Oct. 29, 1968 P. G. CASSIDY 3,407,552

BASEMENT WATERPROOFING METHOD AND ARRANGEMENT

Filed Jan. 20, 1967 2 Sheets-Sheet 1

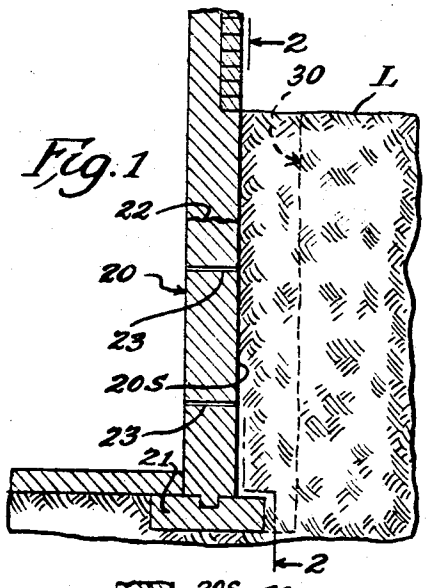


Fig. 1

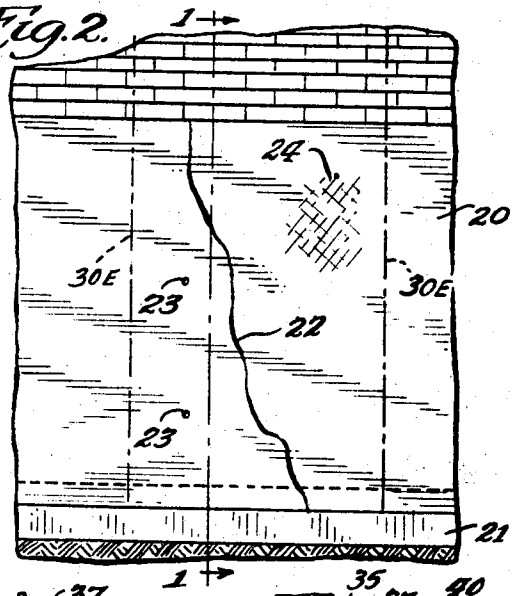


Fig. 2.

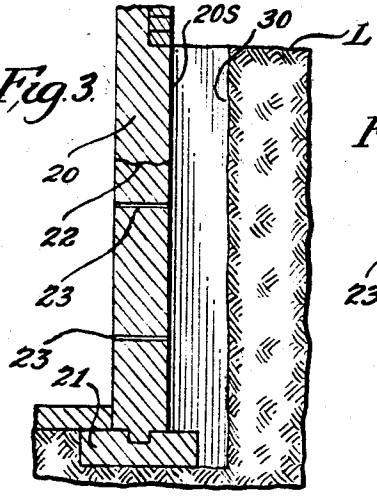


Fig. 3.

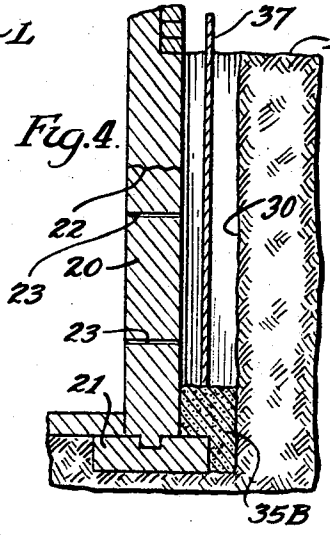


Fig. 4.

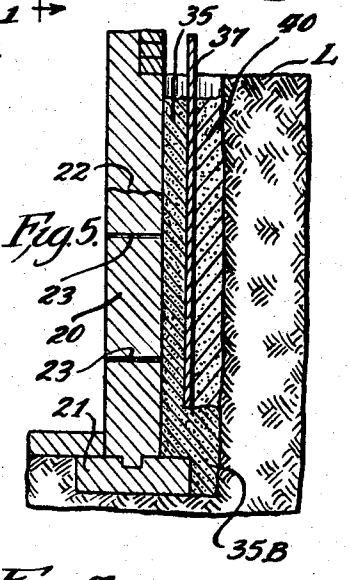


Fig. 5.

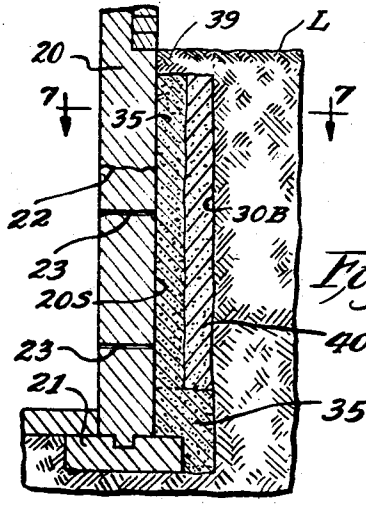


Fig. 6.

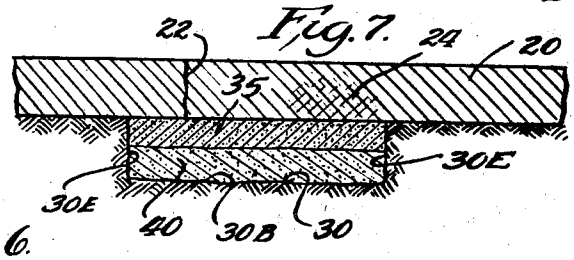


Fig. 7.

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Fig. 8.

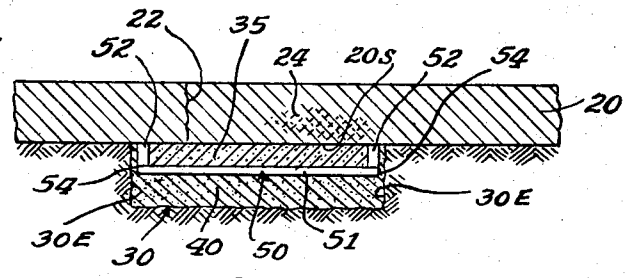


Fig. 9.

