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2,628,173

METHODS OF COATING METAL ARTICLES WITH BITUMINOUS MATERIALS

Filed Oct. 30, 1947

2 SHEETS--SHEET 1

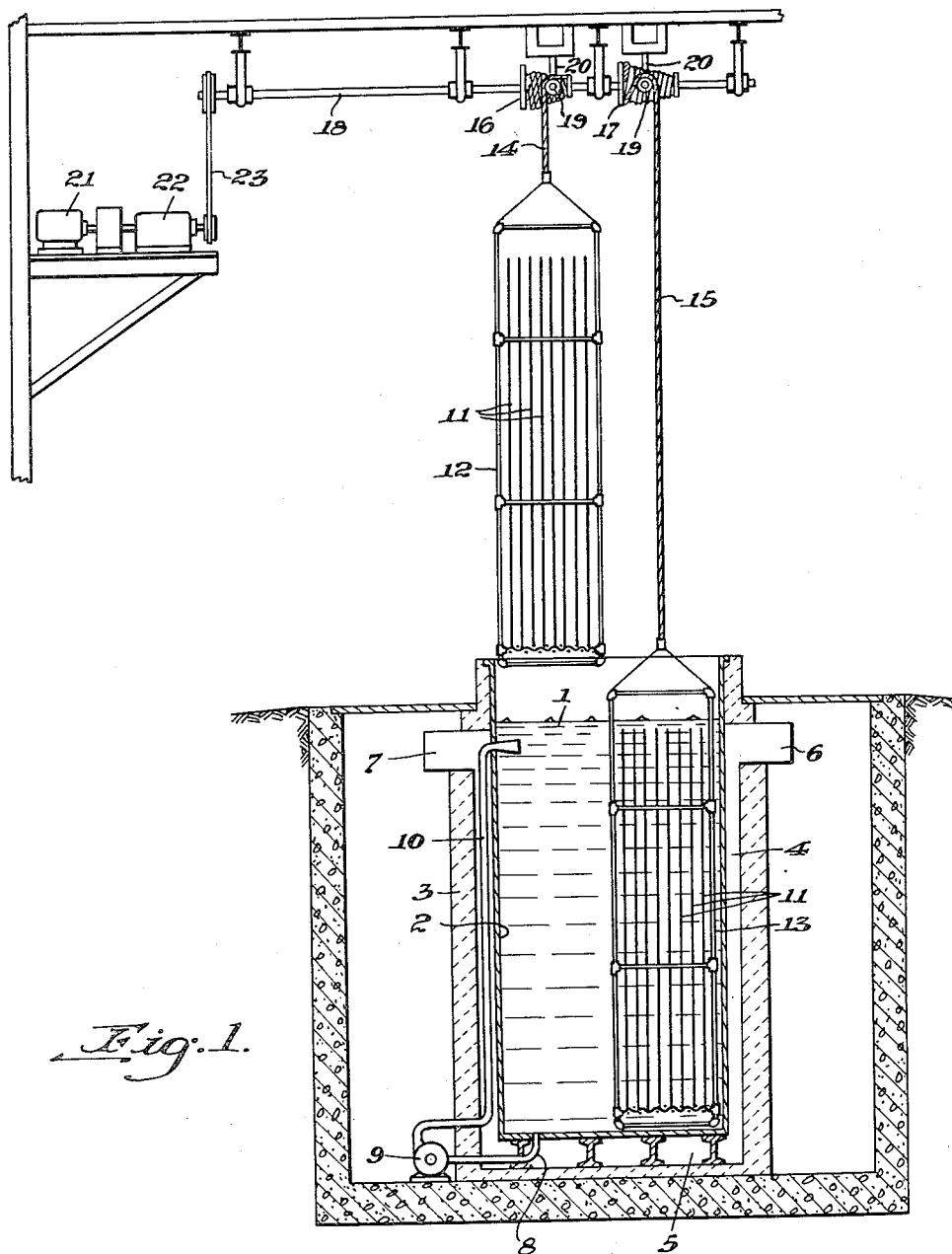


Fig. 1.

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2 SHEETS—SHEET 2

Fig. 2.

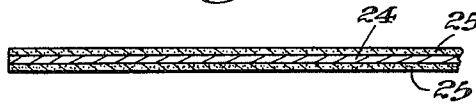


Fig. 3.



Fig. 4.



Fig. 5.

