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PROTECTIVE COATING OF METAL PIPE
AND THE LIKE

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Our invention relates to protective coating of metal, and especially coatings on hollow metal containers or conduits, hereinafter generally referred to as "pipe." The invention is particularly useful in the coating of cast iron pipe intended to convey water and fluids of strongly corrosive character, such as acid (or alkaline) liquors or solutions, including dilute acids and salts used for many industrial or technical purposes, as well as sewage.

Heretofore, cast iron pipe has ordinarily been protected by internal and external carbonaceous coatings, as of tar, asphalt, or other normally solid bitumen, often with fillers of finely divided inert material. Formerly, it was considered necessary to apply a double coating of the bitumen, by immersing the pipe twice in a bath of fluid (molten) coating material or "pipe dip" as it is commonly called; but more recently, it has been found possible to produce an equally satisfactory coating at a single immersion, by having the pipe heated to substantially the temperature of the coating bath when immersed therein, as described in Patents Nos. 2,114,974 and 2,114,975, granted April 19, 1938, to L. A. Camerota.

Regardless of whether produced by single or double immersion, the carbonaceous coatings heretofore used have been subject to imperfections that impaired their protective efficacy as against strongly corrosive fluids in the pipe: i. e., there have been minute pinholes in the coatings through which the fluid came in contact with the metal, producing corrosion known in the art as tuberculation, which increased progressively as it gradually dislodged the coating material around the original pinholes. To detect such pinholes in the (internal) coatings of nearly all new pipe, it is only necessary to ground the pipe to one side of an electric circuit including a source of voltage and current, as well as a millivoltmeter, and to connect a porous pad saturated with liquid electrolyte to the other side of the circuit and move this pad along the internal surface of the pipe. Whenever the area of coated surface in contact with the wet pad contained one or more pinholes, the millivoltmeter would give a reading indicative of the defect.

If the normally solid coating is made thicker than usual in order to insure against pinholes, then it sags or runs more or less when softened by hot weather, or by hot fluid in the pipe, becoming obviously uneven, and leaving thinly coated areas, or even bare uncoated places.

Such minute defects in apparently sound coat-

ings have proved most important in the inside coatings of pipes.

These drawbacks of ordinary carbonaceous coated pipe have led to the introduction and use of cement-lined iron pipe; but such lined pipe is unduly expensive. Pipe lined with vitreous enamel may be used; but such a lining makes the pipe very expensive.

An important aim of our invention is to produce improved coatings that will be firmly adherent and fully protective, inert to corrosive substances or conditions, unaffected by heat or cold, free of initial defects like pinholes, will not run or sag materially, and will be resistant or immune to apparent (or real) deterioration by weathering, and relatively inexpensive. We have found that such improved coatings can be produced by coking on the pipe a layer or coating of carbonaceous material (with or without a filler) by coking heat suitably developed or applied. The coked-on carbonaceous residue has a higher adherent affinity for the metal than the carbonaceous material would have if left uncoked, is infusible and insoluble, even under extreme conditions of use and storage, and forms a coating that is continuous and of absorbent or retentive character. The protection and the good appearance of the pipe are finally developed by an uncoked carbonaceous covering layer or coating over the coked-on layer, of asphaltic or tarry character. This outer covering layer or coating acts as a saturant for the basic coked-on layer, which is left somewhat porous by volatilization of constituents of the carbonaceous material from which it is formed. Because of the holding properties of the coked-on undercoat, the outer coating may be of considerable thickness without tending to sag or run, even at elevated temperatures. The improved coating can be produced at very moderate cost with a uniformity such as to pass the electrical test above described.

The coked-on layer is improved by the use of finely divided filler material in the carbonaceous coating material whence it is formed. The filler, when used, gives the coked layer body, fills minute voids or interstices in the surface of the pipe, and presents a finely roughened surface that anchors the outer uncoked layer. The carbonaceous material serves as a binder for the filler particles, and when coked cements them firmly to the metal.

