

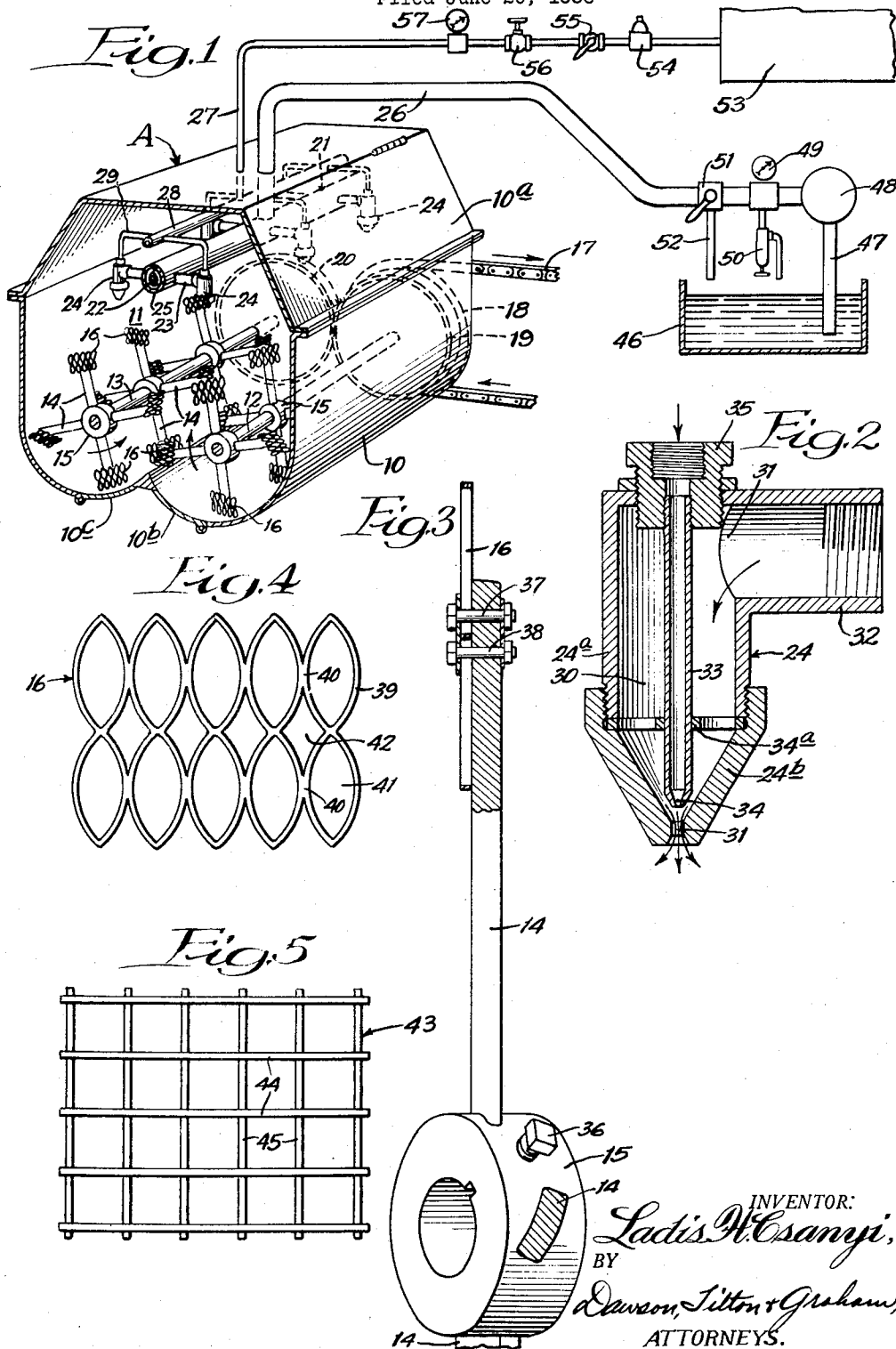
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APPARATUS FOR MIXING FINELY-DIVIDED SOLIDS WITH LIQUIDS

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1

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APPARATUS FOR MIXING FINELY-DIVIDED SOLIDS WITH LIQUIDS

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This invention relates to apparatus for mixing finely-divided solids with liquids. Apparatus constructed in accordance with this invention will have particular utility for distributing plastic binders in liquid form or other relatively viscous liquids over the surfaces of finely-divided solids. For example, the apparatus of the invention can be used to prepare a pulverulent mastic from a bituminous binder and a mineral aggregate. Many other specific applications, however, will occur to those skilled in the particular arts to which this invention pertains.

