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Dick E. Stearns
INVENTOR.

BY Browning & Simmons
ATTORNEYS
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Dick E. Stearns
INVENTOR.

BY Browning & Summers
ATTORNEYS
This invention relates to an apparatus for applying a coating material to a surface, especially to a curved or cylindrical surface such as the exterior of a conduit, pipe or the like. In one of its aspects, this invention relates to an improved method for distributing a coating material over such surface.

Pipes, pipe lines and the like are frequently protected from corrosion and electrolysis by an application of a coating material. In certain instances, a wrapper is applied over the coating material before the same has hardened, with the result that the wrapper is embedded in the coating material and thereby bonded to the pipe as a part of the protective covering. In other instances, the coating material alone is relied upon to protect the pipe. The coating material ordinarily employed is comprised of a coal tar or asphaltic product with which a suitable material is customarily admixed as a filler. The coating material is normally solid at atmospheric temperatures but can be heated to an elevated temperature to render it sufficiently fluid to be applied to the surface of the pipe to be coated. A supply of the coating material is conventionally maintained in a large supply vessel or kettles mounted on wheels or treads in such a manner that it can be pulled along parallel to the pipe line. The vessel and its contents are ordinarily heated by an open flame burner disposed in a conduit passing through or under the vessel and the amount of heat supplied is controlled by suitable means to prevent overheating of the coating material with resultant cracking or thermo-decomposition thereof. Suitable stirring procedures are also employed to maintain the filler in a dispersed phase in the fluid coating material in the vessel.

Conventional commercial pipe coating apparatus is basically comprised of a frame mounted on metal crawler wheels and is powered by an internal combustion engine to propel itself along the pipe line as a runway. The frame carries with it a coating shoe which is commonly an annular ring extending around the pipe and from which the coating material is caused to be discharged onto the pipe surface. A supply or sump pan is situated underneath the coating apparatus to catch the coating material spilling from the coating shoe and flowing and dripping off the pipe. The coating material is pumped from the large portable kettles into the sump pan from which it is picked up by a second pump and pumped into the shoe. The sump pan usually has an open flame heater built into it as an integral part thereof to prevent the coating material from cooling.

A disadvantage of present apparatus is in the fact that it relies on gravity to drain off excess coating material from the pipe and on the control of viscosity of applied material to determine the thickness of material which will adhere to the pipe, and thus does not result in uniform thickness of coating. Obviously, this necessitates the use of excessive amounts of coating material in order to insure the maintenance of minimum thickness standards, and is therefore wasteful.

Another disadvantage of such apparatus arises from the fact that coating material such as coal tar enamel, as it is applied to the pipe and as it lays in the sump pan, gives off dense clouds of noxious fumes which not only obscure the operation of much of the apparatus, but also are a definite safety hazard since the fumes are toxic to humans.

Still another disadvantage is the use of the sump pan. This necessitates twice pumping of the coating material, adds weight to the coating apparatus supported on the pipe, and also permits overheating of the coating material inasmuch as the sump heater is manually adjusted and, hence, subject to the error of human judgment.

Accordingly, one object of this invention is to provide a coating apparatus wherein these and other disadvantages are eliminated.

It is an object of this invention to provide an apparatus adapted to apply and distribute a coating material in a fluid state uniformly on a surface to be coated.

Another object of this invention is to provide an apparatus adapted to distribute a coating material in a fluid state over the surface of a conduit to produce a coating of uniform thickness.

Still another object of this invention is to provide an apparatus for coating a conduit wherein a coiled spring is provided to roll along the surface of the conduit and to position the fluid coating evenly upon such surface, in a measured amount.

Another object of this invention is to provide an apparatus for coating a conduit wherein a fluid coating material deposited on the surface of such conduit is uniformly distributed by a coiled spring adapted to roll over such surface, the adjacent loops of such spring and the surface of said conduit forming uniformly dimensioned and uniformly spaced areas, so that a predetermined amount of coating material will be applied and positioned by said spring as it rolls along the pipe.

Still another object of this invention is to provide in a pipe coating apparatus a coiled spring adapted to roll along the pipe to position the coating material upon the surface of the pipe so as to form a coating of a substantially uniform thickness completely around its periphery, said spring being so constructed and arranged that when adjacent loops thereof are abutted against one another at a point adjacent the surface of the conduit, there will exist a space between each pair of such adjacent loops and the adjacent surface of the conduit by means of which the coating fluid can be formed into ridges of predetermined size as the spring rolls along the conduit.

Yet another object of this invention is to provide a conduit coating apparatus wherein the fumes of coating material are removed from the immediate vicinity of such apparatus to provide safer and more efficient working conditions.

Yet another object of this invention is to provide a conduit coating apparatus wherein the supply of coating material is maintained in but a single vessel at a controlled temperature and can be transported to and from such vessel by means of a plurality of flexible conduits arranged in heat exchange relationship with each other.

