

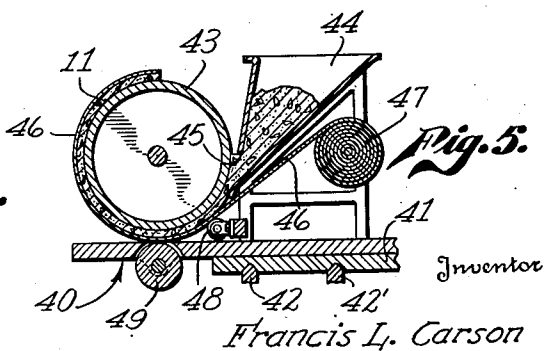
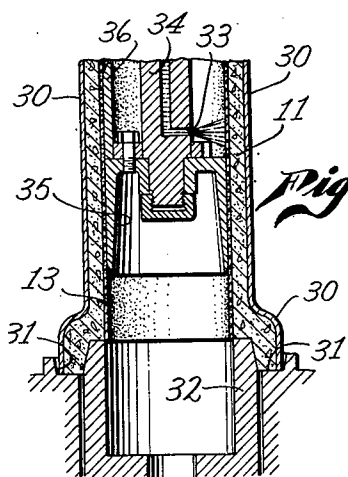
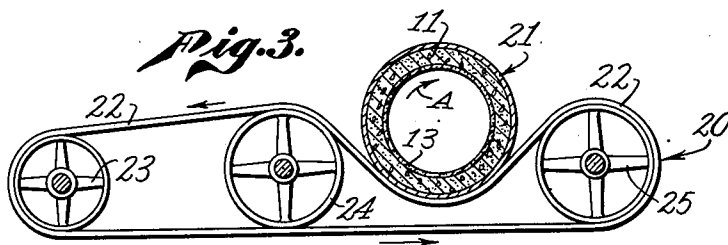
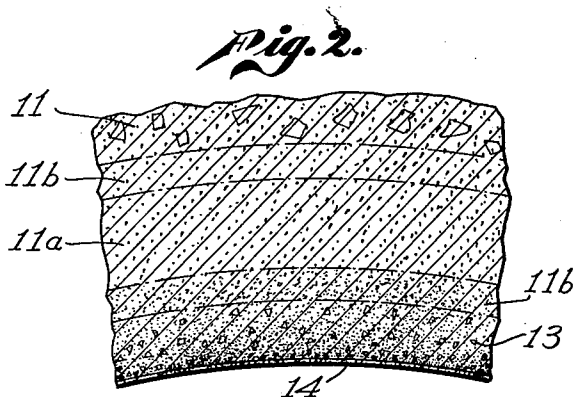
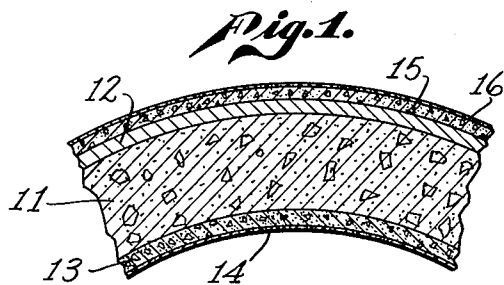
June 14, 1938.

F. L. CARSON

2,120,309

METHOD OF APPLYING NONCORROSIVE SURFACES TO PIPE AND THE LIKE

Filed Nov. 11, 1935



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UNITED STATES PATENT OFFICE

2,120,309

METHOD OF APPLYING NONCORROSIVE SURFACES TO PIPE AND THE LIKE

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Application November 11, 1935, Serial No. 49,228

1 Claim. (Cl. 91-68)

This invention has to do in a general way with improved materials for surfacing objects or articles which are normally subjected to corrosive action so as to render them non-corrodible and is more particularly related to improved methods and materials which are especially adapted for use in lining and coating Portland cement concrete pipe and the like.