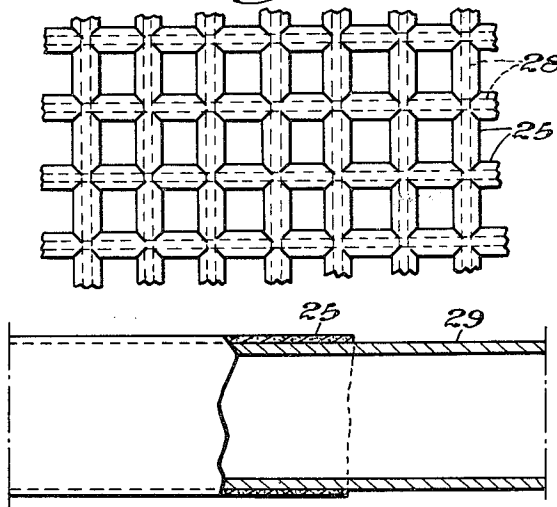


Fig. 6.

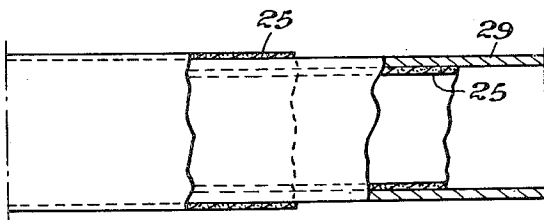


Fig. 7.

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UNITED STATES PATENT OFFICE

2,628,173

METHOD OF COATING METAL ARTICLES
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Application October 30, 1947, Serial No. 783,128

6 Claims. (Cl. 117-113)

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This invention relates to improvements in methods of preparing bitumen-coated metal articles or structures and to improved coated metal products in which a bituminous coating is maintainable in its originally applied position on surfaces of the metal throughout the range of atmospheric temperatures.

In prior methods of coating metal articles with bituminous materials, it has been difficult rapidly and economically to form on metal surfaces a coating of such materials or uniform thickness throughout. Generally when spraying or brushing a bituminous liquid material on a metal surface, there is considerable overlapping and an uneven surface develops. When applying a bituminous coating to a metal sheet or other metal article by a dipping process, the coating on one portion of the metal surface is generally apt to be thicker than on another portion. In most coating processes with bituminous materials, more than one application is necessary, or a subsequent separate heat treatment is required to obtain the desired uniformity.

Not only it is desirable to prevent an economic waste of the coating material resulting from the application of an excess over that required for a minimum coating thickness, but an excess thickness of coating on portions of surfaces is attended by objectionable results in the use of the articles. For example, variations in the thickness of coating on a surface may result in objectionable variations in the appearance of coated articles. Also, difficulties arise from such variations in thickness when coated metal sheets for instance are to be connected to each other by overlapping, or to a supporting structural element, and when these variations occur at the contacting portions of a sheet.

Metal articles, particularly metal sheets and other structural metallic elements, coated with bituminous materials have previously not been entirely satisfactory for other reasons. The coating on such elements when exposed to the weather would either crack too easily at freezing atmospheric temperatures or would flow too readily on the metal surface at high atmospheric temperatures, or they would do both. Various attempts were made to overcome one or the other of these defects, such as by adding fillers or by the use of primers. Little was accomplished without such agents by way of providing a coating that would neither crack readily on metal at freezing temperatures nor flow on the metal at high atmospheric temperatures. Furthermore, insufficient attention appears to have been given to the fact

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that in hot summer weather a black body becomes considerably hotter than the atmosphere, and that a material considered to be friable is generally more readily cracked on a hard metal surface than on a surface which gives under the application of a mechanical shock.

An object of the present invention is to provide an improved method of coating metal articles with a bituminous coating composition, and by such method obtaining a coating of substantially uniform thickness throughout the entire coated surface and effecting the coating operation rapidly and economically. Another object is to provide an improved coated metal article in which a bituminous coating in direct contact with the metal will not flow even on vertical surfaces of the metal at high atmospheric temperatures, and also will not crack or chip off in handling or in ordinary service of the article especially at low atmospheric temperatures.

In the practice of the present invention in its applicability to the manufacture of coated metal objects such as prefabricated metal and structural shapes, including flat and corrugated metal sheets or plates, for instance, for roofing and siding; gutters, valleys, eaves, flashings, downspouts, pipes, etc., the metal objects are immersed in the bituminous coating material which is heated to a liquid state. After immersion the objects are withdrawn from the fluid coating material, and in the period of withdrawal the movement is preferably gradually decelerated.

