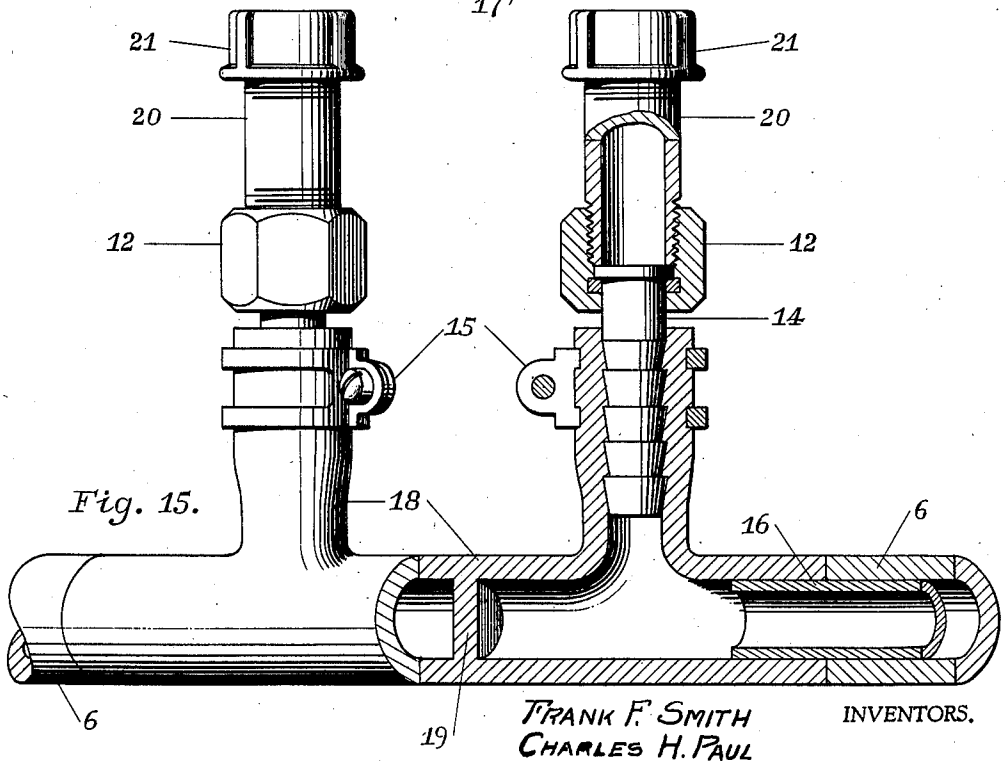


Fig. 15.



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UNITED STATES PATENT OFFICE

2,333,826

GROUT EXPANDING ELASTIC SEAL

Frank Folsom Smith, Denver, Colo., and Charles Howard Paul, Dayton, Ohio; Camilla W. Paul, executrix of said Charles Howard Paul, deceased, said executrix assignor to Camilla W. Paul

Application August 30, 1940, Serial No. 354,806

15 Claims. (Cl. 72—106)

This invention relates to the sealing of the cold joints or construction joints of concrete structures wherever it may be desirable or essential to prevent the intrusion of water or other fluids, either into the interior of such structures, or the escape outwardly from their interior cavities, as the case may be.

It is well known, to those skilled in the art, that large masses of concrete, during the hydration or curing process when the water, cement paste and aggregate mixture is setting and hardening, develop a relatively high temperature due to the chemical reactions that occur during that period, and this temperature rise is accompanied by the inevitable expansion of the concrete mass, so that its bulk becomes appreciably larger during this hydration period. It is after growth or increase in physical dimensions caused by the chemical reactions with attendant temperature rise within its mass, followed by its gradual cooling when these chemical reactions have run their complete cycles and cease to develop further heat, that it begins to contract as its temperature falls, and in so doing either cracks at more or less regular intervals if no contraction joints have been provided, or shrinks away at these joints if they have not been properly located, leaving an interstice between adjacent faces through which fluid leakage, either inwardly or outwardly, may occur, as circumstances dictate.

Our invention is a method and apparatus whereby the contraction joints or planes of shrinkage separation are caused to occur in those predetermined localities in the concrete structure which are most desirable from a structural or utility standpoint, and which, during the cooling and shrinkage period, as well as throughout the later life of the structure after cooling and shrinkage has been consummated, effectively seals off these shrinkage interstices against either inward intrustion or outward leakage and at the same time forms effective keying means of material effect in maintaining the continuity of action of the complete structure in resisting deformation and attendant stresses that the structure has been designed to withstand.