As is well known to those familiar with the art, one of the most serious difficulties encountered in sewer systems arises from the corrosive action which is set up in the pipe as a result of the acid or alkaline nature of the sewage and especially in the case of concrete pipe as a result of the sulphurous acid gas which is released due to bacterial action in the sewage liquid and which enters the more or less porous cement concrete wall of the pipe, building up its concentration therein to such an extent as to have a highly destructive action on the concrete.

It therefore becomes a primary object of this invention to produce a lining or surfacing material which is especially adapted for use in lining sewer pipes and the like, such material being impervious to the infiltration of gases and liquids alike and being inert or resistant to solutions of either alkaline or acid character. It is a further object of this invention to provide a material of the class described which is insoluble in the ordinary oils and solvents, such as fats, fatty acids, animal and vegetable oils, bituminous, or paraffine base crude petroleum oils and their distillates.

As is also well known to those familiar with the art, Portland cement concrete pipe, especially that which has been formed by the conventional spinning or centrifugal method develops an apparently inert powder which accumulates on the inner surface of the pipe with the excess water and constitutes a serious problem from the standpoint of installing an adherent lining to the pipe. This slurry stratum is, when it becomes dry, powdery at its exposed surface, becoming solid with depth so that at substantially one half inch from the exposed surface it is composed of neat cement, forming a strong bond to the concrete wall which it covers. The powdery condition of the surface, however, has heretofore prevented the attachment of an enduring lining, since previous attempts to line pipe of this character have been made by using a hot plastic substance like bitumen, wax, tar, or the like which depends upon its sticky character while hot to hold it in place. These have uniformly failed because of their inability to obtain a secure anchorage on

the dust layer above described. This results in peeling. The existence of water in the concrete creates a pressure on the inside of the lining, loosening the lining from the dusty surface to which it has been imperfectly fastened, forming blisters.

It therefore becomes a further object of this invention to provide a surfacing material of the class described which possesses the property of admixing with and infiltrating into and through this slurry coat by capillary action so as to form what may be termed a fusion bond between the lining or surfacing material and the body of the concrete.

In contemplation of the foregoing objectives, I have discovered that synthetic resins, for example, vinyl resinoids, phenolithic resinoid liquids, crysol formaldehyde liquid and the urea formaldehyde condensation syrups possess the property of forming an impervious and a substantially inert skin which when the resin is used with a suitable solvent or carrying liquid and is applied to a porous surface such as is presented by concrete, forces the solvent and a portion of the resin to be assimilated into the pores of the concrete, thereby fusing or locking the inert lining body and skin to the surface to which it is applied. In the case of concrete pipe, this synthetic resin and its associated solvent has the peculiar property of admixing with the wet slurry powder, the water being forced to the inner surface outside of the skin formation and the majority of the slurry powder being retained with resin in the lining and its skin. My invention, therefore, broadly contemplates the use of synthetic resins as a lining or coating material for articles and objects of the class described, particularly for use as a lining for concrete pipe.

In order to provide a coating or lining having a certain amount of plasticity and also to provide a cheap surfacing composition which may be economically applied to a depth sufficient to guard against the possibility of the lining being worn through by abrasive action or by impact, it is a further object of this invention to provide a composition which includes, in addition to the synthetic resin, a suitable aggregate which, when combined with the synthetic resin liquid, will form a plastic composition. This composition may be readily applied as a lining or coating material and when the resin is cured or condensed it will form a chemically inert body of substantial thickness which becomes, in view of the zone of fusion mentioned above, as an inte-

gral part of the object or article to which it is applied.

Although the composition contemplated by this invention is especially adapted for use in lining concrete pipes and has corresponding advantages in connection with any porous material in that it forms a skin which forces the solvent and the resin into the pores of the material to form a fusion bond, the material contemplated by this invention also lends itself to efficient and useful application as a covering for metal pipes such as steel pipes. When used in this connection the synthetic resin insures a firm adhesive bond to the steel surface and affords a corrosion proof coating which is impervious to infiltration of air and water, is inert to light polymerization and is of a high dielectric number. I have further discovered that mixtures of synthetic resin binders and mineral aggregates can be produced, which under the mechanical methods of forming and compacting pipes, can be used solely in constructing pipe of great tensile and comprehensive strength. My invention, therefore, also contemplates a pipe or the like in which non-corrodible surfaces are obtained by forming the pipe itself of a mineral aggregate composition containing a synthetic resin as a binder.