Still another object of this invention is to provide a pipe coating apparatus where in the means for distributing the coating material onto the pipe can be heated by indirect heat exchange with a heat carrier medium in the form of coating material circulated at a suitable temperature therethrough from an external source maintained at an optimum temperature.

Another object is to provide such an apparatus wherein the distributing means may be heated and maintained at a predetermined temperature by a heat conducting fluid which will remain fluid at atmospheric temperatures.

An even further object of this invention is to provide a pipe coating apparatus which can be moved along a pipe
at a uniform rate of speed by a plurality of rollers driven by a means including an endless chain passing through a self-lubricating system.

An even further object of this invention is to provide a pipe coating apparatus wherein the supply of coating material is maintained in a single vessel at an optimum uniform temperature and can be passed therethrough in such a manner that the distribution means can be heated and maintained at a substantially that of the heated coating material, said distribution means being so arranged that the coating material can be discharged therefrom onto the pipe in a sheet-like film not given to splashing, said coating material being uniformly and evenly distributed upon the exterior surface of the conduit by a rolling coil spring and any fumes from the hot coating material being removed from the immediate vicinity of the coating apparatus.

Other objects, advantages and features of this invention will be apparent to one skilled in the art upon a consideration of the written specification, the appended claims and the attached drawings wherein:

Fig. 1 represents an end view of a preferred embodiment of the apparatus of this invention;

Fig. 2 represents a plan view of the apparatus of Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a diagrammatic illustration showing the flow of coating material in the apparatus of this invention;

Fig. 5A is similar to Fig. 5 but illustrates a more preferred embodiment of this invention;

Fig. 6 is a partial cross-sectional view of the spring employed in the apparatus of this invention to distribute the coating material over the surface to be coated;

Fig. 7 is a view taken on the line 7—7 of Fig. 6;

Figs. 8, 9, 10 and 11 are cross-sectional views of the loops of several types of springs which can be employed in accordance with this invention;

Fig. 12 is a plan view, partially in section, of that portion of apparatus of this invention which is adapted to roll along a pipe;

Fig. 13 is a sectional view taken along the line 13—13 of Fig. 12;

Figs. 14, 15, 16 and 17 are sectional views taken on the lines 14—14, 15—15, 16—16 and 17—17, respectively, of Fig. 13.

In the drawings, like characters of reference are employed to designate similar parts throughout the several views.

Referring now to Figs. 1 and 2, there is shown a portable vessel 20 mounted upon tracks 21 in such a manner that it can be pulled parallel to a pipe or pipeline by a tractor attached to hitch 22. Vessel 20 is adapted to receive a supply of coating material therein and to maintain the same at a constant elevated temperature by heating means 23 which can be a firebox passing through or underneath the vessel and having disposed therein an open flame burner. It is contemplated that the action of the burner shall be controlled by a thermally responsive device such as a thermostat mounted in the body of liquid in vessel 20 in order to maintain such liquid at a temperature which is substantially constant. Ordinarily such temperature for maintaining the usual coating material in a satisfactory state of fluidity will be in the range of 300°F to 550°F. A stirring apparatus (not shown) can be inserted in vessel 20 to maintain any filler in the coating material in a dispersed state. The apparatus for applying the coating material to and distributing the same over the surface of the pipe or other conduit is designated in Figs. 1 and 2 by the numeral 24. In general, this apparatus is adapted to receive the coating material in a heated fluid condition from vessel 20 and to apply it uniformly over the outer surface of pipe 25.

Referring now to Figs. 12 and 13, the apparatus for applying and distributing the coating material over the surface of the pipe is shown in some detail. This apparatus comprises a means for depositing the coating material onto the pipe which means can be an annular ring or shoe 26 adapted to extend around the pipe to be coated and to have its inner face 27 removed a substantial distance, say 1/2 to 2 inches, from the outer periphery of the pipe in order that the shoe can pass over any protrusions or uneven portions of the pipe such as welds, wrinkles in bends, out-of-round sections and the like. Shoe 26 is preferably made of a metal having high resistance to wear such as magnesium or aluminum and has disposed therein a passageway 28 which is annular in nature and which extends completely around the ring except for a portion 28a which forms a partition to divide the annular passageway. This passageway is adapted to receive hot coating material from vessel 20 through conduit 29, pump 30 and conduit 31 (Fig. 5). Pump 30 is of the reversible type and is driven by an electric motor 32 (Fig. 2). Conduit 31 is formed with two branches. One branch has a check valve 29a therein and takes suction near the bottom of vessel 20 through screen 29b. The other branch has a check valve 29c and discharges in member 36, described below. A two-way valve 33 is inserted in conduits 31 and 32, as shown, to direct flow through either of them. Conduit 31 opens into passageway 28 at one side of partition 28a. The hot coating material from conduit 31 flows around passageway 28 and discharges from through conduit 35 from which it discharges into a cylindrical perforated member 36 arranged above the surface of the material in vessel 20. Member 36 and its appurtenant apparatus will be described more fully hereinafter. As the hot coating material flows through passageway 28, the shoe 26 will be heated to a temperature which substantially approaches that of the hot coating material.