By proper control of the total withdrawal time and various interdependent factors and by deceleration of the movement of a metal sheet during the period of withdrawal in the improved method, coatings of various desired thicknesses and of desired uniformity are obtainable with a molten thermoplastic bituminous material such as asphalt, tar or pitch base coating materials, coal-digestion pitches in general and preferably with the particular type of bituminous composition referred to hereinbelow. No volatile solvent is needed in the coating composition. By means of the decelerating movement, as distinct from uniform or accelerating movement, the excess coating material on the successively withdrawn upper portions of the metal surface is permitted to flow continuously onto the liquid surface of the coating material in the bath in such a manner that the coating adhering to the metal surface is of substantially uniform thickness throughout.

The thickness of the coating adhering to the metal surface depends on the total time of with-

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drawal of a metal sheet or other object under a given set of conditions. For instance, if the temperature of the molten bituminous coating material, the temperature of the atmosphere into which the metal article emerges, and in some instances the type of article and thickness of metal, are fixed, the thickness of the coating is varied by changing the total time of withdrawal of the article. If any of the above assumed fixed factors, particularly the first two, are varied then the time of withdrawal is varied to obtain the same approximate thickness of coating. A thin coating is obtained by maintaining a higher temperature in the bath and/or by slowly withdrawing the object. A thicker coating is obtained at a lower temperature and/or by rapid withdrawal. In any of these instances by properly decelerating the rate of withdrawal the coating provided on the withdrawn metal object is of substantially uniform thickness on the entire superficies of the coated metal.

A highly improved coated metal product is obtained in the above improved method by employing a bituminous composition in which a combination of physical characteristics is adjusted so that the hardened coating obtained after immersion does not flow on vertical surfaces of the metal at highest atmospheric temperatures or at temperatures reached by the black coated metal in hot summer weather, and also does not chip off on the hard surface of the metal at low atmospheric temperatures in the course of packaging, shipping, loading and unloading, erection, or service exposure. The composition is a so-called coal-digestion pitch of the type disclosed in my Patent No. 2,395,041, dated February 19, 1946, and containing preferably a relatively high proportion of heavy water gas tar heavy oil, as distinct from light water gas tar heavy oil referred to as water gas tar heavy oil, in uniform admixture with thermally decomposed bituminous coal and heat-liquefiable bitumen. The coating of the composition has a particular combination of softening-point and penetrations by which the improved coated metal product is obtained. Direct application of the coating to a metal surface without the use of priming coats is accomplished. A single coating is sufficient for protecting the metal surface. Due to its non-flow and non-crumbling characteristics, solid particulate material or mineral aggregate, uniformly spread on the coating in surface treatments, are held rigidly in their originally applied position.

Though a bituminous coating composition may have a low temperature susceptibility, that is, though it exhibit a low degree of change in consistency with change in temperature, this property alone does not permit indiscriminate application to metal surfaces. A bituminous coating composition may have a low temperature susceptibility and yet if it lacks a suitable yield value it will flow at high atmospheric temperatures on inclined or vertical metal surfaces. Furthermore such a composition may have a good temperature susceptibility but if it also exhibits high consistency it may be brittle at moderately low temperatures.

To obtain the improved coated metal product it is found that when the coating on the metal has a high softening-point it should have in combination therewith a relatively high instead of a low penetration at 32° F. and a relatively low instead of a high penetration at 115° F., which penetrations are determined in accordance with the recommended procedures of the American

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Society for Testing Materials. These penetrations are expressed hereinbelow in units of one-tenth of a millimeter with weights and periods as follows:

At 0° C. (32° F.)	-----	200 grams, 60 seconds
At 25° C. (77° F.)	-----	100 grams, 5 seconds
At 46.1° C. (115° F.)	-----	50 grams, 5 seconds

When a coating on a metal article has a low penetration at 32° F. and particularly when it has a high softening-point, it is too brittle to withstand shipping and erection in cold weather. When the penetration is high at 115° F., though the softening-point is high, the coating is apt to flow at high atmospheric temperatures, and is more susceptible to sticking, marring or other accidental damage in service.

The invention is further explained with reference to the accompanying drawings which diagrammatically illustrate a form of apparatus for practicing the method and several types of products obtained.

In the drawings, Fig. 1 is a vertical sectional view through a coating tank showing a rack for articles to be coated positioned in the tank and another rack above it, combined with an elevation of mechanism for raising and lowering the racks; Fig. 2 is a cross sectional view of a fragment of a coated flat metal sheet; Fig. 3 is a cross sectional view of a fragment of a coated corrugated metal sheet; Fig. 4 is a cross sectional view of a fragment of a coated woven wire or wire mesh sheet; Fig. 5 is a top view of the fragment shown in Fig. 4; and Figs. 6 and 7 are longitudinal sectional views of fragments of pipes coated respectively outside, and both inside and outside.