The synthetic resins contemplated by this invention in a composition of the class described have a distinct advantage in that they may be readily obtained or placed in the liquid state and while in such state can be easily and quickly applied as a lining or coating material after which they can be readily cured either by permitting them to stand over a period of time or with the application of heat. In curing, the resins go through a process of condensation in which their properties of inertness and impermeability are developed.

Another important feature of my discovery resides in the modifying action which the synthetic resins have on asphalts, tars, pitches, bitumens and the like. Another important feature resides in the discovery of the miscibility of lining mixtures containing these resins and mineral aggregates with water as an extender of the solution.

The details in the compositions contemplated by this invention together with details in certain preferred methods of application will be best understood from the accompanying drawing which is chosen for illustrative purposes only and in which:

Fig. 1 is a fragmentary sectional elevation showing a portion of a pipe which has been lined and coated with the material contemplated by this invention;

Fig. 2 is an enlarged fragmentary section which will be used to illustrate the fusion or bonding action between a composition of the class contemplated by this invention and a concrete pipe;

Fig. 3 is a diagrammatic view illustrating one manner of applying lining of the class contemplated by this invention to the interior of a concrete pipe;

Fig. 4 is a sectional elevation of more or less diagrammatic nature illustrating another method of applying the lining to the interior of a concrete pipe; and

Fig. 5 is a sectional elevation of more or less diagrammatic character illustrating the manner in which a composition of the type contemplated by this invention may be applied as a coating for pipes.

Referring now to the drawing with particular

reference to Fig. 1, numeral 11 indicates the wall of a concrete pipe which is formed in a reinforcing shell or steel external pipe 12. The inner surface of the concrete pipe is shown as being provided with a lining of any suitable thickness indicated by numeral 13 and the steel pipe or reinforcing shell is shown as being provided with a cover coating indicated by numeral 14. It is to be understood that so far as the function and application of the lining 13 is concerned, the pipe 11 may be considered as having been formed of any suitable material and need not be provided with the reinforcing shell 12. Also as regards the cover coating 14, the function of this coating remains the same whether the shell or pipe 12 is provided with a lining or not and also regardless of the composition of the surface upon which the coating is applied.

The lining 13 is, at the time of its application, composed of a plastic composition consisting of a liquid synthetic resin and a suitable aggregate such as a mineral aggregate or a graphite or a mixture of mineral aggregate and graphite or other suitable materials.

So far as I am aware, any liquid synthetic resin may be used in the composition contemplated by this invention and by the term "liquid synthetic resin" I refer either to a synthetic resin in the primary syrup stage of condensation such, for example, as a phenol formaldehyde resin or a urea formaldehyde resin in this stage of its formation or to a solution of a synthetic resin in the secondary solid stage of condensation such as vinyl resin which I consider preferable for use in connection with this invention and which I will refer to in the exemplary compositions to be hereinafter described.

Referring back to Figs. 1 and 2 with the foregoing remarks in mind, the lining 13 is formed by coating the interior of the pipe in any suitable manner such as will be hereinafter described, with the plastic composition composed of a solution of vinyl resin in any suitable solvent such as acetone, benzol, toluol or the like mixed with a suitable aggregate. The solvents for the vinyl resin being readily volatile, quickly evaporate from the inner surface of the lining and leave a dense impervious skin which stops further evaporation and forces the solvents with a portion of the vinyl resin into the pores of the concrete. The skin above referred to being indicated by reference numeral 15.