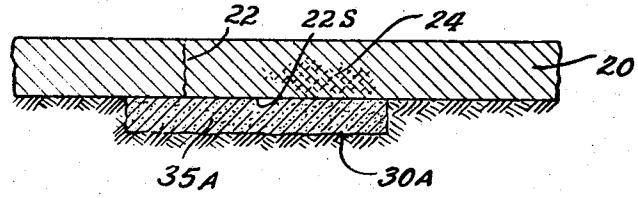


Fig. 10.

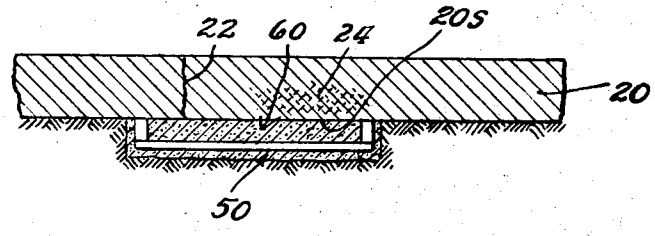
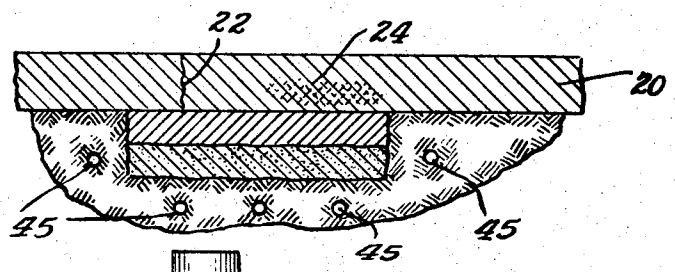


Fig. 11.



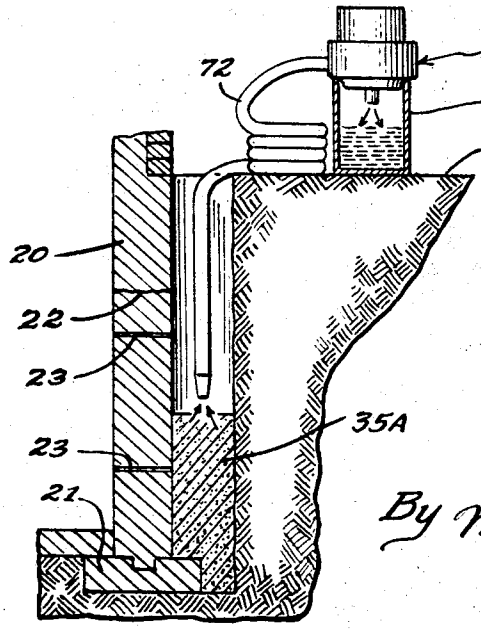


Fig. 12.

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3,407,552

BASEMENT WATERPROOFING METHOD AND ARRANGEMENT

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Continuation-in-part of application Ser. No. 372,336, June 3, 1964. This application Jan. 20, 1967, Ser. No. 632,119

9 Claims. (Cl. 52—169)

ABSTRACT OF THE DISCLOSURE

This invention relates to a basement waterproofing method and means especially adapted for use in connection with post backfill waterproofing basements of residences, commercial establishments, and the like which involves removing just enough earth from the wall surface in question to permit the application thereto of just that amount of dry granular water expansible material (such as bentonite) which will adequately cover the wall defect to provide permanent and immediate waterproofing, and which involves providing ways to immediately, or at some subsequent time, test or prove the waterproofing effectiveness of the job to the customer's satisfaction.

This application is a continuation-in-part of my now abandoned application Ser. No. 372,336, filed June 3, 1964, the disclosure of which is incorporated herein by this reference.

In basements of residences, business buildings and the like, it is often found that leaks develop in the exterior basement walls due in some instances to faulty materials in the wall and in other instances to settling cracks that become progressively larger or wider over the years. Wall defects of the aforesaid character, or due to other reasons, enable water to penetrate the wall into the basement, and such leaking walls present one of the most troublesome problems of building maintenance.

Various methods has been employed in an effort to waterproof such walls. Many of the methods involve patching or filling of leaks or holes in the wall from the inside, and sometimes from the outside, with cementitious mixtures, asphalt, pitch and various kinds of caulking compounds being employed for this purpose. Most of these patching materials tend to shrink or dry out over a period of time so as to lose their waterproofing effectiveness, and in addition to this, and probably a more serious difficulty, is the further opening of settlement cracks as a building continues to settle. This added settling, of course, produces cracks or openings between the patching material and the original cracked surface.

Other waterproofing efforts include the application of an asphalt membrane or coating to the outer surface of the basement wall, and, of course, this is usually done when the building is originally erected and before backfill has been effected. After backfill has been effected, the application of such waterproofing requires digging out the earth adjacent the wall, the cleaning, brushing, chipping and other treatment of the wall surface to obtain adhesion, and spraying or painting the asphalt material onto the surface of the wall. In some instances, efforts are made to provide such a membrane or coating by injection methods that avoid the necessity of excavation, which leaves adhesion and the provision of a continuous coating largely to chance. The asphalt membrane or coating, of course, initially provides a good seal, but as the material dries out with age, it reaches a point where it cracks due to further building settlement so that its waterproofing effectiveness is destroyed.

Other methods of waterproofing include the injection,

in the ground adjacent the basement wall, of a bentonite slurry that is comprised of about 80 percent or 90 percent water, and while it is intended that this slurry be injected into all of the available space adjacent the wall, the heterogenous nature of soils makes it oftentimes not possible to pump the slurry to all places required. For instance, given a hard clay backfill adjacent a foundation having voids of various types because of gravel or trash deposits or the like, the pumped materials will follow paths of least resistance and pass into the voids which may be located elsewhere than where the operator wants the slurry to go. The use of pumped slurry assumes a uniform or homogenous backfill structure, e.g. sand, through which the slurry can be pumped, and this obtains in relatively few places in this country. It also assumes that outside drain tile does not exist around the foundation, as drain tile can be effectively clogged by the pumping of bentonite slurry at the footing grade.