An objective of our invention is to provide a simple, positive and economical method and means for sealing against the intrusion or escape of fluid or gaseous substances through the cold joints, or construction joints, or contraction joints, in concrete structures, that will be effective as soon as the concrete in such structures has hardened and cured sufficiently to make it capable of withstanding the usage for which it is intended.

An objective of our invention is to provide means whereby an effective resistance in shear is located at contraction and construction joints in concrete structures, insuring against lateral displacement of those adjacent portions of the structure separated by said joints, so that the structure will set essentially as a monolithic whole.

An objective of our invention is to provide means built into concrete structures at predetermined locations best adapted structurally to insure that the contraction of the concrete mass subsequent to the thermal expansion occurring during the hydration and curing process, will cause separation between the various portions of the structure to occur within and at those precise locations defined by the inbuilt elements of our invention.

An objective of our invention is means for sealing contraction cracks due to reducing temperatures occurring within concrete structures, which will be effective as soon as the structure has cured sufficiently to be capable of being put into use, and will continue to be effective even if a further separation within reasonable limits later occurs between adjacent concrete faces at these cracks.

An objective of our invention is to so arrange the means for sealing cracks in concrete, originating from thermal action or otherwise, as will permit the later introduction of grouting material into the lowest portion of the sealing system first, allowing it to drive the air contained in the system before it as it progressively fills the system with grout so that the air is moved to a higher and higher level until finally the grout material reaches the highest part of the system, completely filling same, and begins to discharge through the air vent or vents which we have placed at the uppermost part of said system, thereby assuring complete ejection of air, and complete filling of the grouting space or spaces within the sealing system.

An objective of our invention is a sealing system for structures cast from concrete, liquid stone, placeable plastic, or similar flowable materials which will later solidify and become rigid during their curing periods, in which the sealing system includes tubular members of an elastic material such as rubber, neoprene, Thiokol or other similar synthetic plastics, embedded at predetermined locations within such structures, with said elastic tubes either independent or interconnected in such manner as to make a complete closure circuit at each predetermined joint location, and so arranged that cement grout or similar mixtures can be injected into inlets at the lowest portion of each system, and the entire grout receiving space in each system filled therewith, whereupon the air venting orifices at the top of the system are then closed and additional grout under pressure is pumped therein until the elastic tubes are expanded in their interior diameters by from ten to fifteen percent, thereby putting the material composing the walls of the tubes into heavy compression tending to expand

their outer diameters, and forcing their outer surfaces to flow into all voids and interstices in the adjacent surfaces of the concrete within which they are embedded.

A further objective of our invention is a circumferential hoop-like sealing means in the transverse construction or contraction joint faces of concrete lined tunnels or conduits, wherein the grouting material employed to fill a hollow plastic elastic sealing member may be introduced at the highest portion of the hoop and constrained to flow down one side of the hoop to its lowest portion and then fill the opposite side of the hoop from the bottom upwards, driving the air before it and out of the topmost portion of the hoop through a valves orifice closely adjacent to the inlet orifice where the grout material is being introduced, a diaphragm being interposed between said closely adjacent inlet and outlet orifices to direct the incoming grout material into its proper channel and thereby insure free egress of the air from within as the grout fills the space.

The foregoing and other salient features of the invention will be made clear as the description continues, reference being made to the accompanying drawings, but before proceeding with a detailed description it is believed desirable to point out a few specific uses, of the many, to which this invention may readily be applied, such as the construction joints in large swimming pools where it is important that leakage outwardly therethrough be stopped, to pressure conduits carrying water to turbines whereby power is developed and where, in many cases, the high fluid pressure in such conduits, if allowed to escape through construction joints, however small, and into adjacent seams in the rock, as in case of pressure tunnels, would gradually build up hydrostatic pressure over progressively widening areas until finally the force so generated would become greater than the rock could withstand and serious damage or destruction of the conduit and associated works would inevitably ensue. The invention is especially advantageous when applied to municipal aqueducts carrying water for domestic use over a long course of varying elevations, where the low portions are subjected to heavy internal pressures and in other portions, as on the crests of hills, may actually be serving as siphons so that negative pressure is present within, tending to suck ground water through any joints not sealed, and the invention's capacity to seal against intrusion as well as outward leakage thereby prevents the entrance of the ground water in such areas of negative pressures and thus preserves the water or other fluid within the conduit from being contaminated.