The action of the lining material and its consequent results are perhaps best illustrated from Fig. 2 which illustrates an enlarged section through the inner surface of the pipe and in which the main body of the concrete is indicated by reference numeral 11, such main body having on its inner face a zone or region of neat cement indicated by 11a which increases in density toward the body 11 and may be considered as being fused therewith in a region or zone of blending between the neat cement and the concrete indicated by numeral 11b. During the formation of concrete pipe, especially in the spinning method, there is carried to the inner surface of the region or zone of neat cement 11a a certain depth of fine slurry powder which has no adhesive properties and which has heretofore constituted a serious barrier against the obtainment of a fast lining on the concrete. I have discovered, however, that synthetic resins of the type contemplated by this invention possess the peculiar property of admixing with this slurry powder so

that the powder in effect becomes a part of the aggregate.

Also as indicated above the skin 14 forces the solvents with a portion of the synthetic resin into the zone or region of neat cement, forming in the region 11b which would normally be faced with a layer of the powdery material referred to, a zone of fusion which extends back into the neat cement and may even be carried back into the main body of the concrete 11. In this way the lining material 14 with its synthetic resin and aggregates is, during the curing operation, firmly bonded or fused to the body of the pipe so that the entire mass becomes an integral unit as indicated by the cross-hatching in Fig. 2.

As regards the curing operation, it will be understood by those familiar with the art, that synthetic resins possess the peculiar property of changing in character during a substantial period of time after the solvent is removed or with the application of heat. The curing operation may, therefore be effected by permitting the pipe or other object to stand over a substantial period of time, or by heating the pipe with the application of hot air or in any other suitable manner to a temperature at which the resin condenses or congeals. In the case of vinyl resin which is used for the purpose of illustration herein, I have found that complete congealing can be effected by heating the pipe to a temperature of substantially 250°. After the resin has been congealed or cured it becomes inert to its ordinary solvents also to chemical action of bases and acids and to infiltration of gases or liquids.

The cover coating 15 which is illustrated as being applied to the steel or reinforcing pipe 12 is also formed of a plastic composition containing a synthetic resin of the class described, together with an aggregate material. This cover coating is preferably associated with a fibrous sheet 16 formed of canvas, paper or other suitable material which becomes impregnated with the vinyl resin or other synthetic resin and which, during the curing operation in which the resin is condensed in the pores of the fibrous sheet, forms a chemically inert and impervious covering which is backed up by sufficient depth of synthetic resin and aggregate to guard against abrasion and impact.

The proportion of synthetic resin and aggregate or other material used in forming these linings or coatings may be varied depending upon the particular conditions or circumstances under which they are to be applied. Also various types of aggregates may be employed as has been indicated hereinabove, and the size of the aggregate may be varied depending upon the thickness of the coating to be applied and the manner in which such coating is applied. Various proportions in the compositions which may be used in lining or coating materials of this character will be described in connection with the examples to be hereinafter given which illustrate the different methods of applying the linings and coatings to pipes.

Referring now to Fig. 3 which is an exemplary illustration of one method whereby the composition contemplated by this invention may be applied to pipes, reference numeral 20 indicates a diagrammatic illustration of a machine or mechanism which may be used for forming concrete pipe or lining steel pipe with concrete by the so-called spinning method. In this method a cylindrical pipe or form 21 is supported in any suitable manner such as by means of a belt 22 so that it

can be rapidly rotated about its longitudinal axis. The belt is shown as being run over pulleys 23, 24 and 25 which are driven in any suitable manner so as to impart rotation to the pipe or form in the general direction of the arrow A.

With a rapidly spinning pipe or form of this character the concrete is delivered into such form and is spread over the interior thereof by centrifugal action to form a wall of concrete of any desired thickness which, during its formation, as pointed out above, carries the water and slurry powder to the interior surface, such powder normally forming a surface coating which has impaired the application of lining materials heretofore used. In using the composition contemplated by this invention the lining material may be inserted in the interior of the pipe while it is still in the wet condition or it may be inserted in a pipe which has been previously dried and cured under which circumstances it is preferable to wet the interior of the pipe before adding the lining.