For some purposes, liquids have heretofore been mixed with finely-divided solids by spraying the liquids into mechanical mixers within which the solids are being stirred and agitated. So-called "pug mills" have been used in this way for preparing bituminous paving mixes, but the results have not been completely satisfactory. It is a specific object of this invention to provide an improved apparatus for preparing paving mixes and other types of bituminous mastics, which apparatus will also have other applications in the mixing of finely-divided solids with liquids. Further objects and advantages will appear as the specification proceeds.

This invention is shown in illustrative embodiments in the accompanying drawing, in which—

Figure 1 is a cut away perspective view of the mixing apparatus constructed in accordance with this invention together with certain auxiliary equipment which is shown somewhat diagrammatically for purpose of clarity; Fig. 2, a detailed sectional view of one of the foaming spray nozzles of the apparatus of Fig. 1; Fig. 3, an enlarged detailed side view, partly in section, of one of the mixing arms and fluffing tips of the apparatus of Fig. 1; Fig. 4, an enlarged front view of one of the fluffing tips as shown in Figs. 1 and 3; and Fig. 5, an enlarged front view of a modified form of a fluffing tip which can be substituted for the tip of Fig. 4.

As already indicated, this invention is concerned with an apparatus for mixing finely-divided solids with liquids. In the preferred embodiments of the invention, the casing will usually be employed to provide a mixing chamber and one or more rotatable shafts will be extended through a portion of this chamber. A plurality of outwardly-projecting mixing arms will be carried by the shaft means and arranged thereon with respect to the chamber casing to cast the finely-divided solids from the lower to the upper portions of the chamber when the shaft means is rotated at a high velocity. There will also be provided nozzle means for spraying liquids into the upper portion of the chamber, and the nozzle means will include elements therein for combining liquids with gases under pressure within the nozzle means and thereby forming the liquids into dispersed foams as they are sprayed from the nozzle means. Still further advantages can be obtained where the mixing arms are equipped with fluffing tips having a perforated, open construction.

Looking first at Fig. 1, there is shown a mixing apparatus A having a casing 10 which provides a mixing

2

chamber 11 therein. Laterally spaced-apart shafts 12 and 13 extend across the lower portion of chamber 11. It will be understood that the ends of these shafts are mounted in suitable bearings so that they can be rotated at high velocities. Each shaft is provided with a plurality of outwardly-projecting mixing arms 14 which are attached to hubs 15 that are rigidly locked to shafts 12 and 13. The arms 14 on each shaft are arranged to intermesh with the arms on the other shaft, as indicated in Fig. 1. Preferably, the outer ends of arms 14 are equipped with sieve plates 16. As indicated in Fig. 1 and shown more clearly in Fig. 3, sieve plates 16 are disposed in angular relations to the rotational planes of the arms about shafts 12 and 13. Means is provided for simultaneously rotating shafts 12 and 13 in opposite directions with the arms 14 on each shaft moving upwardly during the intermeshing thereof, as indicated by the rotational arrows in Fig. 1. In the illustration given, a chain 17 drives a sprocket wheel 18 on the end of shaft 12, which shaft end also carries a gear wheel 19 that drives an opposed gear wheel 20 on shaft 13, thereby rotating shaft 13 at the same velocity but in an opposite direction from shaft 12.

Within the upper portion of chamber 11 is supported a structure which can be collectively designated as a spray bar 21. More specifically, spray bar 21 includes a liquid distribution manifold 22 communicating with a plurality of outwardly extending branch pipes 23 on the end of which are mounted nozzles 24. Distribution manifold 22 is encased in a jacket 25 to which heating fluid can be supplied when desired. The liquid to be sprayed is supplied to manifold 22 through conduit 26. The gas or liquid foaming agent for foaming the liquid as it is sprayed is supplied through conduit 27 to another manifold 28 from which it is distributed to the nozzles 24 through branch pipes 29.

Figure 2 shows the interior construction of nozzles 24. These nozzles include a body portion 24a and a tip portion 24b which together provide interiorly a flow chamber 30. Tip portion 24b has a restricted orifice 31 communicating with flow chamber 30 on its inside and discharging to the atmosphere on its outside. Body portion 24a is adapted to supply liquid to flow chamber 30 from pipe 23 through nipple extension 32. Preferably, tip portion 24b consists of a conical fitting which is threadedly connected to body portion 24a, and the outer ends of elbow extension 32 are interiorly threaded for connection to pipe 23. Nozzle 24 also includes a gas or foaming agent supply tube or conduit 33 which extends through chamber 30 from the top thereof to a point adjacent the inside of orifice 31. Conduit 33 terminates in an outlet 34 which is within tip portion 24b and which is oriented toward orifice 31. In the illustration given, the centered relation of conduit 33 within chamber 30 is established by ring 34a which slidably receives conduit 33. The upper end portion of conduit 33 is threadedly connected to a plug fitting 35, which in turn is threadedly connected to the top wall of body portion 24a. The outer interior portion of plug 35 is threaded to receive the threaded ends of foaming agent-distribution pipes 29. It will be seen that the conduit 33 can be advanced toward or retracted from orifice 31 by the rotation of plug connector 31, and a further adjustment can be made, if desired, by rotating conduit 33 with respect to plug 35. It will be understood that centering ring 34a is provided with cut-out segments so that the upper and lower portions of the chamber 30 are in open communication.