After the shoe 26 has been brought to the desired temperature, valve 33 can be rotated to a position such that the coating material passing from pump 30 will discharge from the valve into conduit 32 and thence into a passageway 38. Passageway 38 is annular in nature and extends completely around shoe 26. A slot 39 is cut from the inner face 27 of shoe 26 into passageway 38 in such a fashion that fluid coating material maintained under pressure in passageway 38 by pump 30 can discharge through the slot onto the surface of the pipe to be coated. Passageway 38 is preferably made with a cross-sectional area several times as large as the cross-sectional area of slot 39. When so constructed, the pressure drop caused by the fluid being pumped through passageway 38 will be only a small fraction of the pressure drop caused by the fluid in passing through slot 39. In this manner, the flow of fluid coating material will be substantially equal through the slot all along its length and such fluid will accordingly be deposited uniformly around the periphery of the pipe to be coated. Slot 39 is preferably positioned at an angle with the surface of the pipe in order that the coating material discharged therefrom may strike the surface of the pipe at an angle to prevent excessive splashing thereof.

Since it is extremely difficult, if not impossible, to adjust the rate of flow of coating material to the surface of the pipe so that the amount deposited thereon from slot 39 will be precisely that which is required to form a coating of the desired thickness, it is advantageous to deposit an amount of coating material on the pipe which is in excess of that required to form coating of the desired thickness. In accordance with this invention, a coil spring is provided to roll over the surface of the pipe after the coating material has been applied thereto and to uniformly distribute the material along the pipe in an amount which is just sufficient to form the coating of the desired thickness. This spring is designated generally by the numeral 40 and can have one of several embodiments. In general,
the spring is a close wound spring having loops wound on a constant radius about the longitudinal axis of the spring. The term "close wound" refers to the spacing, if any, between the adjacent loops of the spring when at rest and, in general, defines a spring wherein no or substantially no space exists between adjacent loops, i.e. they are one another. The spring is sufficiently close wound that when the ends of the spring are joined or attached together and the spring is placed around the periphery of the pipe or conduit along which the spring is to roll, the adjacent loops of the spring are in abutment at those portions of the loops nearest the pipe surface. A spring of this character is subject to some stress when its ends are joined together with its axis around a substantially circular configuration. The length of the spring can be adjusted so that it fits closely around the conduit to be coated and, with its ends secured together, sufficient stress will be placed on the spring to prevent its sagging away from the bottom of the conduit. When properly placed, adjacent loops will be in substantial abutment along the periphery of the pipe contacted by those loops. However, it will be understood that adjacent loops need not of necessity be in abutment at a point nearest the conduit but that there may be a spacing therebetween provided that such spacing is not so great that the fluid coating material will flow in excessive amounts through such spacing. Preferably, however, the loops are in abutment at the point nearest the pipe surface. It will be seen that with this construction the spring can ride over uneven and out-of-round portions of the pipe. In fact, where there exists an angular protrusion, the spring will ride thereover and provide a fillet of coating material in the angular space around the protrusion.

As shown in Figs. 6 and 8, the latter being an enlarged cross-sectional view of two adjacent loops of the spring, the loops may be comprised of loops 41 of circular cross-section 41a. When the spring is properly disposed around the circumference of pipe 25, the portions 42 of adjacent loops nearest to the circumference of the pipe will not be substantially separated one from the other and will be, preferably, in abutment at a point 42a. In this manner, there is formed between adjacent loops of the coil at the points where they contact the periphery of the pipe spaces or areas 43. Then as spring 40 rolls along the length of the pipe, the coating material will be momentarily moulded and measured by spaces 43, leaving behind the spring ridges of the coating material which, immediately after the spring has become out of contact with such ridges, will smooth out due to surface tension to fill in the valleys therebetween and form a coating around the pipe of uniform thickness. The cross-sectional area of any one of the spaces 43, shown in an enlarged view in Fig. 8, is preferably substantially equal to that contained within the dashed outline 44 shown in Fig. 8 which represents that portion of the finished coating having a desired thickness "r" and extending between the points of contact of adjacent loops with the surface of the pipe to be coated. In other words, the area of space 43 must be such that a ridge will be formed of an amount of material which, after flowing transversely into the valleys on each side, will fill one-half of each valley to form a coating of the desired thickness.

It will be appreciated that the coiled spring shown in Fig. 6 has been somewhat distorted from its actual configuration for purposes of illustration. Thus, in a coiled spring, the large diameter pipe, the outer and inner portions of the loops 41 will not be spread apart to the extent shown in Fig. 6. In fact, when employing a spring on a pipe having a diameter of thirty inches, spreading between the outer portions of the loops of the coil will not be of any marked extent. It is to be noted also that the cross-sectional diameter of the loops 41 as shown in Fig. 6 has been exaggerated for purposes of better illustrating the spaces 43 and their function.