As an example of this type of procedure, let it be assumed that a lining of $\frac{1}{8}$ th inch thickness is to be applied to the interior of the pipe. The lining material for a situation of this character would preferably incorporate an aggregate having a maximum particle size of say $\frac{1}{16}$ th inch graded down to 200 mesh. The grading is done to obtain maximum density of the finished product and forms no part of this invention. The aggregate formed in this manner is then mixed in the proportion of 3 parts aggregate to 1 part of 10% solution of vinyl resin. Such solution containing 10% of the whole as a solid resin. This mixture of dissolved synthetic resin and aggregate is sufficiently liquid to be pourable.

In the case of a freshly formed pipe after the spinning pipe has been sufficiently compacted to qualify as a standard spun product, I pour a lining mixture such as is described above into the pipe and continue the spinning operation at sufficient speed to spread the mixture over the wall area of the pipe.

During the spreading of the lining mixture the water and some of the slurry dust from the interior of the pipe breaks through the lining material in small globules leaving a large proportion of the free dust mixed with the aggregate of the lining material where it is coated by the dissolved resinoid content thereof. In this connection I have discovered that even though synthetic resin solutions are neither miscible directly with water nor emulsified directly therewith, the wet particles of stone, sand and dust can be induced into and mixed thoroughly with the other aggregate particles which are coated with the dissolved resinoid in solution with the proper solvents.

As the lining material is compacted during the centrifugal action the surplus liquid content of the lining containing a proportion of fines and slurry dust works out to the exposed surface of the lining, forming the impervious skin. The evaporation of the solvents from the resin is extremely rapid so that the skin quickly forms and as it is drying it continues to hold some of the dissolved resinoid within the body of the lining. As the concrete takes its initial set the process of crystallization thereof leaves small voids therein which assimilate surplus liquefied resin from the lining. In other words, the solvents pass off through the concrete leaving the lining locked to the concrete with a strong adhering bond of resin which obliterates any definite line of cleavage between the lining and the

concrete forming what is in effect an integral homogeneous mass.

After the final curing of the concrete to a satisfactory condition for its purpose, it is only necessary to heat the lining to the temperature necessary to fuse all of the resin coated particles contained therein to a homogeneous mass which is integral with the smooth skin-like coating and the concrete surface upon which the lining is applied.

Various means may be employed for accomplishing this heating operation, for example, hot air radiating from a cylindrical heating chamber thrust into the lined pipe has been found to be very satisfactory. The time element is of no importance other than that the heating must be continued to heat the lined pipe to approximately 250° in the case of vinyl resin which requires that temperature to fuse and congeal or condense. It is to be understood, of course, that other vinyl resins possessing higher or lower melting points may require different fusion temperatures and other resins than the vinyl resins may require different temperatures depending upon their own peculiar characteristics necessary to effect their condensation or fusion.

It is to be understood that although the spinning means was described above in connection with the lining of a concrete pipe, such method is also applicable to the lining of metal tubes or pipes since the synthetic resin in the composition contemplated by this invention firmly adheres thereto and insures the same results as are outlined in the case of spun concrete.

In Fig. 4 which illustrates another manner of applying the lining composition contemplated by this invention, I have illustrated the method in conjunction with an apparatus similar to that disclosed in the J. L. Halstead Patent No. 1,838,546.

In the procedure here the pipe which may or may not be contained in a suitable form 30, is inserted in an annular channel 31 upon a projecting well 32. The lining material is applied under pressure through a side opening 33 from a hollow mandrel 34 which carries a pressure head 35 and trowel members 36.

The lining material in this example may be formed by first making a mixture of dry vinyl resin powder and a mineral aggregate, the vinyl resin being pulverized to pass a 100 mesh screen and the aggregate passing a 10 mesh screen. This mixture may be proportioned in the ratio of 1 part vinyl resin powdered to 20 parts by weight of aggregate. This mixture is then mixed with a 12% vinyl resin solution in the ratio of substantially 20 parts by weight of liquid to 100 parts by weight of dry mixture which is now stiffly plastic like putty. To this stiffly plastic mixture I then add 40 parts by weight of water, the whole now forming a softly plastic mixture which can be readily applied through the medium of the apparatus shown in Fig. 4.