The invention may be readily applied to concrete culverts, flumes, dams, pontoons, caissons, sewers and sewerage works, subaqueous tubes for train and automobile traffic under rivers, retaining walls, tanks, bins, foundations, vaults, roofs and, in short, to any large concrete structure, or other plastic molded structures, where either inward or outward passage of fluid under pressure is to be restrained, or where monolithic action of the structure in compression and in shear is desired, or both. It will be understood by those skilled in the art, that while we have given a few specific uses herein, there are many more other uses to which the invention may be applied with equal facility, without departing from the scope of the invention as defined by these specifications and claims.

Reference is now made to the accompanying drawings in which

Fig. 1 is a vertical sectional view showing a fragmentary portion of the wood form or lagging defining what will later be a joint face of the concrete structure wherein the joint sealing mechanism is to be installed after concrete has been poured upon the right hand side of the form.

Fig. 2 is a vertical section similar to Fig. 1, after the concrete on right of joint has been placed and has hardened. In this view the form has been removed and a tubular sealing member is held in place in the half round groove, previously formed in the concrete.

Fig. 3 shows the concrete placed upon the left hand side of the joint, and totally enclosing the tubular sealing member.

Fig. 4 is a view similar to Fig. 3, except that the concrete on left side of joint has now hardened and cured, and the shrinkage attendant with the curing process is indicated as now having occurred, leaving a contraction crack between the concrete on the right and the concrete on the left. The cooperating parts as shown in this figure are now ready for the final sealing operation, consisting of the injection of grout under pressure into the interior of the tubular member.

Fig. 5 is a vertical sectional view similar to Fig. 4, but with the final sealing operation completed.

Fig. 6 shows a typical pressure aqueduct tunnel through rock with the invention applied thereto.

Fig. 7 is an enlarged detail at A of Fig. 6, showing the upper face of the concrete lining in the tunnel invert prior to the placing of concrete in the upper portion of the tunnel arch.

Fig. 8 is an enlarged detail at B of Fig. 6, showing the grout expanded sealing member in place in one of the transverse joints in the concrete tunnel lining, with the hose connections for introducing grout.

Fig. 9 is an enlarged vertical section taken upon the plane 9—9 of Fig. 8, showing a vertical extension of the tubular sealing member, with the hose connection nipple clamped in place by a hose clamp.

Fig. 10 shows the lower end of vertical extension of Figs. 8 and 12 prior to its being vulcanized into the correspondingly shaped notch in Fig. 11.

Fig. 11 shows the tubular member, notched out to receive similarly shaped lower end of the vertical extension of Fig. 10, before vulcanizing into place.

Fig. 12 shows the lower portion of the vertical extension of Fig. 10 after it has been vulcanized in position to form the T shaped connection extending upwards to receive hose connection nipple and the connection seen in Figs. 8 and 9.

Fig. 13 shows a joint between the ends of any two adjacent tubular members, with the connection sleeve shown in location therein.

Fig. 14 shows a typical pressure aqueduct, with the lower or invert concrete which is first poured, protruding beyond the completed arch portion to the right, and exposing a modified form of the invention; and

Fig. 15 is an enlarged fragmentary view of Fig. 14, illustrating the manner of segregating one portion of the longitudinal joint member from

the next adjacent portion by the soft rubber diaphragm partition in the molded rubber outlet manifold.

In the accompanying drawings illustrating the invention, like parts are similarly designated throughout.

In the application of the invention it is of prime importance that the elastic tubular sealing member 6 be uniform throughout its length in the freedom for enlargement of its tubular bore 10 by the introduction of the semi-fluid plastic or fluid grout sealing material under pressure therein, so that when hydrostatic pressure is applied to its interior thereby, there will be no restraint of the expansive enlargement by the presence of metallic or other non-elastic fittings as would be the case were conventional hose-joining connections used wherever one lengths terminal is to be joined in fluid-pressure tight continuity with the next one, or wherever a side connection is to be similarly made to a main tubular member. This freedom of expansion by action of interior pressure in every portion of the tubular member or members, embedded within the concrete structure where complete sealing is essential, is accomplished by squaring the ends of the tubular members 6, Fig. 13, that are to be joined and then inserting a relatively thin walled tubular connection sleeve 16 into the ends of the tubular members 6 and bringing them together after their interior cylindrical surface of 16 have been coated with an appropriate elastic cement similar to tire patch rubber cement. Usually the jointing process just described will be sufficient for those installations where but nominal or normal grouting pressures will later be applied, but in those installations where, due to the size of the concrete structure, or for other reasons, the grouting pressure will be very high, we then apply a portable vulcanizing form over the joints which have previously been made up with the connection sleeves as just described, and by the resulting thermal action supplied by the vulcanizer unit, fuse the parts in separably together into single unit. In similar manner a T shaped vulcanizer is used to clamp the pre-shaped tubular member 6 shown in Fig. 11 to the matingly shaped lower end of the vertical extension 13 shown in Fig. 10, in proper relationship and firm contact, and vulcanize them into a single piece as shown in Fig. 12.