A type of apparatus suitable for the practice of the method of this invention and illustrated in the above Fig. 1 is described and claimed in an application of Morton I. Dorfan, Serial No. 489,347, filed June 2, 1943, and now abandoned.

By way of example, but not of limitation, the improved method will be explained in conjunction with the above apparatus and as applied to metal sheets, for instance, of iron or steel, tin, zinc, copper and/or other metallic elements, for providing such sheets with a coating of bituminous material, the coating being of substantially uniform thickness throughout the coated area of the sheets. In the apparatus shown, a body of heat-liquefiable bituminous coating material 1, such as coal tar or pitch, water gas tar or pitch or other tars or pitches or mixtures thereof, and particularly the coal-digestion type of pitch such as that herein described, hardenable at atmospheric temperatures, is placed in a metal tank 2 which is surrounded by a casing 3 which is spaced from the sides and bottom of the tank to form vertical and horizontal passages 4 and 5, respectively, for the flow of gases or fluids for heating the coating material and maintaining it at the desired temperature. The heating fluids are received and discharged through conduits 6 and 7 near the top of the tank 2. A preferred form of the heating apparatus is disclosed in Patent No. 2,365,336, issued December 19, 1944, to which reference may be made for further details of its construction and operation.

To circulate the heated coating material and thereby facilitate its maintenance in the tank at a substantially uniform temperature throughout, some of it may be withdrawn from the bottom of the tank 2 through a pipe 8 by a pump 9 and

reintroduced into the reservoir in an upper zone thereof through a pipe 10.

Flat or corrugated metal sheets 11 to be coated are placed in racks 12 and 13 and supported preferably in vertical position and suitably spaced laterally from each other to permit ready contact of their surfaces with the coating material. A preferred form of rack is shown in detail in an application of Morton I. Dorfan, Serial No. 489,349, filed June 2, 1943, now Patent No. 2,344,855, to which reference may be made.

Means are provided for elevating one of the racks while the other is being lowered, and for decelerating the rate of withdrawal of each from the tank 2 during elevation. The racks 12 and 13 are suspended from above the tank 2 by cables or other suitable flexible members 14 and 15 respectively. The cables 14 and 15 are oppositely wound on and are attached at their upper ends to the larger diameter portions of conical drums 16 and 17, respectively. These drums are attached to and adapted to be rotated by a horizontal drive shaft 18. The face of each drum is provided with a spiral groove for receiving the cable that is attached to the drum, the spirals being in opposite directions when the drums are positioned as shown, but of the same pitch. To position each rack so that when lowered and elevated it will move vertically and have no lateral movement such as would take place if its supporting cable extended directly downwardly from the drum, each cable extends over an idler pulley 19 spaced horizontally from the drum and suspended by a flexible member 20 which serves as a swivel to permit the idler to rotate on a vertical axis. The shaft 18 may be driven by a constant speed motor 21 through a speed changer 22 the driven element of which is connected to the shaft 18 by a belt 23.

In coating corrugated or flat steel sheets of 22 United States standard gauge and twelve feet in length with a pitch having a softening-point of about 100° C. (212° F.), for instance, the pitch in the tank 2 is preferably maintained at a temperature within the approximate range of 300° to 400° F. (148.9° C. to 204.4° C.) depending on the thickness of the coating desired. The sheets, positioned vertically in a rack 12 or 13, are preferably permitted to remain totally immersed in the heated fluid to bring the temperature of the metal up to substantially the temperature of the molten pitch. Thus the pitch is permitted to wet the metal surface thoroughly, fill all the rough areas or surface abrasions completely, and to flow over all the contours of the metal surface, to insure formation of a continuous coat. If desired, the sheets may be preheated before submerging them in the pitch so as to keep the temperature of the bath from fluctuating too much.

After submergence, the sheets are withdrawn from the pitch at a gradually decelerated rate of movement. A total withdrawal time for a twelve foot sheet may be within the approximate range of 70 seconds to 300 seconds, the selected time determining the thickness of the coating. This time is varied by changing the speed of rotation of the shaft 18. The drums 16 and 17 being conical and the angular velocity of rotation being kept uniform during a given withdrawal period, the deceleration is preferably kept substantially uniform from beginning to end of such period. For a twelve foot sheet a satisfactory deceleration is obtained by withdrawing the sheet at an initial rate of 15 feet per minute and a final rate of 6 feet per min-

ute. In general, the ratio of the initial rate to the final rate may be 2:1 or greater. If the ratio is less than 2:1, the improvement in the uniformity of the coating thickness is less than desired. The greater this ratio of initial to final rate the more nearly uniform will be the coating thickness throughout the length of the sheet. Ratios above 5:1 are considered impractical for industrial utilization in connection with the slight further improvement in uniformity obtainable concurrently with such greatly increased ratios.