As stated, the cross-sectional configuration of the loops of coil 40 may be of other forms than circular. For example, the loops 41 can have a cross-sectional configuration which is triangular in nature as illustrated in Fig. 9. When so formed, the apex of the triangle should be turned outwardly from the longitudinal axis of the pipe in such a manner that such apex can roll along in contact with the surface of the pipe to be coated. When the coils are thus formed, there will exist a triangular space 44 between adjacent loops of the coil and the coating fluid is measured by this space in the same manner as described with respect to space 43. When the sides 44a and 44b of the triangular cross-section are equal in length, i.e. the triangle is isosceles, the height of space 44 should be twice the thickness of the applied coating in order that the coating material measured by the upper half of the space will be just sufficient to fill the triangular valleys left by the coils of the spring as they roll through the fluid coating material.

In Fig. 10 another modification of the cross-section of the loops forming the coil 40 is shown. In this modification the loops are of substantially rectangular cross-section and have their outer faces serrated by triangular protrusions 40a. This type of spring is particularly adapted to be employed when the thickness of a coating is to be very rigid.

In Fig. 11 there is shown still another cross-sectional configuration which can be employed for the loops of coil 40. This configuration is likewise triangular in nature, similar to that shown in Fig. 9 except that a trapezoidal section 45 is left along the base of the triangular section on the inside of the coil spring in order to provide a planar bearing surface 46 between adjacent loops of the coil. Bearing surface 46 can be formed at a slight angle so that adjacent loops can abut together over the entire surface.

The coiled spring 40 of this invention is receivable in a recess 47 on the inner face 27 of shoe 26 in such a manner that advancement of the shoe along the length of the pipe will cause the wall of the recess to impart a rolling movement to coil 40. A wear plate 47a of a hard metal can be provided to prevent excessive wear of shoe 26 by spring 40.

As stated, it is desirable to discharge an amount of coating material onto the pipe which is in excess of that which will actually be required to form the desired thickness of coating. This excess of material will flow along the surface of the pipe ahead of spring 40 as a roll of fluid 48 and as the excess becomes larger and larger, a portion of it will flow downwardly into the lower section of annular recess 47. A sump 49 is provided around the lower portion of inner face 27 of shoe 26 and opens into recess 47 to collect the excess of coating material therefrom. The material collected in sump 49 is removed via passageway 50 and conduit 51 to pump 52 from whence it is discharged through line 53 into the perforated member 56 situated in vessel 20. Pump 52 is driven by electric motor 52a.

In accordance with this invention, there is provided a means for removing the fumes of coating material from the area between shoe 26 and the conduit 25 and then exhausting them at a point remote from the coating apparatus. This exhausting means can comprise an annular duct 55 disposed around shoe 26 and having an annular opening therein through which the pipe which has been coated can be received. Connecting to duct 55 is a discharge conduit 56 in which is situated a blower 57 driven by electric motor 57a. Blower 57 is adapted to pull fumes through the duct 55 and discharge the fumes through a stack 58. Stack 58 can extend above the coating apparatus a sufficient distance to prevent the fumes from obscuring the coating apparatus and from contacting any operators in the vicinity.

Means for propelling shoe 26 and appendant apparatus along the length of pipe 25 and in spaced relationship thereto is shown in Figs. 12 and 13. This means
can comprise a carriage having a saddle member 60. Rotatably received in saddle member 60 are shafts 63 on which are rollers or wheels, designated generally by the numeral 64. Rollers 64 are adapted to roll along the upper surface of the pipe and to support saddle 69 thereabove. Rollers 64 can be comprised of three 
sections 65, 66 and 67. These sections have the shapes of saddle members and also may have 85 serrated surfaces slightly concave in order that they may fit closely along the circumference of the pipe. Sections 66 and 67 are not keyed to shaft 63 and can rotate freely and each independently thereon. They are preferably comprised around their outer peripheries of hard rubber so that when key 62 is inserted into shaft 63 and its periphery is comprised of a softer rubber. The diameter of section 65 is made larger than that which would be required for it to contact the surface of the pipe when sections 66 and 67 are resting on the pipe. When so constructed, sections 66 and 67 are free each to rotate independently on shaft 63 and bear the major portion of the weight of the coating apparatus. Section 65, on the other hand, bears a lesser portion of the weight, but, nevertheless, a sufficient portion that its softer rubber periphery is somewhat compressed so that this section can act as the driving means for propelling the carriage along the pipe. It is to avoid the slipping tendency of roller 64, due to the difference in circumference at various sections along its width, is decreased and yet an efficient driving means is provided.

The outer ends of shafts 63 are fastened to worm wheels 68 which are driven by worm gears 69 borne on rotatable shafts 70. Also attached to shafts 70 are drive gears 71 adapted to be driven by an endless chain 72 passing through chain housing 73. Chain 72 can be of the type known as the "silent" chain in which case it is supported from contact with the chain housing by means of a plurality of idling gears 74 spaced around the periphery of the apparatus in such a manner that the drive chain is prevented from rubbing against the chain housing. These idling gears can be rotatably supported on shafts mounted in the side walls of the chain housing. When it is desired to eliminate a portion or all of the idling gears and to permit the drive chain to bear on the chain housing, a roller type chain is employed. This type of chain has rollers in its links which roll along the chain housing and thereby decrease or eliminate the rubbing of the chain on the housing. Means for driving chain 72 around the chain housing can comprise a driving gear 78 attached to shaft 79. Shaft 79 can be driven by means of motor 80 acting through speed-reducing gears situated in gear box 81. The speed of motor 80 is geared down by means of the speed-reducing gears and the other gears in the apparatus to such an extent that rollers 64 will be turned at a speed sufficient to pull the coating apparatus along the pipe at any desired rate.