By making the joint in this way we insure practically uniform expansion of the tubular members 6 at their jointures and junctions with that occurring in every other portion of their lengths and thereby make their sealing action continuous throughout every portion of their embedded lengths.

Wherever exterior prolongations of the tubular members 6 are necessary to permit injection of the grout, as at B and E in Fig. 6 and B in Fig. 8, and for air venting as at F in Fig. 6, it is not essential that those portions which protrude beyond the concrete should possess this expansion property inasmuch as those portions are not effective and are not required to seal off passage of fluid as is the case where they are embedded. This being true, conventional metallic hose connection nipples 14, Fig. 9, hose clamps 15 (see also Fig. 8), and hose connection couplings 12 can be and are employed, since their restraint of the tubular members 6 expansive properties in these localities are immaterial.

In pressure aqueducts and tunnels similar to that shown in Fig. 6, in the larger sizes it is usually customary to "drive the tunnel," i. e., excavate the rock, and then place the concrete lining in the invert or bottom first, with extensions running up a short distance on either side, and terminating in planes parallel to the longitudinal axis of the tunnel as seen at G in Fig. 6, and shown again somewhat enlarged in Fig. 7. Terminating the concrete lining first placed at these planes G, as just described, will obviously automatically form longitudinal cold joints or construction joints in the lining whenever the remaining concrete lining constituting the arch is placed above, and it will be just as essential to seal off these longitudinal joints as it is to seal the transverse joints previously described.

To accomplish this sealing of these longitudinal joints we form a half round groove 17, Fig. 7, in the face of each of the clamps G, and place tubular sealing members 6 in these grooves and provide them with suitable grout injection connections such as that shown at E of Fig. 6, before placing the next lift of concrete lining, which in larger size tunnel structures usually terminates in similar longitudinal planes as shown at H in Fig. 6, which likewise in their turn are provided with tubular sealing members and grout injecting connections.

As will be seen in Fig. 7, we preferably isolate the transverse sealing installations from the longitudinal sealing installations, as this makes the systems simpler and easier to install, saves the interconnecting joints and makes it possible to pressure grout and seal each joint independently. Occasionally special conditions make it desirable or necessary to depart from this practice, in which case the longitudinal sealing members can then be interconnected to the transverse joint sealing members.

In forming the recess in the concrete we use half round pieces 2, Fig. 1, to shape the half round grooves in the concrete first placed, which will later receive the tubular members 6. These half round forming pieces 2 may be made of finished wood where straight grooves are required, particularly if they are of considerable length, but where curving grooves are required, particularly if they are of considerable length, such as that shown in Fig. 7 at 17, then we preferably employ rubber or some other similar flexible material that may be bent and curved to conform with the curves desired and then continue the tangent lengths with half round wooden forms again.

In the foregoing description the method of filling the transverse joint sealing tubular members with grout from the bottom allows the grout 11 to drive the air out above it until the grout reaches the highest portion of the system, whereupon the air escape orifice, or orifices if a dual fitting 18 with segregating diaphragm 19, see Fig. 15, is used at F in Fig. 6, at the high point is closed and the final predetermined grouting pressure is applied to the sealing system from the fitting at B in the invert of the tunnel. In certain instances it is sometimes necessary, or desirable, to depart from this system by injecting the grout in at the high point of the system through one leg of a dual manifold fitting such as that shown in Fig. 15, where the diaphragm 19 allows the grout to go down only on that side where, after removing one of the pipe caps 21, the grout fitting has been connected. The mating pipe cap 21 is likewise removed in such a case and a suitable gate or globe valve, screwed onto the nipple 20, and by opening this valve the air within the tubular sealing mem-

ber 6 is allowed to escape as the grout is introduced through the adjacent nipple 20. The grout as it descends downward around one side of the hoop encircling the conduit bore drives the air out before it up through the other side of the hoop and out through this valve. As soon as the system has been filled and grout starts to flow through the valve, the valve is then closed and the final grout sealing pressure is then applied to produce the required compression within the sealing system as hereinbefore described.