The mixture is delivered through the conduit 34 under sufficient pressure that it is projected out against the inner surface of the concrete, the trowel members and the pressure head spreading and kneading the same to form a dense compact lining surface. In the application of the lining by this machine the water is squeezed out of the mixture, the resins dissolved and partly dissolved unite throughout the mixture leaving a surplus of resin at the surface against which the revolving tool or head applies and which forms into a glass like skin on finally drying.

This skin like that formed in the process outlined above, forces a certain amount of the resin solution into the body of the concrete and thereby forms a homogeneous integral fusion bond as outlined above.

The curing of this lining may be performed by air drying as the concrete cures, in the case of a freshly formed concrete pipe, or by the application of heat as was previously described.

It will be observed from the two examples given above, that the lining was applied to the pipe section before they had been laid. My invention also contemplates the further use of the lining of interiors of large sewer mains and the like after they are in place. In this latter connection I prefer to mix a solution of vinyl resin and solvents containing approximately 12% vinyl resin. This solution is then applied to the inner surface of the concrete pipe as a thin coating, for example, such as may be obtained through the use of an ordinary paint spray outfit at the rate of one gallon of solution to approximately 250 square feet of surface area.

After this has been done another mixture of vinyl resin pulverized to pass a 100 mesh screen with mineral aggregate ground to pass a 12 mesh screen, are mixed in the ratio of say 1 part by weight of the powdered resin to 20 parts by weight of mineral aggregate. Using the conventional cement gun equipment with this mixture and a 12% vinyl resin solution as the carrier therefor, I then apply a coating of vinyl resin and aggregate to the interior surface of the pipe.

The proportion of liquid to dry aggregate of the type described above is in the neighborhood of 40 to 100. The action of the solution upon the fine particles of dry vinyl resin in the aggregate is instantaneous, causing these fine particles to gelatinize and act as an adhesive for all the particles of mineral aggregate.

The evaporation of the solvent from thin layers applied in this manner is so rapid that the spraying process is practically continuous over a 100 square foot area. By repeated applications with this process a coating of a thickness of from 1/16th or 1/8th inch or greater may be readily built up. The skin formed on the surface of the finally applied coating has the characteristics pointed out above. The lining may be cured by air drying over a period of substantially ten days and as a consequence becomes a hard integral part of the wall of the concrete.

Referring now to Fig. 5 for a further example of the use of the composition contemplated by this invention, I have illustrated therein a machine indicated by reference numeral 40 for covering pipe, such machine being of the general character described in U. S. Patent No. 1,979,656 issued to Nathan B. Whitman.

This machine, which is diagrammatically illustrated in Fig. 5 consists of a platform 41 supported on longitudinal guide rails 42 and 42' and adapted to be moved longitudinally in parallel relation to a rotating pipe 43 in any suitable manner not shown.

The platform 41 carries a hopper member 44 adapted to contain the coating material, the mouth 45 of the hopper being positioned adjacent the pipe 43 and above a strip or belt of fibrous material such as paper or canvas 46 which is supported in a roll 47 and is adapted to be wound upon the pipe during its rotation and during the longitudinal movement of the platform upon which the hopper and roll are carried. Pressure rolls 48 and 49 are provided for the

purpose of squeezing the coating material and the covering sheet against the surface of the pipe. This machine and its method of operation form no part of this invention and further details in its construction and operation will, therefore, not be described.

The material used in the hopper 44 in connection with this particular method may be of the general character described in conjunction with Fig. 3 or Fig. 4. In covering a pipe by this method, under the pressure applied by the machine, the surplus liquefied resinoid is squeezed into the pores of the paper or cloth fibrous sheet so that it infiltrates toward or to the outside of the sheath and after the escape of the solvents condenses therein to form a strong reinforced shell which, upon curing, becomes hard, impervious to air and normal liquids to which it may be subjected and has the additional advantage of being highly dielectric in character.