After withdrawal of the coated sheets the coating is hardened by cooling. If desired, the coated sheets are subjected to various surface treatments hereinafter mentioned.

The bituminous composition for preparing the improved coated metal products is one that preferably consists of approximately 15 per cent to approximately 40 per cent by weight of heavy water-gas tar heavy oil in uniform admixture with thermally decomposed bituminous coal, and heat-liquefiable bitumen. The composition is prepared so that it will preferably have in combination a softening-point of above approximately 95° C. or relatively high, a penetration of at least about 10 at 32° F. or relatively high, and a penetration of not more than approximately 85 at 115° F. or relatively low.

Various methods of preparing the particular bituminous composition or coal-digestion pitch referred to, may be employed.

In one procedure, coal and tar or pitch are heated together and, while stirring the mixture, the temperature thereof is gradually increased over an extended period of time to substantially 300° C. or preferably to a temperature in the approximate range of 300° C. to 310° C. Any distillate obtained is discarded. The heated material is fluxed to the required softening-point and penetrations with heavy water gas tar heavy oil to obtain the bituminous product for providing the desired improved bitumen-coated article.

In an alternate procedure, coal, and tar or pitch, and heavy water gas tar heavy oil are initially thoroughly mixed, heated together, and while mixing, the temperature is gradually raised over a period of time to obtain a product having the desired softening-point and penetrations. In another procedure, though not as desirable as those indicated above, coal is dispersed in heavy water gas tar heavy oil, and tar or pitch are then added while heating and stirring. During or after a period of gradually increasing temperature, depending upon the proportions of materials originally combined, additional quantities of pitch or tar or heavy water gas tar heavy oil, or combinations of these are added as necessary to obtain a product having the desired softening-point over the approximate range of 95° C. to 150° C. and the penetrations specified above.

The above processes are varied depending upon the coal and tar or pitch used and upon the nature of the product to be obtained. The coal is a bituminous coal such as, coking coals including either high or low volatile bituminous coal, and certain commercial non-coking bituminous coals.

Highly improved results are definitely and particularly obtained by using for the tar or pitch constituent heavy water gas tar or a pitch residue derived from the distillation of heavy water gas tar. Heavy water gas tar is obtained

from water-gas generator plants in which Bunker-C or similar grades of residual petroleum fuel oil are used for carbureting. This tar, though produced from a petroleum raw material, is composed mostly of aromatic constituents. Heavy water gas tar should be differentiated from what is known as water gas tar or light water gas tar which is produced in the carbureter of a water gas plant when petroleum distillates are used as carbureting material. In certain industrial groups heavy water gas tar is termed residuum tar to distinguish it from what was formerly known as water gas tar or is known today as light water gas tar. Other heat-liquefiable bitumens including tars and pitches, either singly or combinations thereof, may be added to the heavy water gas tar, or may be substituted in whole or in part for the latter. Such other bitumens in addition to heavy water gas tar are, for example, coal tar (from high or low temperature coking processes), water-gas tar, oil-gas tar, Pintsch gas tar and wood tar, and the corresponding pitches derived from the above-mentioned tars.

The heavy water gas tar heavy oil, or high boiling distillate, which is included in the coal-digestion pitch, and which lowers the susceptibility of the viscosity of the product to change with temperature, is obtained by distilling heavy water gas tar and separating the distillate recoverable above approximately 300° C. during the increasing temperature interval when samples of the distillation pitch residue increase in softening-point from approximately 95° C. to approximately 150° C., as measured by the A. S. T. M. standard ring and ball softening-point test. Only a minor portion of said oil thus prepared will boil below 300° C. Typical distillation results obtained at atmospheric pressure for a sample of heavy water gas tar heavy oil so prepared are given in the following table:

Temperature, °C.	Percent Distillate
270-----	3.9
300-----	15.8
355-----	68.9
375-----	82.6
400-----	92.9

In the preparation of the digested coal product, the ingredients are placed in a still or digesting tank provided with or without mechanical stirrers or other means of agitation and provided with heating means. In large scale production a still, provided with heating tubes positioned so as to distribute heat uniformly throughout a batch, may be used. The rate of rise in temperature of the heating vessel in the initial stages at least is preferably low to permit the evaporation of any water present which might cause excessive foaming. The coal used may be preferably initially dehydrated which is best accomplished by finely dividing it and then subjecting it to a drying treatment. By proper division of the coal to a finely pulverized condition more uniform distribution thereof in the liquid media is readily attained. Coking of the material or too rapid decomposition of constituents therein, particularly where the higher concentrations of coal are employed, is avoided by maintaining moderate rates of temperature rise.