Furthermore, as the slurry dries out under drought conditions and the like, there is a cracking and displacement of the bentonite so that areas that were originally protected by the slurry are now exposed to water that may enter through cracks or the like in the wall and which will not be stopped by dried out slurry until it has had time to re-gel. Chemical injection is also used in some instances, but has not ben found to be satisfactory in many types of soil, e.g. clays.

In any event, the slurry injection method is generally classed as a form of temporary dampproofing that is employed as a stop-gap measure until a more permanent method can be performed.

Also, waterproofing has been attempted by digging relatively large trenches or excavations along the troublesome portion of the basement wall and filling this excavation with slurried or dampened bentonite. This approach, however, not oly requires a large amount of the expensive bentonite material, but also requires damage to or destruction of bushes and other plantings, sidewalks, patios, etc., that are customarily found adjacent residential and many commercial waterproofing sites. Furthermore, the waterproofing results have proved to be negligible and no better than one would expect from temporary dampproofing. Consequently, this method has not been used to any great extent because it has been not only deemed to be too costly and destructive of adjacent property, but also functionally ineffective from a true waterproofing standpoint.

More recently, a prefabricated dry bentonite containing panel of the type disclosed in Clem Patent 3,186,896 has become available in the form of a corrugated paperboard carrier in which the voids thereof are filled with dry bentonite; such panelling is designed to be applied against the etxerior surface of basement walls or the like before backfill has taken place, and since the paperboard is intended to serve only as a convenient way to package the bentonite for application purposes, it is apparent that it serves no useful purpose once the backfill is in place. Furthermore, the corrugations extend through the width of the bentonite layer provided by the panelling, which is only about 7/64 of an inch in thickness when dry, and provide ready paths for water to reach the wall through the bentonite. Also, the bentonite is separated from the wall surface to be protected by the cardboard container. Moreover, the layer of bentonite is so microscopically thin that once the cardboard container deteriorates the few ounces of material per square foot involved would become displaced into the fissures of the soil, and would not even cover the irregularities of the concrete or block wall to be waterproofed, which oftentimes has form and mortar irregularities equal to ten to thirty times the thickness of the bentonite of this paneling in the dry state. Furthermore, there can be no assurances that the bentonite will always

be in a state of expansion, and in fact, during periods of drought it will return to original dry volume, which for this panelling would be only a few ounces per square foot. During periods of drought it is not uncommon for the earth bank surrounding the wall to shrink away one-half inch or even much more from the wall to be waterproofed. The resulting void would render the above system a total loss.

Thus, while the arrangement of the Clem patent purports to overcome the use of the expensive and complicated forms, bulkheads and the like that were theretofore said to be required by prior art practices, of which Bechtner Patent 2,277,286 was cited as an example, to hold the bentonite, techniques of this type are incapable of providing immediate and permanent waterproofing results.

My invention has to do with a post backfill manner of using bentonite in its dry form and applying same to the defective wall area in a manner that minimizes possible expansion and permits one to, for the first time, provide immediate and permanent waterproofing for such defects from the outside of the wall without extensive backfill removal.

In those instances where a basement wall is to be waterproofed so that it will withstand the next rainstorm is being able to assure the owner that the waterproofing operation has been successfully applied to the basement wall, and under the prior methods that have been used, such as those above described, there have been no quickly performed test procedures for determining whether or not the faulty portion of the wall has in reality been waterproofed, one of the most important considerations or the like.

In practicing my invention, a small scale excavation is made along the defective wall surface of the backfill thereagainst and only of that length longitudinally of the wall surface to be treated that will adequately expose the wall defects that are to be waterproofed, and of such a width laterally of the wall that will permit application to the excavation of a layer of dry water expansible material such as bentonite in the special manner I have devised for post backfill waterproofing. This involves forming in direct contact or in engagement with the wall surface in question a continuous layer of bentonite or its equivalent in dry bulk form having a thickness in the range of from about four inches to about eight inches and fully compacting same by vibration to eliminate all voids and the like, and enclosing such layer in the excavation so that full expansion of the bentonite or its equivalent when dampened or wetted is precluded. The water expansible layer is applied in such a manner that the portion thereof engaging the wall surface is dry, and the waterproofing is achieved primarily by virtue of a body of compacted dry bentonite or its equivalent material forming the water barrier, rather than a body of wet or dampened and expanded bentonite.

In one form of the invention the water expansible layer alone is used while in another form the water expansible layer is backed up by a water permeable layer of incompressible material such as sand. In either case, the resulting installation lends itself to immediate testing by flooding the area with water, or testing at a later date to verify the correctness of workmanship by a vacuum excavation of the water expansible material, which is only possible if the water expansible material is dry.

My studies have established that not only does fully expanded bentonite leak, but when it dries out it fissures, and thus forms numerous cracks through which water readily passes until the bentonite again becomes wet. Furthermore, I have found that drought conditions cause a considerable amount of settling and shifting with the result that cracks between the ground and the waterproofed wall may open up as much as an inch, and further, existing wall cracks enlarge and new ones may become formed. I have found that the loss of bentonite into such cracks and other resulting cracks or crevices is indeed material and that permanent waterproofing cannot be achieved without taking this into consideration.

The layer of water expansible material I provide for post backfill waterproofing is not only uninterrupted across the area to be waterproofed, compacted, and dry in the area of the wall defect, but just as important, provides sufficient "reverse in depth" within itself to self compensate for the sifting of dry bentonite into drought caused cracks, separations, and the like to maintain the desired water sealing action.

The result is that by practicing my invention I am able to, for the first time, provide immediate and permanent waterproofing using a post backfill procedure, without performing a major backfill removal operation, and without resurfacing the outside of the defective wall surface.

In view of the foregoing it is the primary object of the invention to provide a method and arrangement for post backfill waterproofing basements of residences and the like which is concerned with removing only that amount of earth from the wall surface in question to permit the application thereto of just that amount of a dry granular water-expansible material that will adequately cover the wall defect to, for the first time, provide truly permanent and immediate waterproofing.

Another principal object of the present invention is to enable the waterproofing of a basement wall to be accomplished in such a way that it may be immediately tested to determine whether or not the cracks in the wall have been sealed.

A further object of the invention is to provide an immediate and permanent waterproofing method and arrangement using dry bentonite that insures that full expansion of all the bentonite used will be avoided.