Saddle 60 is attached to a structural ring 76 adapted to extend around pipe 25. Structural ring 76 is constructed through an insulating gasket 83, preferably of fiber glass, to shoe 26 and in this manner, shoe 26 is supported concentrically around pipe 25 and is adapted to be moved therewith along saddle 60. The other end of saddle 60 is attached to a second annular structural ring 77. Chain housing 73 and rings 76 and 77 may be joined such as by each other by struts 75 and 75a. A support frame 85 is provided for motor 80 and speed reducer 81. This frame is attached to ring 76 through gasket 86 and also to ring 77.

Flexible conduits 31, 32, 33 and 35 are preferably constructed of a heat conducting material in such a manner that they are flexible and are then mounted in a side by side relationship as shown in Fig. 4, so that there can be an inter-change of heat between the various conduits. The nest of four conduits can be enclosed in an insulating liner 87 surrounded by a protective liner 88 made of a tough, rugged material in order that the four conduits can be handled as a unit. A heat conducting material, such as metal shavings and the like, can be packed around the four conduits and inside of liner 87 to enhance the heat exchange between the conduits. The nest of conduits can be suspended in an inverted U-shaped fashion as shown particularly in Fig. 1. A suspension pole 85 is mounted on the side of vessel 20. Pole 85 is preferably flexible at its upper end 85a and bears a hanger 85b having a roller therein to support the nest of conduits passing therebetween and yet to allow movement of pole 85 and vessel 20 relative to the pipe coating apparatus supported by the pole itself. Each end of the nest of conduits can be formed into a union member 89 adapted to be coupled to a corresponding union member 90 with the conduits in each union member lined up with those of the other member. In this manner, the nest of conduits can be conveniently attached at each of their ends in a single connecting operation.

As stated, excess coating material is pumped by pump 52 from shoe 26 to vessel 20 through conduit 51. Pump 52 will from time to time pull air through line 51 and to prevent air bubbles from being incorporated in the coating material contained in vessel 20, means are provided for blowing air bubbles from the coating material. Means for blowing air bubbles from the coating material is comprised a cylindrical perforated member 36 which can be formed of a screen having a fine mesh. Preferably, the size of the perforations is such that the coating fluid must be forced outwardly through the perforations. The material thus forced from member 36 flows down plate 91 as a thin film to pass over the edge of this plate and onto the wall 92 of vessel 20. The lower edge of plate 91 is preferably spaced a very short distance, such as 1/4 inch, from the wall 92 of vessel 20 in order that the coating material may flow onto that wall from the plate, and thence down into the body of coating fluid in vessel 20. In this manner, any air bubbles which may be in the coating material returning to vessel 20 will be broken up by evaporation of the coating material through the perforated wall of member 36, and will be removed from the coating material as the same flows along plate 91 in a thin film.

Disposed on a support attached to vessel 20 is an electrical generator 94 driven by a prime mover 93. This generating equipment is provided to make the coating apparatus fully portable. The employment of electrical motors 57a and 80 on that portion of the apparatus supported by the pipe being coated decreases the weight on the pipe, and hence decreases the weight which must be supported by the side-board of the tractor in raising the pipe off of the ground to a coating position. An electrical conductor 95 is supported by roller member 96 attached to hanger 85b and is employed to conduct electricity from generator 94 to motors 57a and 80. Member 96 is so constructed that conductor 95 can slide therethrough as pole 85 moves responsive to movement of kette 20 as the latter passes over uneven ground. Clamps 97 secure conductor 95 to the nest of conduits and provide spaced support therefor.