The temperature at which coal and a bituminous medium are heated together to provide the

protective coating of the present invention should not be lower than that at which a satisfactory dispersion is obtained within a reasonable time from a practical standpoint, namely, substantially 270° C., and the temperature should not be permitted to rise so high as to decrease unduly the life of the heating equipment, namely, approximately 350° C.

In adjusting the characteristics of the final coating material, it is noted that generally the increase in proportion of coal results in more pronounced departure from simple viscous flow properties, and in increased softening points of the products. The greater the proportion of dispersed coal, the harder the final product, and the greater the proportion of admixed heavy water gas tar heavy oil the softer the product and the greater the improvement in temperature susceptibility. The greater the proportion of the coal and heavy water gas tar heavy oil as distinct from tar or pitch, the better the improvements in viscosity-temperature susceptibility and the greater the resistance to flow under stress. The addition of heavy water gas tar heavy oil alone to a bitumen such as coal tar pitch as well as to coal and tar or oil mixtures and especially coal-digestion pitches, and the uniform distribution of the heavy water gas tar heavy oil therein, result in a homogeneous product having a relatively lower viscosity susceptibility to temperature changes than does the original bitumen.

It is found that in the preparation of the products claimed, protective coating with the desired characteristics may be duplicated by adjustment of the proportions of coal, dispersing media and heavy water gas tar heavy oil; by control of heating temperatures; by addition of dispersing media and/or heavy water gas tar heavy oil to a batch under treatment at predetermined stages in the coal digestion process and at predetermined rates; by adjustment of the length of time of mixing and heating given proportions of the ingredients and of the manner of mixing same; and, if desired, by alternative treatments of the coal dispersion product with dehydrogenating agents such as sulfur, and/or air or oxygen-containing gases, or by vacuum distillation of the coal dispersion product and subsequent addition of heavy water gas tar heavy oil, thereby replacing lower boiling oils by the higher boiling heavy water gas tar heavy oil.

For purposes of illustration, the following examples are provided to indicate more specifically, procedures by which coal-digestion material is produced:

Example 1.—About 187 parts by weight of heavy water gas tar and about 47 parts by weight of powdered bituminous coal are heated together in a still preferably while stirring. The temperature is gradually raised to a temperature of about 305° C. over a period of approximately five and one-half hours. This temperature is maintained for about four hours during which time there results a distillate of about 5 to 6% based on the tar. At the end of this time heating is discontinued and the mixture permitted to cool. After about forty minutes and while the temperature is slowly dropping, about 54 parts by weight of heavy water gas tar heavy oil are stirred into the heat-treated coal and tar mass. The resulting product is discharged from the still at around 225° C. The softening-point of this product is about 102° C., and the penetration at 32° F. is 14; at 77° F. is 20.5; and at 115° F. is 40.

Example 2.—A still is charged with about 60

parts by weight of heavy water gas tar heavy oil to which about 37.5 parts by weight of powdered coking coal are added, and then about 52.5 parts by weight of coke oven tar pitch, while stirring and heating. The charge is preferably heated slowly to a temperature of about 300° to 310° C. This range is reached in about two and one-half hours and is substantially maintained for about five hours. The temperature of the charge at the end of another hour is reduced to about 245° C. and about 22 parts by weight of heavy water gas tar heavy oil added while stirring. At two successive intervals thereafter of about thirty minutes apart, about 10 parts by weight of coke oven pitch are added while stirring. The product is discharged from the still and is ready for use. Its softening-point is about 104° C. and the penetration at 32° F. is 15; at 77° F. is 25; and at 115° F. is 40.

Example 3.—A still is charged with about 4770 gallons of heavy water gas tar at about 60° F., about 13,200 pounds of pulverized bituminous coal, and about 1450 gallons of heavy water gas tar heavy oil. The charge is then slowly heated to about 300° C. over a period of about twelve hours and is maintained at this temperature for an additional two to four hours. Tests are made on softening-point and penetrations and the material is discharged from the still and barreled. A typical sample has a softening-point of 112° C. and penetrations at 32° F. of 15; at 77° F. of 22; and at 115° F. of 40.