Still another principal object of the invention is to enable waterproofing operations for basements of residences and the like to be carried out in a simple and economical manner that avoids damage to or destruction of shrubbery, flowers, patios, driveways, and the like that are found in the immediate area of the wall that is to be waterproofed.

Other and further objects of the present invention will be apparent from the following description, claims, and the accompanying drawings, which, by way of illustration, show several preferred embodiments of the present invention and the principles thereof, and what is now considered to be the best modes in which to apply these principles.

In the drawings:

FIGURE 1 is a vertical sectional view of a basement wall that is to be waterproofed;

FIGURE 2 is a vertical sectional view taken along the line 2—2 of FIGURE 1 and showing the external surface of the wall;

FIGURE 3 is a vertical sectional view similar to FIGURE 1 and showing the excavation that is made at the wall area to be waterproofed, following one procedure of my invention;

FIGURES 4 to 6 are sectional views similar to FIGURE 3 and showing successive steps in the waterproofing operation there involved;

FIGURE 7 is a horizontal sectional view taken along the line 7—7 of FIGURE 6;

FIGURE 8 is a view similar to that of FIGURE 7 illustrating a modified arrangement following the procedure of FIGURES 3–7;

FIGURE 9 is a view similar to that of FIGURE 7 but illustrating a simplified waterproofing procedure in accordance with this invention;

FIGURE 10 is a view similar to that of FIGURE 9 but illustrating a form that may be used in practicing the procedure described in connection with the showing of FIGURE 9;

FIGURE 11 is a view similar to that of FIGURE 7 illustrating an alternate manner of testing a waterproofing

job performed in accordance with the procedure of FIGURES 3–7; and

FIGURE 12 is a view similar to that of FIGURE 6 but illustrating an extraction form of testing procedure that is employed in connection with the waterproofing job performed as described in connection with the embodiment of FIGURE 9.

However, it is to be distinctly understood that the specific drawing illustrations provided are supplied primarily to comply with the requirements of the patent code, and that the invention may have other embodiments employing the same or equivalent principles and structural changes may be made as desired by those skilled in the art without departing from the invention.

GENERAL DESCRIPTION

For purposes of disclosure the invention is herein illustrated and described as applied to the waterproofing of a basement wall **20**, which may be part of a residence or the like, that is carried by a footing **21** and which, below the exterior ground level L, has several points of water leakage caused by commonly encountered defects, including an angular settling crack **22**, open tie rod holes **23**, and a honeycomb or porous area **24**. Properly installed concrete does not present water leakage problems in the absence of such defects, and these defects may, of course, occur either singly or in groups. The present invention provides a practical way to effectively seal any such defects in a simple and effective manner that requires no inside work, and permits the required work outside of the building to be accomplished neatly and easily without having to be concerned in any way with the surface of the concrete itself or obstructions such as adjacent shrubs, sidewalks or the like.

This invention is directed specifically to the water proofing of residential basements or the like after backfill has been effected and ordinarily would be practiced some years after the residence has been occupied and the owner has put in shrubs, flowers, sidewalks, a driveway, a patio, or the like which must not be damaged in practicing the waterproofing techniques.

In accordance with my invention, an excavation is made along the defective wall surface **20S** of only that length longitudinally of the wall surface that will adequately expose all such defects and of that width laterally of the wall to permit application to the excavation of a layer of dry granular water expansible material such as bentonite that will provide permanent waterproofing with immediate waterproofing characteristics.

Further in accordance with this invention, the installation is so arranged that its waterproofing effectiveness may be immediately tested if so desired, as by saturating the adjacent ground with water in flooding quantities. Additionally or alternately, a further aspect of this invention involves testing the installation waterproofing effectiveness, when and if questioned, by extracting the water expansible material so that it can be inspected inch by inch down through the height thereof, whereby installation defects may be readily exposed and corrected and the reusable water expansible material returned into the excavation.

In the practice of my invention I have found that the layer of water expansible material such as bentonite that is to be used for waterproofing purposes must be dry and in abutting or direct contact relation with the surface of the defective wall, it should be thoroughly compacted in place to eliminate all possible voids on all sides, the space available for the bentonite to expand in should be less than that which would permit the bentonite to fully expand, and it should have a continuous thickness laterally of the wall in the range of from about four to about eight inches, and preferably about six inches.

The expansion space relation indicated and indicated minimum thickness dimension of the layer of water expansible material are important aspects of my invention since they insure that when the installation is completed, the waterproofing job will be permanent if the installation is correctly done in accordance with my invention. My tests and experience have shown that when my expansion space relation is observed and the layer of water expansible material has the indicated lateral thickness, no amount of flooding, settlement, drought, or the like will dilute the waterproofing characteristics of the bentonite, displace the water expansible material from waterproofing relation to the wall it is protecting, or create leakage causing fissures or separation in the waterproofing layer.

These are important aspects of the invention since fully expanded bentonite leaks water, and also it can become fragmented or separated from the wall under a number of commonly experienced circumstances. For instance, once the water expansible material has become dampened and later an extreme drought situation occurs, the water expansible material will tend to fission out thus forming numerous cracks through which water can readily pass when the first drenching rain comes along. In accordance with my invention, the water expansible layer has the minimum thickness dimension indicated which preserves enough dry water expansible material adjacent the wall to flow into the fissures and close them; thus, the dry bentonite material, being free flowing in nature, effects a self-sealing action with regard to any fissuring that may occur along the outwardly facing surface of the layer of water expansible material.

Similarly, the bentonite materials provide a self-sealing action when either the ground or the basement wall or both is subject to settlement. While the top elevation of the layer of water expansible materials might lower somewhat as a result of this type of self-sealing action, the layer of water expansible materials is installed up to a height with respect to the wall defects that will readily accommodate this without exposing the defects.