Other features and advantages of the invention will appear from the following description of species or forms of embodiment. All the features disclosed are, indeed, of our invention, so

far as novel over the prior art. In practice, the invention may be carried out in the following manner:

The cast iron or other metal surface is first cleaned, if necessary, to remove all loose scale or rust. If the surface is greasy, the grease should be removed (or destroyed) in any convenient way, as by heating. If the pipe is heated as a preliminary of the coating and coking operation, a separate heating to get rid of grease is of course unnecessary.

After such of the foregoing procedure as may be necessary, the pipe is preferably rotated about its longitudinal axis while the internal carbonaceous coating (as of tar or asphalt), with or without filler, is applied to its interior. This may be done while the pipe is rotating on the first set of driven pipe-supporting heating-station rollers in the apparatus disclosed in the aforesaid Patents Nos. 2,114,974 and 2,114,975; and the coating material may be sprayed on the inside surface of the pipe through a nozzle constructed to deliver the liquid material from all sides, as a spray covering the full 360° around the nozzle. The nozzle (which may be formed or mounted on the free end of a long supply-pipe) is inserted into and passed through the revolving pipe to be coated, spraying its interior surface evenly from end to end. The revolution of the pipe and the centrifugal force assist in distributing the liquid coating material quite uniformly, as a thin, even coating layer.

While the pipe is still being rotated, the coated surface is heated (as by the gas jets associated with the several sets of rollers at the heating station of said apparatus in the aforesaid patents) to a temperature sufficient to expel the volatiles of the coating material and coke it: e. g., a temperature of some 550° to 650° F. or higher, and preferably within the range of about 600° to 650° F. This heating of the coated pipe may be effected quite rapidly, in about six minutes' time or even less. In the coking, some of the constituents of the coating material go off by direct volatilization, including water and lighter hydrocarbons, while others are decomposed by the heat to yield gaseous or volatile substances that go off in the same way. The temperature should preferably be so high that the coating on the pipe "smokes dry"—which means that all the volatile matter is driven off—but it should not be high enough to cause actual burning of the carbonaceous residue. A sufficient degree of coking is indicated by firmness of the coating while still hot, and also by its insolubility in usual solvents for the original carbonaceous coating material, such as toluol. In other words, coking is sufficient when the coating has become infusible and insoluble.

The coating thus produced consists essentially of carbon, together with any filler used. The coked matter acts as a bond, adhering firmly to the metal surface and holding the filler particles firmly. Fine, light fillers produce a coating that feels smooth and non-dragging to the fingers, while coarser fillers produce a coating which is somewhat rough or dragging to the touch, although visibly smooth. In either case, however, the coating is very finely porous or interstitially superficially, due to the escape of volatiles in coking, and is thus admirably suited to hold an outer layer or coating, and to be strengthened mechanically and improved protectively thereby. The coked layer can be built up to considerably greater thickness by repetition of the procedure

used in its formation, as many times as desired.

After completion of the coked-on coating or layer, the coated pipe is allowed to cool to a suitable temperature for the application of the outer or covering coating or layer: i. e., a temperature below the flash-point of the coating material for the outer coating. For this outer coat any of the usual pipe dips may be used, such as crude or refined tars melting at about 70°–140° F. and flashing above 300° F. This may be used at a temperature of about 300° F., and may be applied to the pipe as soon as the latter has cooled to about 300° F. The outer coating is preferably applied to the outside of the pipe as well as to its inside, as by immersing the hot pipe in the fluid-coating material. The partial cooling and the dipping of the pipe may also be effected in an apparatus such as shown in the aforesaid Camerota Patents Nos. 2,114,974, and 2,114,975, after the pipe leaves the heating station(s) where its first coating or layer has been applied and coked on.

As an alternative to the above-described procedure of first coating the pipe, and then heating to coking temperature, the pipe may first be heated to a coking temperature of around 550°–650° F., and then immersed briefly in the liquid coating material, thus gathering a coat of the latter which is at once coked on the pipe by the heat of the latter. When the thus coated pipe has cooled down to a suitable temperature (as 300° F.) it may be immersed in the hot liquid pipe-dip material (at 800° F.) for the outer layer or coating.