Example 4.—About 69 parts by weight of heavy water gas tar, about 69 parts by weight of coke oven tar and substantially 45 parts by weight of powdered coking coal are brought together and heated slowly to 300° C. over a period of about three to four hours. The temperature is maintained at about 300° C. for an additional three to four hours whereafter substantially 73 parts by weight of heavy water gas tar heavy oil are added. After introduction of the oil the heating is discontinued and the resulting product is permitted to cool. The softening-point of the product is substantially 103.2° C., and the penetration at 32° F. is 29; at 77° F. is 36; and at 115° F. is 60.

In the application of the above preferred coal-digestion pitch to bare metal surfaces by the above improved coating method as well as in other methods as by rolling, spraying or brushing, a highly improved coated product is obtained in which the coating resists flow on vertical surfaces at highest atmospheric temperatures which are in the neighborhood of about 130° F. and also at temperatures reached by the black coated article at such atmospheric temperatures, which may approximate 150° F. to 160° F. or higher. The coating also resists chipping and spalling in cold weather as indicated above.

A coal-digestion pitch exemplified above is applied in the above described dipping method by melting the pitch and maintaining it at a temperature of about 350° to 360° F. By employing the steps in this method as described, a coating of uniform thickness is obtained throughout the coated area of a metal article. In a single dip, coatings of approximately .3 to .1 pound per square foot, both sides, equivalent to thicknesses respectively of about .025 to .008 inch, are readily obtained in a period of withdrawal for a twelve foot sheet of about seventy seconds to about 300 seconds respectively with a deceleration ratio of at least 2:1.

To the coating, and while it is still tacky, finely divided mineral dusts or flours, or mineral or

other granules of various sizes and colors, mica, and metal scales, and other particulate materials may be applied for decorative or other purposes. Such materials applied by brushing or pressure are held rigidly in place on the improved coated product throughout the range of atmospheric temperatures and at the highest temperature reached by the metal product in hot weather. If desired, a colored or pigmented outer paint or other coating may be applied to the dip-coat.

Figs. 2 to 7, inclusive, illustrate diagrammatically some of the articles coated in a single hot-dip process. In Fig. 2 a flat sheet 24 of metal is shown coated on both sides with the protective coating 25. In Fig. 3 a corrugated sheet 26 of metal is shown coated on both sides with the protective coating 25. Solid particulate material 27 is shown uniformly distributed on the surface of the dip-coat on one side of the sheet. Both sides may, if desired, be coated with the same or different particulate materials.

In Figs. 4 and 5, a woven wire sheet 28 is shown with the protective coating 25 on the wire strands and the spaces between the strands left open.

In Fig. 6, a pipe 29 is shown with the protective coating 25 on the outside. To coat only the outside of pipes in a dip-coating process, the pipe lengths are capped at both ends and placed vertically in the molten bituminous coating material. A vent is provided at the upper end of each pipe to permit the escape of air from the inside on expansion due to the heat of the bath. With both ends of the pipes left open, the inside as well as the outside are coated as in Fig. 7.

In the process of the present invention, particularly good results are obtained from the application of merely a single hot-dip coating of the coal-digestion pitch described herein. A firmly bonded, non-brittle, water insoluble, highly weather resistant, protective coating which is highly satisfactory over wide temperature intervals is provided. No additions of inert fillers or use of fibrous coverings are necessary. Other bitumens of similar high softening points can not retain the firm bonding, non-brittle character at low temperatures that are retained by the hereindescribed preferred coal-digestion pitch coatings particularly when applied by a single dip-coat process. The non-brittleness and strong adhesiveness of the latter coatings are strikingly demonstrated by bending tests, nailing tests and sawing tests. Sheets coated with such coatings can be readily cut with a hand saw at room temperatures without rupturing the bond and may also be cut by means of a torch without affecting more than an extremely slight adjacent strip. When the improved coated sheets are bent or subjected to impact or shock the coating adheres firmly to the metal surface at a bend or at the point of stress, whereas many other bituminous coatings when subjected to these tests crack, chip, and lose the bond to the metal surface.

Various modifications and changes may be made in the method, materials and equipment described hereinabove without departing from the scope of the invention. It is to be understood that the description should be interpreted as illustrative and not in a limiting sense and that the invention is not restricted to the disclosure other than as defined in the appending claims.