In discussing the operation of the apparatus of this invention, let it be assumed that the apparatus has been standing overnight and it is necessary to place it in operation. To do this, coating means 23 is fired up and continued in operation until the automatic temperature control means thereof throttles it down. At this point, the coating material in vessel 20 will be at the desired temperature and will be in a fluid state. Valve 33 is then turned so that coating material can be pumped by pump 52 through conduit 31 into passageway 28. The coating fluid will then circulate through this passageway and exit through conduit 35 to be returned to vessel 20. After the fluid has been circulated through passageways 23 until shoe 26 has been heated to the desired temperature, valve 33 is turned to discharge the coating fluid through conduit 32 into passageway 38 from which it
will flow through slot 39 onto the surface of the pipe to be coated. Motor 80 is started which causes the pipe coating apparatus to move along the length of the pipe. In so moving, coiled spring 40 will be rolled along the surface of the pipe and will accumulate a roll of fluid coating material 49 ahead of it. This roll of material insures that there will always be an adequate supply of material at all points around the periphery of pipe to fill the spaces existing between adjacent loops of the coiled spring and the periphery of the pipe. As the spring rolls along the surface of the pipe, it will leave behind it ridges of fluid coating material corresponding in size and shape to the spaces existing between adjacent loops of the spring. These ridges of coating material, immediately after the spring has passed, will, due to their fluid state and surface tension, flatten out and fill the valleys existing therebetween where the spring has rolled. In this manner, there is formed an evenly distributed coating of a uniform thickness of material over the periphery of the pipe. Inasmuch as the volume of coating material pumped through passageway 38 and slot 39 is made to be in excess of that required to coat the pipe to the desired thickness, the excess will gradually accumulate at the lower portion of the pipe 25 and will drip therefrom into the recess 47 and sump 49. The fluid accumulating in sump 49 will be withdrawn through passageway 50, conduit 51 and pump 52 to be discharged into vessel 20. In this manner, although the desired excess of coating material is maintained on the pipe surface ahead of coiled spring 40, any excess which may drip therefrom will be caught and returned to vessel 20 to avoid wastage. Gasket 83 is extended substantially to the pipe surface to enclose the forward end of the space within the shoe and prevent ready escape of coating material therethrough.

As the coating operation proceeds, motor 57a can be turned on to drive blower 57 to remove any fumes of coating material from the interior of shoe 26. Such removal will prevent the fumes from interfering with the desired observation of the operation of the apparatus and from contacting any operator who may be adjacent to that apparatus.

When it is desired to shut down the coating apparatus for a short period of time, valve 33 can be turned to cause heated coating material to flow from vessel 20 through line 31, passageway 28 and thence back into vessel 20 through line 35. In this manner, shoe 26 is maintained at an elevated temperature while coating material is not actually being applied. When it is desired to shut down the coating apparatus for an extended period of time, such as overnight, pump 30 is reversed and valve 33 turned so that conduit 31 is connected to the pump. Pump 30 will then draw fluid from conduit 35, passageway 28 and conduit 31 and discharge the same through check valve 29c into perforated member 36. Check valve 29a will prevent discharge of fluid through screen 29b. When pump 30 has removed all of the fluid which can be removed from passageway 28 and attendant conduits 31 and 35, valve 33 can be turned to permit pump 30 to draw fluid from conduit 32. After this has been done, the conduits 31, 32, 35 and 51 will be substantially empty and the coating apparatus can be permitted to stand idle and to cool to a temperature below the melting point of the coating fluid. Of course, the lower portion of passageway 38 will be filled with an coating material which, upon cooling will solidify, but this can be melted, upon resumption of operations, by circulating hot coating material through passageway 28 from kettle 20.

Referring to Fig. 5a, there is shown a preferred embodiment of the apparatus of this invention wherein an independent heating fluid is employed to heat shoe 26 and the conduits connected thereto. In this embodiment, a portion of vessel 20 is divided off from the remainder of the vessel by a wall 100 to provide a separate fluid-tight compartment 101. Compartment 101 is adapted to contain an inert heat carrier fluid 102 having a freezing point below the lowest atmospheric temperature to be encountered. Such fluid can be a suitable petroleum oil or the like which is a liquid at the temperature and pressure employed and which is stable under such conditions.

This heat carrying fluid is maintained at an elevated temperature by the conduction of heat from the hot coating material 103 through wall 100. Pump 104 can then pump the hot carrier fluid from compartment 101 through screen 105 and conduit 31 into passageway 28 of shoe 26. The carrier fluid, after circulating around through passageway 28, returns to compartment 101 via conduit 35. After shoe 26 has been heated, coating material from vessel 20 is pumped to passageway 38 and slot 39 by pump 106 via screen 107 and conduit 32. Excess coating fluid accumulating in sump 49 is returned to perforated member 36 and vessel 20 via conduit 51 and pump 52. In other respects, the operation and construction of shoe 26 and vessel 20 is the same as that described with reference to Fig. 5. Of course, conduits 31, 32, 35 and 51 of Fig. 5a are nested together in the same manner as the like numbered conduits of Fig. 5.

The operation of the embodiment of Fig. 5a is the same as that of Fig. 5 except that the heat carrier fluid passing through conduits 31 and 35 is circulated independently of the coating material passing through conduit 32. Thus, the heat carrier fluid can be circulated, if desired, not only to heat shoe 26 before coating material is pumped thereto but also to continue such heating while the coating material is passing to the shoe. When the coating apparatus is to be shut down and permitted to cool, it is not necessary that shoe 26 and conduits 31, 32, 35 and 51 be drained of coating material as is necessary with the embodiment of Fig. 5 because the employment of the heat carrier fluid, which does not solidify at atmospheric temperatures as does the coating material, permits it to be circulated through conduits 31 and 35 and shoe 26 to melt the coating material contained therein. For these and other advantages, it is preferred to employ the embodiment of Fig. 5a instead of the embodiment of Fig. 5.