Thus, I prefer to call the layer of water expansible material that is provided in accordance with my invention a self-maintaining waterproofing effectiveness layer, which refers to a layer of initially dry granular compacted water expansible material such as bentonite having a thickness in the range from about four inches to about eight inches laterally of the wall and uninterrupted by foreign materials extending through or into the bentonite, such as paperboard or other bentonite packaging mediums, which would create direct passages through the bentonite through which water can readily pass into the vicinity of the wall defect being waterproofed. In other words, the layer of water expansible material in accordance with my invention is one integrated and continuous self-restoring mass of water expansible materials across the area of the wall surface being waterproofed, and it is applied in such a manner that all of it cannot fully expand in the space available regardless of what water conditions might be.

The maximum thickness dimension indicated is determined by the maximum dimension of excavation width that should be employed for waterproofing residential basements and the like to avoid the damage mentioned above as well as the economics in using the expensive bentonite materials. The width dimension used within the range indicated is governed by water conditions at the work site; if down spouts are near by the maximum width dimension should be considered while if the ground is normally dry the minimum width dimension may be employed.

Referring now specifically to the drawings, FIGURES 1–7 disclose an embodiment of my invention in which the installation comprises a continuous layer of water expansible material **40** such as sand or gravel whereby after the installation is completed, the waterproofing effectiveness of the installation may be tested by supplying water in large or flooding quantities to the water permeable layer **40**.

The embodiment of FIGURE 8 illustrates a novel form

50 useful in connection with practicing the method of FIGURES 1–7.

FIGURES 9 and 10 illustrate a simplified procedure employed in connection with my invention in which the layer of water permeable material is omitted. FIGURE 11 illustrates an alternate testing procedure for use in connection with the methods of FIGURES 1–8, and FIGURE 12 illustrates an alternate testing procedure that is especially adapted for use in connection with the methods of FIGURES 9 and 10 whereby the water expansible material is extracted from the excavation to examine it inch by inch down through the waterproofing layer for possible installation defects.

It will thus be seen that my invention has provided a basement waterproofing procedure and arrangement especially adapted for application to residential basements and the like which involves a small scale and delicate excavation of a narrow slot in the backfill of just enough width to accommodate my afore-defined self-maintaining waterproofing effectiveness layer of water expansible material (and the water permeable layer if used), with my self-maintaining waterproofing effectiveness layer being applied in abutting relation to the wall surface to be waterproofed without any treatment of the wall surface itself being required.

SPECIFIC DESCRIPTION

Referring now to the embodiment of FIGURES 1–7, in carrying out the waterproofing operation there illustrated, the excavation **30** is made along the defective wall surface **20S** so that all the defects are exposed as well as an area surrounding all such defects. Thus, where defects **22**, **23** and **24** are to be sealed, the excavation may be extended along the wall **20** to the lines E of FIGURE 2 which should provide a minimum of from four to five inches between the edge of the excavation and the next adjacent defect to thereby fully expose the defects in the area surrounding same and waterproof same with my installation. The excavation **30** in the form of FIGURES 1–7 is also preferably extended downwardly to the level of the bottom of the footing **21**, and its dimension normal to or laterally of the wall **20** is preferably in about the range of about 8 to 10 inches.

The excavation **30** is made by using conventional augers, pivoted shovel pairs, and/or other suitable digging equipment that will form the narrow slot in the ground or backfill that takes the form of excavation **30**.

The excavation **30** thus provides a narrow slot in the ground exposing the wall defects and adjacent wall surfaces to be waterproofed and said excavation or slot provides end faces **30E** and a back face **30B** (FIGURE 7).

After completion of the excavation (which is shown in FIGURE 3), the bottom portion of the excavation along the outside of the footing **21** and along the line of the junction of the wall **20** with the footing **21** is filled with a water expansible material **35** such as bentonite, as indicated at **35B** in FIGURE 4 which is compacted in place in any suitable manner. The water expansible material as applied must be dry and in unpackaged or bulk form, in accordance with my invention. Thus, if the material **35** comes from the supplier in a sack or the like, it must be applied in bulk form to the excavation without the sack as packaged containers of the material when applied against a wall inherently form leak passages between them.

A vertical division wall or form **37** is then inserted into the excavation **30**, as shown in FIGURE 4, which wall is proportioned so that its vertical end edges engage the ends **30E** of the excavation and its bottom edge rests on the initial fill **35B** with the top of the wall or form being disposed within ready reach of the workers as indicated in FIGURES 4 and 5. The division wall **37** is disposed substantially midway between the wall **20** and the excavation surface **30B**, to thus divide the excavation into an inner space and an outer space though wall **37** should be positioned to provide the aforedescribed minimum space of about four inches between the surface **20S** and wall **37**. The inner and outer spaces are then filled progressively upwardly to a point slightly below the level L (see FIGURE 5), with the inner space that is adjacent the wall **20** being filled with the same material **35** in bulk form that is used for the bottom fill **35B**, while the outer space is filled with an incompressible water permeable material **40** such as sand or gravel. Care is taken to compact the bentonite material **35** in place to eliminate all voids, and for this purpose suitable vibrators such as those used in connection with pouring concrete may be used.

The division wall **37** is preferably removed from between the two layers and this may be accomplished progressively as the fill proceeds or it be accomplished in a single operation after the inner and outer spaces have reached the level indicated in FIGURE 5 with respect to the wall defects being waterproofed.

After the removal of the division wall **37**, the top of the excavation **30** is filled up to the ground level L with top soil **39** (see FIGURE 6).

Throughout the installation care must be taken to insure that only the bentonite and incompressible materials such as finely divided sand go back into excavation **30** so that the space the bentonite can expand into is as restricted as possible.

Immediately after installation, or if preferred, prior to the introduction of the top soil **39**, the waterproofing effectiveness of the installation, according to my invention, is tested by supplying water in large or flooding quantities to the water permeable layer of material **40**. It has been found that if a proper overlap of from 4 to 5 inches is provided laterally beyond, above, and below all wall defects, such as the defects **23** and **24**, and my minimum layer thickness criteria is observed, the presence of water thus introduced through the permeable material **40** along the length of the layer **35** immediately causes such expansion of the water expansible material about the side or border surfaces of the layer formed by material **35** as permitted by the space available so as to form a leak free casing about the body of material **35** that seals off the several defects from the water and prevents leakage through the wall **20** and leaves an adequate reservoir of dry water expansive material for self-repairing the water seal provided (by flowing into cracks and the like) to make the waterproofing permanent against the adverse effects of all settlement, drought and the like conditions that may reasonably be expected.