This type of covering is preferably cured by applying heat to the inside of the pipe until the outer surface reaches the desired curing temperature. In this way the heat drives the solvents from the body of aggregate through the impregnated cloth or paper condensing the resin content of the lining to its final condition of insolubility or permanent set. The transmission of the temperature through the lining is progressive so that the final fusion and condensation takes place in the impregnated fibrous sheath after the solvents have been evaporated from the underlying aggregate.

As a further example of my invention, I may prepare a composition by using an aggregate of the general character above referred to and mixing therewith a solution composed of 16% air refined asphalt, having a melting point around 300° F., 1% crepe rubber of commerce, .03% of sulphur, .15% vinyl resin and 82.82% of a solvent containing toluol, acetone and benzol. The foregoing "solution" is mixed with the aggregates in proportions of substantially 40 parts by weight of solution to 100 parts by weight of aggregate, and the composition may be applied in any of the various manners outlined above. In this composition the rubber adds a certain amount of resiliency to the lining, the vinyl resin gives it a degree of internal plasticity and induces the fusion bond above referred to and prohibits the possibility of the asphalt chipping. Although this example has been confined to the use of asphalt, it is to be understood that similar results are obtainable and feasible by using various compositions such as tars, pitches, bitumens and the like, since they are all subject to modification by the introduction of dissolved synthetic resins.

It is to be understood that while I have confined myself in the examples above to the use of vinyl resins, all of the synthetic resins are, so far as I am aware, adaptable to this use with the same advantages. For example resins of the phenolithic group, urea formaldehyde syrups, the furfurol phenol type, the cresylic acid condensation resinoids, the glycerol resins and the like, all being condensable or congealing under the application of heat or by time alone; and all being capable in solution with solvents of penetrating porous surfaces such as concrete, brick or wood and adhering to concrete, steel, brick, wood and the like and being capable of binding mineral aggregates into homogeneous wholes, may be employed with advantage in compositions of the type contemplated by this invention.

It is also to be understood that while I have

confined my illustrations to use of this composition in connection with concrete pipe, that these materials and methods are equally applicable to lining and surfacing pipes of other materials or other objects such as dam, reservoir surfaces, foundation surfaces and the like.

Furthermore it is to be understood that while in certain of the examples given above I refer to the use of a dry soluble resin powder as an admixture to the dry aggregate, I may substitute therefor a partially dissolved resin for the same purpose. In adding partially dissolved resins in their gelatinous condition I prefer to place them with the dry mineral aggregate and mix the same in a ball mill or colloid mixer to insure a proper coating of the aggregates by the fused gelled resins. The addition to such a mixture of a resin solution insures sufficient plasticity and infiltrating characteristics together with the desired skin forming tendency to afford the results which I obtain.

Also in the various examples given above, I refer to the use of mineral aggregates but it is to be understood that the selection of fillers or coloring admixtures for use in this connection is wide and varied. For example, diatomaceous earth, carbonaceous materials, graphite and mineral or vegetable fibers may be used as the whole or a part of the aggregates for the surfacing composition contemplated by this invention.

I have found in practice that ground graphite screened to pass a 16 mesh screen, forms with the liquefied resinoids above referred to, an ideal surfacing material and also that flaked graphite all passing 100 mesh screen used in a ratio of say 10% by weight to 90% by weight of silica sand passing a 10 mesh screen, forms an ideal filler for such voids as might appear in a surfacing material formed without 200 mesh particles of ground silica or the like. I have also found that this graphite material improves the appearance of the skin which forms on the exposed surface and that in all cases the liquid resins referred to herein mix perfectly with and coat and bind the particles of graphite under the conditions and methods outlined above.