As has been set forth, the apparatus of this invention is powered by electrically driven motors. Such feature particularly lends itself to ready control of the coating apparatus. Thus motor 80, which drives the coating apparatus, including shoe 26 and spring 40, along the pipe to be coated can be of the variable speed type and provision can be made of a suitable electrical control means for controlling the speed of this motor and hence the rate of travel of the coating apparatus along the pipe to be coated. In like manner, motor 30a which drives pump 30 can be of the variable speed type and can have its speed varied by suitable control means inserted in its power supply circuit. Motor 52a can be of the same controllable type. It is contemplated that the controls for these motors, as well as various temperature indicating devices, can be mounted on a central control panel 110 (Fig. 2) near a seat 111 on which an operator may seat himself in such a manner as to observe the operation of the coating apparatus and to control the same.

It is contemplated that a means for wrapping a wrapping material around the periphery of the pipe after the coating material has been applied thereto and before it has set into a solid state can be employed in conjunction with the apparatus of this invention in a conventional manner. Such means can be attached to the rear of the apparatus in a manner well known to those skilled in the art.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the structure and method.
It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. An elongated member coating apparatus which comprises, in combination, a coil spring having loops wound on a constant radius about a longitudinal axis and adapted to be disposed around the circumference of an elongated member to roll therealong, said spring being under a tension sufficient to maintain it in contact with the circumference of said elongated member but insufficient to cause those portions of the loops of the spring that said elongated member to become substantially separated one from the other, an annular shoe adapted to be disposed around said elongated member, said shoe having an annular recess on its inner side to receive said spring in such a manner that movement of said shoe along the length of said elongated member causes said spring to roll therealong, said shoe having a first annular passageway therein and having a continuous slot around its inner surface opening into said first passageway whereby a fluid can be forced through said passageway and out said slot onto said elongated member, said elongated member, means for advancing said carriage, a first portable vessel adapted to maintain a coating material at a predetermined temperature, a second portable vessel adapted to maintain a heat carrier fluid at a predetermined temperature, conducting means for passing heated coating material from said first vessel to said first passageway in said shoe, returning means for passing excess coating material from said third passageway to said first vessel, conducting means for passing heat carrier fluid from said second vessel to said second passageway, and returning means for passing heat carrier fluid from said second passageway to said second vessel, conducting and returning means being associated with each other in a heat exchanging relationship.

2. The apparatus of claim 2 wherein said coating means comprise flexible conduits having pumping means associated therewith said conduits being suspended in an inverted U-shape manner.

3. A dope shoe comprising means adapted to be positioned axially along a cylindrical member to form with the member and there around an annular chamber having an annular opening around and adjacent said member and having an inlet opening for introducing dope into said chamber and an outlet opening for allowing excess dope to flow from said chamber, means for regulating the flow of dope through said annular opening, means comprising a helical spring having its helix axis curved to double back on itself to form a closed loop, said spring being disposed within said chamber with its helical axis extending around said annular opening to encircle said member, said spring being free to rotate about its helix axis so as to roll along said member, said spring being in tension when on said member to press inwardly against the outer surface of the member, said dope being spaced apart including those parts thereof which contact said member leaving openings through which dope can flow, and means to retain said spring within said shoe as said member moves through said shoe.

4. An apparatus for applying a coating material to the external surface of an elongated member which comprises, in combination, means adapted to embrace such surface and move therealong for depositing said coating material on said surface, including a body having flanges adapted to extend inwardly toward said surface in closely spaced relation thereto to form a chamber thereover, said body being spaced apart including those parts thereof which contact said member leaving openings through which dope can flow, and means for tensioning said spring into resilient embracing relation with said surface, one of said flanges being engageable with said spring for so rolling said spring upon relative movement between said body and surface.

5. An apparatus of the character defined in claim 5, including means on said body for extending at least substantially across the space between said other flange and the surface to prevent the ready escape of coating material from the chamber.

6. An apparatus for applying a coating material to an external surface of an elongated member which comprises, in combination, means for depositing said material while in a fluid state on such surface, a coil spring extending around and engageable with said elongated mem-
be to uniformly spread and position said material over said surface upon relative movement between said depositing means and said surface, and means responsive to such relative movement for rolling said spring along said elongated member about its own axis and in contact with said material in immediately succeeding relation to said depositing means and in metering relation to said depositing means and said elongated member.

8. An apparatus for applying a coating material to an external surface of an elongated member which comprises, in combination, means for depositing said material on said surface, including a shoe having inwardly extending guides which engage with said member in a spaced relative relation thereto to form an annular chamber thereabout, and a coil spring disposed within said chamber for extension around and in rolling engagement with said member upon relative movement between said depositing means and said surface, one of said flanges being engageable with said spring for so rolling the same along said member after said coating material has been applied thereto.

9. An apparatus of the character defined in claim 8, wherein said spring is of such length that when it is extended around the elongated member those portions of the loops of the spring nearest the elongated member will be immediately adjacent to one another.