From the foregoing it will be seen that our invention provides a simple and inexpensive system and apparatus for sealing construction and contraction joints in concrete structures whereby they are made fluid tight at such joints even after some movement may occur subsequent to their original application, and that such structures that include the embodiment of our invention are also in consequence caused to act monolithically against lateral displacements, and, while we have illustrated and described but one application of the preferred construction and arrangement of the invention to satisfy the patent statutes, we do not wish to be limited to the construction and arrangements shown, as changes may obviously be made in it without departing from the spirit of our invention.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide peripheral recesses, expansible members in said recesses and continuous peripherally, and means permanently expanding said members into pressure contact with the walls of the recesses.

2. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide peripheral recesses, expansible resilient members in said recesses and continuous peripherally, and means permanently expanding said members into pressure contact with the walls of the recess.

3. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide recesses, expansible resilient hollow members in said recesses, and means permanently expanding said members into pressure contact with the walls of the recesses.

4. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide a recess, an expansible resilient tubular member continuous in said recess, and means permanently expanding said member into pressure contact with the walls of the recess.

5. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide a recess, and a permanently expanded resilient member in said recess and coextensive therewith and located in shear with respect to the sections.

6. In a concrete or other plastic molded structure, sections having grooves in adjacent section faces cooperative to provide a recess, a tubular resilient walled member in said recess and coextensive therewith, and a core of rigid material expanding said resilient member permanently into pressure contact with the recess walls, said core being located in shear with respect to the sections.

7. The method of forming sectional concrete structures with expansible sealing means embedded between the sections which comprises pouring the one section with a formed groove for a portion of the sealing means, placing the sealing means in the groove, pouring the adjacent section, and permanently expanding the sealing means.

8. The method of forming sectional concrete structures with expansible sealing means embedded between the sections which comprises predetermining ultimate sectionalization, embedding resilient uniformly expansible sealing means between the sections as poured, and permanently expanding the sealing means following the curing period.

9. The method of forming sectional concrete structures with uniformly expansible resilient walled sealing means embedded between the sections which comprises predetermining the ultimate sectionalization, embedding the expansible sealing means between the sections as poured, and permanently expanding the sealing means to place the walls thereof under compression following the curing period.

10. The method of sealing adjacent sections of a concrete structure comprising sections having adjacent faces cooperatingly grooved to provide a recess, which includes the steps of inserting a tubular elastic member substantially filling the recess, and then pumping a hardening substance into the tubular member to remove the air and permanently completely fill and expand the member into pressure contact with the walls of the recess.

11. The system of sealing concrete structures which consists in predetermining sectionalization, embedding connected flexible elastic walled tubular members between section faces, joining filling inlet tubes thereto, and expelling the air from the tubular members while filling the same completely with a self-hardening material under pressure sufficient to expand the flexible elastic wall of the tubular members into permanent compression against the embedding section faces.

12. The method of constructing a tubular concrete structure which comprises casting the bottom portion in successive sections with longitudinal grooves at the designed juncture with upper sections to be superimposed, forming grooves in adjacent end faces of meeting sections, filling the grooves with continuous elastic walled tubular elements of uniform expansibility, casting the upper sections, filling the grooves in the end faces of the upper and bottom sections, each with a similar continuous elastic tubular element, and pressure expanding the tubular elements with a fluid-hardening agent in a manner to compress the walls of the tubular elements and provide a rigid core therein throughout.

13. In a sealing means for concrete structures, elastic tubular sections, means flexibly and elastically jointing said sections interiorly, and means for injecting an expanding filler into said joined sections.

14. In a sealing means for concrete structures, flexible elastic tubular sections, a sleeve of elastic material inserted and cemented in the adjacent ends of sections to join the same into a ring, and means for filling the ring with a rigid core.

15. In a sealing member for concrete structures, a deformable tubular length, filler and vent fittings joining the ends of said length, and at least one diaphragm intermediate the fittings to regulate the direction of flow.

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