As has been previously pointed out, it is one object of this invention to form a pipe of great tensile and compressive strength, possessing the non-corrosive properties hereinabove referred to, in which the entire wall of such pipe is composed of an aggregate and a binder of synthetic resin. The various mechanical processes known in the art, such as the spinning method illustrated in Fig. 3, the packer head type of method shown in Fig. 4 or the vibrating machine method, may be employed in the manufacture of this pipe. Like the examples given above in connection with the lining materials, the resins and aggregates used and their relative proportion may be varied over wide limits, but for the purpose of more completely illustrating the invention, the following specific examples are given.

In case the pipe is to be made with the packer head type of machine, one form of which is illustrated in Fig. 4, I prefer to use a dry sand and silica aggregate, 75% of which is taken from sharp, clean sand passing a #4 mesh screen with 95% retained on 50 mesh. The other 25% of the aggregate is comprised of selected 200 mesh ground silica or the like. As a binder for this aggregate I prefer to use the jelly-like primary condensation product of cresylic acid and formaldehyde. It will be understood of course that

any of the resins enumerated above may be used in this connection.

To one hundred pounds of this dry aggregate, I add two pounds of jelly-like binder and mix the same thoroughly in a ball mill or other colloid mixer. The composition is now dry to the touch and is in the proper condition to be compacted against the inner surface of the form in a packer head type of pipe forming machine. In a machine of this character a great expanding pressure is exerted against the wall of material during the rotation of the plunger or packer head. The close nesting of all the aggregate particles coated with colloidal resin assures a thoroughly bonded wall and the revolving movement of the plunger produces a smooth finish on the inside of the pipe which is glazed with resin mixed with some of the fine silica dust. If desired a paint coat of liquefied resin may be applied to the surface of the pipe.

Subsequent baking causes the binder to take on those properties of insolubility, infusibility and permanent set associated with synthetic resins.

In preparing a pipe of this character by the spinning or centrifugal method, I may employ a mineral aggregate passing a $\frac{3}{4}$ inch mesh screen (for relatively large pipe) such aggregate containing 20% of fine, passing 200 mesh. This aggregate may be mixed with 20% by weight of a jelly-like solution consisting of 2 parts of vinyl resin gelatinized in 10 parts of a suitable solvent such as acetone. The addition of 2 pounds of resin to 10 pounds of liquid brings about the swelling of the resin and a jelled solution of the resin in the solvent.

This mixture of vinyl gel and mineral aggregate is mixed in a ball mill or other type of mechanical colloid mixer from which it is discharged in a condition slightly moist to the touch, which is a proper condition for spinning in forms to the desired thickness, finish and

density as described above in conjunction with the corresponding lining operation.

The resultant pipe composed of mineral aggregates bound with vinyl resins, on being cured, possesses all the strength factors of a Portland cement concrete pipe and in addition, all the impervious characteristics and interior finish outlined above in connection with the lined or coated pipes. This pipe may be cured by time or by the application of heat.

Other mechanical processes for the manufacture of my pipe are the conventional tamping and vibrating processes. In these cases I prefer to use the normal mineral aggregate now used in Portland cement concrete pipe to which approximately 20% by weight of 200 mesh ground silica or the like is added. A liquid synthetic resin, or resin solution is used as the binder and may be mixed with the aggregate in the general manner described above.

It is to be understood that while I have herein described and illustrated certain preferred methods and compositions contemplated by this invention, that the invention is not limited to the precise examples given hereinabove, but includes within its scope whatever changes fairly come within the spirit of the appended claim.

I claim as my invention:

The method of forming a corrosion-proof lining in a concrete pipe, the inner surface of which consists of the inert powder resulting from the setting of the concrete, which consists in applying to said inner surface a mixture of vinyl resinoids, a highly volatile solvent and an aggregate, and causing the solvent to rapidly evaporate at the exposed surface to form an impervious skin on its exposed surface which prevents further evaporation at said surface, whereby the solvent and resin retained below the surface is caused to infiltrate through the powder and into the pores of the pipe and a fusion between the lining and the body of the concrete takes place.

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