This testing thus not only gives assurance to the contractor as well as to the owner that the work has been performed properly and will accomplish the desired sealing action, but also conditions the body of the material **35** to keep water away from the waterproofed areas of wall **20**.

An alternate method of testing the installation of FIGURES 1–7 is indicated in FIGURE 11 wherein about the installation holes **45** have been drilled by jamming what is known in the art as a studded rod into the ground to the depth required to fully saturate the ground about the installation. Rods of this type are formed with a plurality of orifices leading to a bore which is supplied with water under pressure, and they are forced into the ground by hammering or the like with the water turned on.

Referring now to the embodiment of FIGURE 8, the installation procedure used is the same but a modified division wall or form **50** is employed which is U-shaped or channel-shaped in cross-sectional configuration and may be conveniently made by a scrap sheet of plywood **51** nailed to a pair of scrap two-by-fours **52** disposed along opposite edges **54** thereof.

The form **50** prevents the water expansible material and the water permeable materials from intermixing at the sides **30E** of the excavation **30**. As indicated in FIGURE 8, the long dimension of the two-by-fours (which may be made from ordinary two-by-four lumber) should

extend laterally of the wall surface 20S, and when so disposed the minimum depth criteria of my invention for the layer of material 35 will be met.

Referring now to the embodiment of FIGURE 9, the waterproofing operation there contemplated involves the formation of an excavation 30A in the ground or backfill along the defective wall surface 20S so that all the defects are exposed in the manner already described in connection with the embodiment of FIGURES 1–7. However, in this embodiment of the invention, the excavation 30A can have a depth laterally of the wall 20 which is on the order of 4 to 6 inches and when completed to a depth well past the lowermost wall defect, for instance, 4 to 5 inches, excavation 30A is filled with the dry water expansible material 35A such as bentonite to define a layer that extends up to the level indicated in FIGURES 5 and 6 for layer of material 35. As described in connection with the embodiments of FIGURES 1–8, the water expansible material should be dry, applied to the excavation 30A in unpackaged form, and compacted by vibrating it or the like so that it provides a continuous closely compacted column of dry water expansible material extending between the bottom of the excavation and the top thereof, and that fills excavation 30A to a level below ground level as appears in FIGURES 5 and 6.

In the embodiment of FIGURE 10, the same procedure is followed except the form 50 is inserted in the excavation against the foundation wall as soon the excavation is completed. The form thus defines a space 60 between it and the surface 20S which is then filled with the dry, unpackaged water expansible material such as bentonite in the manner indicated, after which the form may be removed.

In connection with the procedure indicated by FIGURE 10, the excavation can be alternately made by placing the form adjacent the wall in the position indicated in FIGURE 10 and drilling within it, with the form being pushed down by hand as the drilling proceeds.

In accordance with this invention, the installations illustrated by FIGURES 9 and 10 may be tested in several ways to provide the visual test results and water sealing casing for the water expansible material that has already been described.

For instance, the installations of FIGURES 9 and 10 can be tested in the manner described in connection with that of FIGURE 11 whereby the ground surrounding the layers 35A is saturated with water.

However, it sometimes happens that the ground itself is already sufficiently saturated with water to provide an adequate test and seal without further saturation being contemplated. The use of the form 50 is particularly advantageous for these situations as it insures against premature cave-ins and reduces the area of contact of water with the material 35A. In all the forms of the invention the form or divider may be left in place to achieve the same advantage.

Whenever the effectiveness of the installations is questioned, my invention also contemplates the extraction for inspection purposes of the dry portions of layer 35A by employing an arrangement such as that indicated in FIGURE 12 in which a high speed blower 70 is employed to draw up the water expansible material through a suitable hose or conduit 72 and deposit it in a drum 74 on which the blower units 70 may be conveniently mounted. The blower unit 70 may take any suitable commercial form which will provide the vacuum required to draw the water expansible material from the excavation 30A and deposit it within the drum 74 or its equivalent.

If the installation has been done correctly, the water expansible material adjacent the wall imperfection should be dry, and thus will have the fine granular form that bentonite and its equivalents come in, which can readily be extracted from the excavation 30A by a blower arrangement such as that illustrated in FIGURE 12.

The layer 35 can be completely extracted and if found to be free of faulty workmanship can be restored by merely reversing the action of the blower unit 70. Consequently, blower 70 should be of the reversible type.

If the workmanship on the initial installation proves to be faulty, the bentonite material adjacent the defective wall surface will be wet and these areas can be precisely located and the reason for failure determined whether it be of the materials employed or of the workmanship. The wet bentonite material can then be removed in any convenient manner and replaced with dry water expansible material.

In connection with my extraction testing technique, I have found that under some conditions it is desirable to leave the forms 37 and 50 in place since the forms aid in keeping the water expansible material dry and define a convenient pocket from which the water expansible materials can be completely extracted and returned, and this is done where conditions such as soggy ground warrant.

The extraction procedure above described can also be employed in connection with an installation of the type described in connection with the showings of FIGURES 1–7 although this has a disadvantage that the materials forming the two layers become intermixed. However, the extraction procedure will still permit a ready determination of whether or not the wall surface to be waterproofed is dry, which it must if the installation is properly done. In instances where it is contemplated that the extraction procedure may be required for installation of the type indicated in FIGURES 1–7, the division form 37 should be left in place although under such circumstances the top portion thereof would be cut down to the top level of the layers 35 and 40.

It will thus be seen that my invention enables residential basement walls and the like to be permanently waterproofed by a simple and economical procedure which is accomplished in such a way that the waterproofing may be promptly tested to determine whether or not the work has been satisfactory, or it can be tested at any later time to determine whether or not alleged leakage is coming from the installation in question. Testing and verifying waterproofing effectiveness is not done in the industry because of the inability heretofore to verify the immediate effectiveness of the waterproofer's work. There has been no way to economically and visually inspect the waterproofed area without vast excavations. Moreover, the inside wall areas of many homes and commercial structures are covered with dry wall panelling and the like, which make it economically impossible to determine exact areas of leakage, whether prior to or after waterproofing work has been done. My method provides the economy whereby the owner of a building does not have to destroy the inside of a wall in order to waterproof the area of leakage outside.