10. Apparatus of the character defined in claim 8, wherein said spring is of such length that when it is extended around the elongated member those portions of the loops of the spring nearest the elongated member will be spaced from one another.

11. An apparatus for applying coating material to a surface of an elongated member which comprises, in combination, means for embracing said surface and movable therealong for depositing said material in a fluid state on said surface as it so moves, a coil spring connected to said depositing means and so positioned with respect to said depositing means as to embrace said surface and meter over said surface the coating applied by said depositing means as said member passes the embrace of said depositing means and said spring.

12. An apparatus for coating an elongated member of generally uniform shape in cross-section, the combination with a means for embracing such member and moving therealong while depositing a coating material in a fluid state thereon, of a coil spring connected to said depositing means and so positioned with respect to said depositing means as to embrace said member adjacent said depositing means and meter over the surface of said member the coating applied by said depositing means as said member is passed through the embrace of said depositing means and spring.

13. An apparatus for applying a coating material to a surface of an elongated member which comprises, in combination, means for embracing said surface and movable therealong for depositing said material in a fluid state on said surface as it so moves, a coil spring adapted to embrace said surface, and means for moving said depositing means and rolling said spring along said surface with said spring in immediately succeeding relationship to said depositing means to meter over said surface the coating applied by said depositing means as said member passes the embrace of said depositing means and said spring.

14. The apparatus of claim 13 wherein said spring is formed of loops of wire having such a transverse cross-section that when adjacent loops are in abutting relation with each other and the elongated member, a space will be formed between the abutting loops and the elongated member.

15. The apparatus of claim 13 wherein said spring is formed of loops of wire having a triangular transverse cross-section with the apex facing outwardly from said coil.

16. The apparatus of claim 15 wherein the triangular transverse cross-section is isosceles with the apex being between the sides of equal length and wherein the height of said triangular cross-section to said apex is substantially twice that of the desired thickness of said coating material when uniformly spread on said elongated member.

17. In an apparatus for coating an elongated member wherein means are provided for depositing a coating material onto said elongated member, a coating spreader comprising a coil spring adapted to roll along said elongated member to uniformly spread and position said material over said elongated member, said coil spring having its loops closely wound at a constant radius about its axis said loops being of a width having a transverse cross-section with at least two plane sides joining at an apex, said apex being situated to face radially outward from said coil spring, and means for moving said depositing means and rolling said spring in immediately succeeding relation along said elongated member with said spring in coating metering relation to said depositing means and said elongated member.

18. An apparatus for coating an elongated member which comprises, in combination, a vessel adapted to maintain a coating material in a fluid condition at an elevated temperature, means for depositing coating material while in a fluid state onto said elongated member, means disposed in collecting relation to said depositing means for collecting any excess coating material from said elongated member, means for heating said depositing means with heated material from said vessel, means for conducting heated material from said vessel to said depositing means and said heating means, and separate means for returning heated material from said heating means and said collecting means to said vessel, said conducting means and said returning means being disposed in heat exchange relationship with each other.

19. An apparatus for coating an elongated member which comprises, in combination, a vessel adapted to maintain a coating material in a fluid condition at an elevated temperature, means for maintaining a separate heat carrier fluid at an elevated temperature, means connected to said vessel for receiving heated coating material therefrom and depositing said coating material while in a fluid state onto said elongated member, means disposed in collecting relation to said depositing means for collecting any excess coating material from said elongated member, means adjacent to said depositing means for heating said depositing means with heat carrier fluid, means for conducting heated coating material from said vessel to said depositing means, separate means for returning connected coating material from said collecting means to said vessel, separate means for conducting said heat carrier fluid to said heating means from said means adapted to maintain said heat carrier fluid at an elevated temperature and separate means for returning the same to the latter, said conducting means and said returning means being disposed in heat exchange relationship with each other.

20. An apparatus for applying a coating material to the external surface of an elongated member which comprises, in combination, means for embracing the surface to be coated and movable along said member for depositing said material in a fluid state on said surface, a coil spring engageable with freshly deposited material on said surface and movable longitudinally of the axis of said elongated member to closely embrace the surface and uniformly spread and position said material over said surface upon relative movement between said depositing means and said surface, and means connected to said depositing means and responsive to such relative movement for rolling said spring about its own axis along said surface in immediately succeeding relation to said depositing means and indirect metering engagement with the freshly deposited coating material in fluid state.
21. An apparatus for coating the surface of an elongated member which comprises, in combination, a carriage adapted to be propelled along the length of said member, means attached to said carriage for depositing a coating material in a fluid state on the surface to be coated, a coil spring having loops of constant radius of curvature engageable with said member for rolling therealong, means responsive to propelling of the carriage along the length of the member for rolling said spring over said surface having said material deposited thereon, and means for collecting any excess material dropping from said member, said carriage including a shoe having inwardly extending flanges adapted to surround the member in closely spaced relation thereto to form an annular chamber thereabout, and one of said flanges being engageable with said spring upon propelling of said carriage for rolling said spring along the member.