Or, as another variant, the formation of the basic coked-on coating and the application of the outer covering coating may be combined. For this purpose, the pipe may be heated to some 550° F. or more and immersed a short time in hot liquid pipe-dip material suitable for the outer layer (at 300° F.). In this way, the material directly in contact with the hot pipe will be coked on it; and a thin layer of the material around this will adhere to the coked-on layer next the metal, forming an outer layer substantially like that produced in any of the ways already described.

The carbonaceous material for the coating that is coked on may be any that is (or can be rendered) sufficiently fluid to be satisfactorily applied, and that yields a satisfactorily large percentage of coked residue, forming an adherent, infusible, insoluble layer. Preferably the coating material should be fluid at or below 300° F. The heavier hydrocarbons and bitumens are most readily available, particularly those of petroleum origin, the natural and artificial asphalts, and the coal tar pitches and the like. Materials of this sort that are too thick for convenient application may be thinned with a lighter hydrocarbon or oil. Other carbonaceous materials of non-bituminous character offer considerable advantages commercially—either alone or mixed with tars or asphalts or the like—such as carbohydrates including mono-, di-, tri-, and polysaccharides, and inexpensive materials of more or less waste character, like lignin and other substances from farm and forest products. A bitumen that has given good results for the coked-on layer is ordinary commercial water-gas-tar. Any commercial water-gas-tar can be used, without any particular regard for its melting point.

The use of a filler in the coked-on coating is advantageous to give this coating body and thick-

ness. Almost any substantially inert, finely divided filler may be used, that which we at present prefer being slate flour of a fineness of about 150 to 200 mesh, though other inorganic or mineral materials are equally suitable, when obtainable in a finely divided form at low cost. While the proportion of filler may be widely varied, an amount equal to 25% of the total by weight represents good practice. To some extent, the type and quantity of filler will depend on the conditions of use of the coated article. Carbonates of the alkaline earth metals are specially advantageous: e. g., finer grades of precipitated calcium carbonate, of a density of about 30 lbs. per cu. ft., and of a grain size of some 200 mesh. For coal tars and the like, carbonate or other alkaline fillers have the advantage of neutralizing any acid in the tar, which might tend to corrode the metal surface. Some bitumens, such as Trinidad Lake asphalt, naturally contain silicious or other inorganic fillers, which fully answer the purpose of filler in our coked layer or coating.

For an outer coating, any material such as heretofore used on pipe is generally suitable, since the requirements are that it be inert and protective under the conditions of service, that it can be applied in a thin, continuous coat, and that it penetrate and adhere firmly to the coked-on underlayer. Bitumens, asphalts, coal tar pitches, and like materials such as heretofore found useful for coating iron or steel pipe give better results when applied over our coked-on underlayer. Being used in layers of no more than moderate thickness, and impregnating or keying into the coked-on layer, they do not sag or run as when used directly on the metal.

The following further examples illustrate specific ways of applying a carbonaceous layer and coking it on:

Example I

The pipe is heated to 600° F., then dipped for about one second into a mixture of equal parts (by volume) of Trinidad Lake asphalt and refined asphalt having a ball and ring softening point of about 142° F., such as that known in the trade as "hard Stanolite", this mixture being rendered fluid for the dipping by heating it to about 325° F. By the time the pipe has cooled, the coating has smoked dry and is effectively coked. If the dipping time is much longer, say 5 seconds, the coating builds up too thick and will not smoke dry and coke thoroughly.

Example II

The pipe is heated to 600° F., and then dipped for about 15 seconds into a mixture of 72% refined Trinidad Lake asphalt and 28% oil (proportions by volume) which has been heated to 325° F. The oil used may be a petroleum oil of specific gravity about 1.00, such as that known commercially as "Bunker-C oil." The coating smokes fairly dry and is effectively coked, although not quite so well as in Example I.

Example III

A coating mixture of 2 to 4 parts Bethlehem tar and 1 part dead oil (proportions by volume), heated somewhat if necessary to give sufficient fluidity, is brushed or otherwise applied to the cold pipe. The dead oil here referred to is a neutral oil from the fractional distillation of coal tar products, well known commercially under that name. The coated pipe is then heated to above 300° F., preferably about 350° F., for a sufficient time to coke the coating.