It will be further evident that the present invention accomplishes the waterproofing operation in such a way that the required work is performed in the difficult situations customarily presented by residential buildings.

Thus, my invention can be performed in spite of surface obstructions without destruction and without having to go to one of the objectionable temporary dampproofing processes, which heretofore have been the only other solution if one did not desire to make a large excavation, and the necessary and consequent removal of surface slabs, trees, flowers, bushes, etc. which would be required to permit a man to get close enough to the foundation surface to clean it by brushing, etc. and coat it with asphaltic compounds or the like.

The excavation I contemplate can be made, where circumstances require, by drilling at acute angles relative to the surface along the side of slabs to reach an area to be waterproofed which may be as much as thirty to forty feet below the surface. Also the excavation can be performed horizontally from an open pit such as an existing

window well or basement stairway or the like to reach normally inaccessible areas, in which case the water expansible material can be conveniently blown into the excavation by a blower unit such as that illustrated in FIGURE 12. Under such circumstances, an installation of the type described in connection with FIGURE 9 would be desirable, except, of course, for the working angle involved.

It is important to keep in mind that in accordance with my invention, no work whatsoever is required on the inside of the foundation and the outside surface of the foundation wall need not be treated or cleaned in any manner other than knocking large earth lumps off that may adhere to the wall. As a matter of fact, my invention makes it possible to avoid having to discover the exact place of the leakage through the foundation which oftentimes cannot be discovered. Of course, the general area of the leakage must be established so that my self-maintaining waterproofing effectiveness layer of water expansible material may be put in proper relation to the defective wall area.

The thickness or lateral dimension of the layer of water expansible material is considered critical, as already indicated, especially in view of the testing procedure I contemplate. Dry bentonite materials can be conveniently removed from the excavation only by employing a vacuum procedure, and if the layer of water expansible material adjacent a wall defect is too thin, it will become wet and this would effectively rule out my extraction procedure. A most important aspect of my invention is to keep the wall surface of the defective area of the foundation wall bone dry so that when it is necessary to prove that there is no leakage in the area of the installation, the bentonite material may be conveniently removed by the above described vacuum procedures.

The waterproofing installations provided by my invention are absolutely permanent and will last as long as the waterproofed structures stand, in spite of deteriorating, foundation movement, future cracking, winter frost, excessive pressure of water or the lack of it.

This is achieved by using dry water expansible material such as bentonite and forming in direct contact or engagement with the affected wall surface the continuous layer of bentonite material of the above referred to minimum thickness under fully compacted voidless conditions within and without same so that full expansion of the dampened or wetted bentonite is substantially precluded, and there is a sufficient "reserve in depth" within the layer of water expansible materials of sufficient dry water expansible material to self-compensate for any crack formation, separation, sifting of the dry materials into porous walls, holes, and/or sifting into fissures of the surrounding earth, and settlement or shifting of the entire earth bank surrounding the bentonite (which occurs during periods of drought), all without the water expansible materials separating from the wall surface to be waterproofed. My invention is especially formulated to have the reserve in depth needed during drought conditions which have proven the ineffectiveness of such methods as slurried bentonite, injection systems, or the use of containerized sections of cardboard holding bentonite, and other systems involving thin films or layers of bentonite. Droughts have proven this displacement factor to be vital in long term waterproofing involving the use of bentonites of whatever form. Any systems without sufficient reserve in depth will fail with the first rain after a long drought; systems involving bentonite have heretofore assumed wet or at least moist soil conditions during the life of the system to assure against displacement.

Experience has shown that at times when the installation procedure of FIGURES 1–7 is contemplated, there is not sufficient time to install the form **37** and both the layers of water expansible and water permeable material, because of danger of cave-ins and the like. In such instances, the entire excavation is immediately filled with the water expansible material. Under conditions of this sort, the ground is ordinarily oversaturated with water so that the testing procedure can merely involve waiting for the water to stop coming through the water-proofed wall area.

The foregoing description and the drawings are given merely to explain and illustrate my invention and the invention is not to be limited thereto, except insofar as the appended claims are so limited, since those skilled in the art who have my disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

I claim:

1. In the waterproofing of a basement wall having a structural defect therein below the outside ground level through which water may pass from the outside of the wall into the basement, the method that comprises removing the soil adjacent to and laterally for a short distance beyond the defect to provide an excavation exposing said defect and the area surrounding the same, filling the bottom portion of the excavation with a dry granular water expansible material, placing a removable division wall in position in said excavation in spaced relation to the outer surface of the wall, to define a first space between the division wall and said wall surface and a second space between the division wall and the opposite vertical face of the excavation, filling said first and second spaces respectively with such dry granular water expansible material and with a water permeable aggregate material, and then removing said division wall.

2. In the waterproofing of a basement wall having a structural defect therein below the outside ground level through which water may pass from the outside of the wall into the basement, the method that comprises removing the soil adjacent to and laterally for a short distance beyond the defect to provide an excavation having end surfaces generally normal to the wall and an opposite surface facing the wall so as to thereby expose said defect and the area surrounding the same, filling the bottom portion of the excavation with a dry granular water expansible material, placing a removable division wall in position in said excavation and engaging said end surfaces and in spaced relation to the outer surface of the wall to define a first space between the division wall and said wall surface and a second space between the division wall and said opposite surface of the excavation, filling said first and second spaces respectively with such dry granular water expansible material and with a water permeable aggregate material, removing said division wall, and supplying water to the water permeable material to test the effectiveness of the installation.