This application is a continuation-in-part of application Serial No. 479,372, filed March 16, 1943, and now abandoned.

What is claimed is:

1. In a method of preparing coated metal

articles in which method said articles are immersed in and vertical metal surfaces thereof are exposed to a hot molten thermoplastic bituminous coating material, the steps comprising immersing said surfaces in the hot liquid bituminous coating material, elevating said surfaces vertically in said liquid coating material while permitting the material to drain, and during the period of elevating the said surfaces in said coating material gradually decelerating the rate of movement of said surfaces until the said surfaces completely emerge from the said body of coating material and reducing the temperature of the withdrawn coated surfaces to permit the coating to harden, thereby obtaining a hardened coating of substantially uniform thickness over the entire area of said surfaces.

2. A method of preparing coated metal sheets for roofing, siding and other structural purposes, which method comprises: immersing a bare metal sheet in a hot molten bituminous material having a softening-point of above approximately 95° C., a penetration of at least 10 at 32° F. with 200 grams for 60 seconds and a penetration of not more than approximately 85 at 115° F. with 50 grams for 5 seconds, and prepared by thermally digesting bituminous coal in a heat-liquefiable bitumen in a temperature range of about 270° C. to approximately 350° C. and blending heavy water-gas tar heavy oil with the digestion product to the extent of approximately 15% to approximately 40% by weight, elevating the said sheet vertically in the said molten bituminous material at a gradually decelerating rate until the said sheet completely emerges from the said bituminous material, and reducing the temperature of the so withdrawn coated sheet to permit the coating to harden, thereby obtaining a sheet having a hardened coating of uniform thickness that is non-flowing on vertical surfaces thereof at highest atmospheric temperatures and non-brittling on said sheet at low atmospheric temperatures.

3. A method of providing a metal sheet of extensive surface area with a bituminous coating that is non-brittling on said sheet at low atmospheric temperatures and that is non-flowing on vertical surfaces thereof at high atmospheric temperatures, which method comprises: immersing a metal sheet in a hot molten, liquid bituminous coating material at a temperature in the approximate range of 148.9° C. to 204.4° C., the said bituminous coating material having a softening-point in the range of about 95° C. to 150° C., a penetration of at least 10 at 32° F. with 200 grams for 60 seconds, and a penetration of not more than about 85 at 115° F. with 50 grams for 5 seconds, elevating the metal sheet in upright position in said liquid bituminous coating material

and while maintaining the said molten bituminous material in a liquid state and while elevating the said sheet in upright position decelerating the rate of movement of said sheet in the liquid bituminous material until the sheet completely emerges therefrom, the ratio of the initial rate of movement of the sheet to the final rate during elevation of the sheet in the said liquid bituminous material being at least approximately 2:1, thereby providing said sheet with a layer of said bituminous material of substantially uniform thickness over the entire coated area of the said sheet.

4. A method of coating metal sheet material of extensive surface area with a layer of heat-liquefiable bituminous coating material of substantially uniform thickness, which method comprises while maintaining a body of said heat-liquefiable bituminous coating material in a liquid, free-flowing state, said coating material being hardenable at atmospheric temperatures, immersing said metal sheet material in said liquid body, elevating the sheet in upright position in said body while permitting said coating material to drain, and while so elevating the sheet and so maintaining the said body in said liquid, free-flowing, state gradually decelerating the rate of movement of said sheet in said liquid body until the sheet completely emerges from said body, to thereby provide said sheet material with a layer of said bituminous coating material of substantially uniform thickness over the entire coated area of said sheet.

5. The method of claim 4, in which the ratio of the initial rate of movement of the sheet to the final rate during elevation of the sheet in the liquid body of bituminous coating material is at least approximately 2:1.

6. The method of claim 4, in which the ratio of the initial rate of movement of the sheet to the final rate during elevation of the sheet in the liquid body of bituminous coating material is in the approximate range of 2:1 to 5:1.

WILLIAM F. FAIR, JR.

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The following references are of record in the file of this patent:

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Number	Name	Date
1,197,925	Elliott	Sept. 12, 1916
1,481,430	Overbury	Jan. 22, 1924
1,511,059	Maranville	Oct. 7, 1924
2,235,825	Cary	Mar. 25, 1941
2,249,412	Yeager	July 15, 1941
2,267,597	Neville et al.	Dec. 23, 1941
2,350,744	Fordyce et al.	June 6, 1944
2,395,041	Fair	Feb. 19, 1946
2,395,853	Fair	Mar. 5, 1946