Example IV

Proceed as in Example III, but using a coating made up of 4 parts Bethlehem tar, 1 part dead oil, and 4 parts slate flour, by volume.

Example V

Proceed as in Example IV, but using precipitated calcium carbonate in place of slate flour. Although any finely divided calcium carbonate gives good results, the smoothest coatings are those obtained with the lightest grade of precipitated calcium carbonate, which has a bulk density of about 30 pounds per cubic foot.

In the foregoing examples, it will be noted that filler is present in each instance except Example III, inasmuch as Trinidad Lake asphalt inherently contains filler as already stated.

Having thus described our invention, we claim:

1. A process of protectively coating metal which comprises applying thereto a carbonaceous underlayer or coat, coking the same into an adherent residual coating on the metal, and also applying and leaving uncoked an overlayer or coating of normally solid tarry bituminous material, anchored to the metal by said first-mentioned coating.

2. A process according to claim 1 wherein the metal is first coated with the adhesive carbonaceous underlayer and then heated to coking temperature, whereby said underlayer is heated and coked, and the metal with its thus coked-on underlayer is allowed to cool below bitumen-coking temperature before application of the tarry bituminous overlayer.

3. A process according to claim 1 wherein the metal to be protectively coated is heated to bitumen-coking temperature and at such temperature immersed in liquified but normally solid tarry bitumen suitable for the uncoked bituminous overlayer, whereby application of the uncoked overlayer is combined with formation of the coked-on underlayer which anchors said overlayer to the metal.

4. A process of protectively coating metal which comprises applying thereto an underlayer or binder-coat of adhesive fluid carbonaceous binder material charged with finely divided filler particles, coking the same into an adherent interstitial underlayer of residual coke and filler particles held thereby, and also applying and leaving uncoked an overlying layer or coating of normally solid protective tarry bituminous pipe-dip, impregnating said interstitial underlayer and anchored to the metal thereby.

5. A method of preparing metal to receive a protective coating of normally solid bituminous pipe-dip; which method comprises applying to the metal an adhesive tarry bituminous layer or coat, and also heating the metal and the tarry bitumen applied thereto to bitumen-coking temperature, thus coking the tarry bituminous layer into an adherent residual coating on the metal.

6. A process according to claim 5 wherein the metal is heated to bitumen-coking temperature before being bituminously coated, so that the bituminous coating is coked on by the heat of the metal as soon as it is applied thereto.

7. A method of preparing metal for the application of a protective coating which comprises applying thereto a layer or coat of water-gas tar, and also heating the metal and the tar applied thereto to a temperature of substantially 500° F. to 650° F., thus coking the tar into an adherent residual coating on the metal.

8. A method according to claim 7 wherein the tar contains a finely divided alkaline filler.

9. Metal having a protective coating comprising an adherent coked-on carbonaceous underlayer and an uncoked normally solid tarry bituminous outer layer anchored to the metal by said adherent underlayer.

10. Metal having a protective coating comprising an adherent coked-on interstitial underlayer of fine filler particles held in the coked residue of an adherent fluid carbonaceous binder-coat, and an uncoked overlayer or coating of normally solid protective tarry bituminous pipe-dip impregnating said interstitial underlayer, and anchored to the metal thereby.

11. The invention as set forth in claim 10 wherein the filler comprises finely divided mineral particles.

12. The invention as set forth in claim 10

wherein the filler comprises finely divided particles of alkaline reaction.

13. The invention as set forth in claim 10 wherein the filler comprises fine particles of slate flour.

14. Metal pipe protectively coated, both externally and internally, with uncoked normally solid bituminous pipe dip, the internal coating including an adherent carbonaceous underlayer coked on the metal and anchoring the pipe dip coating thereto.

15. The invention as set forth in claim 14 wherein the underlayer comprises fine particles of slate flour filler held by an adherent residue of coked-on water-gas tar.

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