3. The method of post backfill waterproofing a foundation wall from the exterior thereof and below ground level without having to resurface the exterior surface of the wall, which method comprises:

removing from the ground abutting the wall only a sufficient amount of ground longitudinally of the wall to expose the wall surface portion to be waterproofed and define a narrow excavation paralleling said surface of a dimension laterally of the wall sufficient to perform the following filling in step:

filling in the excavation up to but short of the top soil with a layer of self waterproofing effectiveness maintaining dry granular water expansible material in bulk form that extends over said surface portion and is uninterrupted throughout its depth and has a thickness laterally of the wall in the range of from about four inches to about eight inches and is disposed against and in direct contact with the exposed surface while vibrating the material to eliminate all voids in and compact same and maintaining the portion of said material in contact with said surface portion in a dry condition, and filling in the excavation with a layer of water permeable material backing

up the water expansible material, while restricting the space within the excavation for the water expansible material to expand into when dampened to less than that permitting full expansion thereof,

and closing over the top of the excavation with top soil to enclose said layers within the ground and further restrict said space for the water expansible material to expand into,

whereby the water expansible material layer provides immediate waterproofing effectiveness for said wall surface portion and a reserve in depth of sufficient dry water expansible material to self maintain the water barrier provided thereby while accommodating sifting of the water expansible material into cracks and other voids formed during periods of drought between the water expansible material layer and the wall surface portion and in the surfaces of said water expansible material layer facing away from the wall surface that have become wetted and fissioned after drying during drought,

and whereby the water permeable material layer provides a substantially free downward path through which water may be introduced to immediately test the waterproofing effectiveness of the water expansible material layer vertically thereof.

4. In combination with a basement wall against which backfill has been applied up to ground level with the wall having a structural defect therein below the outside ground level through which water may pass from the outside of the wall into the basement,

a vertically extending self waterproofing effectiveness maintaining layer of a dry granular bentonite material in bulk form that expands in the presence of water and that is uninterrupted throughout its depth and has a thickness laterally of the wall in the range of from about four inches to about eight inches and is disposed below said ground level against and in direct contact with the outside of the wall opposite and extends laterally beyond the area of such defect on all sides thereof,

with the portion of said material contacting the wall portion having the defect being in a dry condition,

whereby the water expansible material layer provides a reserve in depth of sufficient dry water expansible material to self maintain the water barrier provided thereby while accommodating sifting of the material into cracks and other voids formed during periods of drought between the layer and the wall surface portion and in the surfaces of said layer facing away from the wall surface that have become wetted and fissioned after drying during drought,

and a second vertically extended layer formed of an incompressible water permeable material disposed below said ground level against the first mentioned layer and held in position by the surrounding soil and providing a substantially free downward path through which water may be immediately introduced to test the waterproofing effectiveness of said first layer with respect to such defect,

said layers being contained within a closed slot formed in the ground adjacent the wall to expose said defect and being proportioned within said slot to restrict the space for the water expansible material to expand into when dampened to less than that permitting full expansion thereof,

said slot having a dimension longitudinally of said wall no greater than that required to expose said defect for application thereto of said first layer,

and said slot having a dimension laterally of said wall no greater than that required to accommodate said layers.

5. In combination with a basement wall against which backfill has been applied up to ground level with the wall having a structural defect therein below the outside ground level through which water may pass from the outside of the wall into the basement, a vertically extending column-like layer of dry granular bentonite material in bulk form positioned adjacent and in contact with the wall, said layer extending longitudinally on both sides of said defect by at least four inches and having a fully dry thickness laterally of the wall in the range of at least from about four inches to about eight inches, said layer extending downwardly to at least the footing of the wall, said bentonite having the characteristic of expanding following wetting thereof and which, after wetting and subsequent drying, will shrink, the top of said layer being below the ground level adjacent the wall, said layer being confined at the top, sides and bottom thereof to an extent such that full expansion of bentonite material in said layer due to wetting thereof is prevented, said bentonite being compacted such that said layer is uninterrupted throughout its height and is in a dense state with voids in and around the layer being minimized, the thickness, width, compacted condition and confinement of the material being such as to provide a self-maintaining reserve in depth of relatively dry material against the wall surface portion having the defect with the reserve being sufficient to accommodate sifting of the material into voids around said material during periods of drought and to maintain, throughout the height of said layer, a waterproofing portion of said material over said defect irrespective of fissures formed in the material layer consequent to wetting of the material and subsequent drying out thereof.

6. The combination specified in claim **5** characterized by and including a vertically extending form positioned outside of but in contact with said layer of bentonite.

7. The method of post backfill waterproofing of a foundation wall from the exterior thereof and below ground level which comprises the steps of

forming an excavation adjacent the wall surface to expose the wall surface portion to be waterproofed and with the excavation extending longitudinally on both sides of the defect in the wall surface while extending laterally of the wall surface a distance at least in the range of about four to eight inches, extending downwardly to at least the footing, and extending longitudinally on both sides of the defect by at least four inches,

filling in the excavation with a column-like layer of dry granular bentonite in bulk form and uninterrupted throughout its depth and thickness to a level short of the top soil and extending laterally of the wall surface a distance in the range from at least about four inches to eight inches,

vibrating the bentonite in said excavation to a dense state to restrict the presence of any voids in and around the layer of material and to provide an uninterrupted column of bentonite,

confining the column-like layer on all sides, the top and bottom of the layer so as to enclose the layer in such manner as to prevent full expansion of bentonite material in the layer when wetted,

the thickness, width, vibrated condition and confinement of the bentonite in said layer being such as to provide a self-maintaining reserve in depth of relatively dry bentonite against the wall surface portion having the defect with the reserve being sufficient to accommodate sifting of the bentonite into voids around said material during periods of drought and to maintain, throughout the height of said layer, a waterproofing portion of said bentonite over said defect irrespective of fissures formed in the bentonite layer consequent to wetting of the material and subsequent drying out thereof.

8. The method of claim **7** characterized by and including testing the effectiveness of said layer by

vacuum extracting from the excavation the portion of

said bentonite forming said layer that abuts said surface and examining the material as it is being extracted for dampness characteristics,

and blowing back into the slot the dry portions of the material so extracted.

9. The method of claim 7 characterized by and including forming the excavation with a width laterally of the wall greater than the width of at least in the range of about four to eight inches while filling in the excavation with a layer of bentonite extending from the wall surface being repaired a distance of at least in the range of about four to eight inches, and filling in the remainder of said excavation with a water permeable material, and then saturating the water permeable material following the preceding steps to ascertain the waterproofing effectiveness of said water expansible material.

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