The constructional details of arms 14, hubs 15, and tip portions 16 are shown more clearly in Fig. 3. The arms 14 are rigidly connected to hub 15, and the hub is provided with a locking screw 36 for securing it to the shaft 12 or 13. Fluffing tip or sieve plate 16 is de-

tachably bolted to the outer end portion of arm 14 as indicated at 37 and 38. The perforated, open construction of tip 16 is shown more clearly in Fig. 4. In this embodiment, the sieve plate is formed of an expanded metal which provides an interlacing network of solid strip portions 39, 40, etc., and openings 41, 42, etc. Figure 5 shows a modified tip construction 43, which consists of a welded wire form having interlacing horizontal wires 44 and vertical wires 45, the wires being welded together at their intersections to provide a rigid construction. Other open tip constructions, such as perforated plate tips, can be used while still achieving some of the advantages of this invention.

The auxiliary liquid supply equipment, as shown in Fig. 1, consists of a liquid measuring device 46, a suction line 47, a pump 48, a pressure gauge 49, a pressure relief valve 50, an operating valve 51, and a circulating line 52. The auxiliary foaming agent supply equipment associated with line 27 includes a supply source 53, a pressure regulator or control 54, an operating valve 55, a volume control valve 56, and a pressure gauge 57.

Operation

The operation of the device for purpose of illustrated can be described in connection with the production of a bituminous paving mix. It will be understood that many of the steps will be in accordance with the usual practice for preparing such mixes, and therefore it will not be necessary to elaborate on the details of these steps. The mineral aggregate will be measured and heated in the usual way, and then introduced into the lower portion of chamber 11. In the illustration given, this can be done by opening hinged lid 10a, and dumping the heated aggregate into chamber 11. The proportion of bituminous binder, usually an asphalt, for combining with the aggregate will be measured at 46, and maintained in a heated or liquid condition for introduction into chamber 11. Steam at a pressure of 80 to 90 p. s. i. (gauge pressure) should be available at 53. The power source (not shown) for driving chain 17 is then started, causing shafts 12 and 13 to rotate at a high velocity and cast the particles of mineral aggregate into the upper portion of chamber 11. In this operation, the tips 16 on the arms 14 will dig or comb through the aggregate, breaking up any agglomerations of particles, and raising and fluffing the particles of solid material into a uniformly dispersed cloud of particles above the highest level of rotation of the tips 16. It will be understood that the peripheral speed, angle of set, and clearances of the tips 16 can be adjusted to achieve the proper digging, pulverizing, fluffing and dispersing effects for the particular mixing operation.

After the shafts have been in rotation for a short time and the particles of aggregate are being repeatedly cast into the upper portion of the chamber 11 to provide a substantially uniform particle dispersion therein, pump 48 is started and the asphalt operating valve 51 is opened. At the same time, the steam operating valve 55 is opened so that both steam and liquid asphalt are supplied to the nozzles 24. Usually, it will be desirable to have the steam pressure slightly higher than the liquid pressure. For example, when steam is supplied at 80 to 90 pounds (p. s. i.), the liquid can be pumped at 320° F., or whatever temperature is required to keep it in liquid condition, and at a pressure of from 50 to 80 p. s. i. These pressures and temperatures can, of course, be varied to adapt the apparatus to particular operating requirements. It is one of the advantages of the apparatus of this invention, however, that high pumping pressures are not necessary, and that both the steam and liquid asphalt can be easily handled at pressures under 100 pounds (p. s. i.). Under such conditions, the steam is injected as a jet into the flowing stream of asphalt as it approaches the nozzle orifice 31. This produces an instantaneous mixture of the steam with the liquid

asphalt, and as the pressure on the mixture is released during its passage through orifice 31, the asphalt is formed into a dispersed form consisting of a multiplicity of tiny bubbles. Further, these bubbles tend to separate from each other by the divergence of the sprayed streams as they issue from the nozzles 24. Consequently, the minute bubbles of liquid asphalt are brought into contact with the dispersed and suspended particles of the aggregate within the upper portion of chamber 11. Upon collision of the bubbles with the solid particles, the bubbles are collapsed thereupon and film over the surface of the particles due to the stored energy of the bubbles. The mechanics of this system are such that the efficiency of the coating operation is substantially independent of the energy of impact between the particles and the bubbles. After the aggregate has been coated with asphalt in this manner, the supply of steam and liquid asphalt to chamber 11 is terminated, and the mixture is discharged from chamber 11 by opening sliding doors 10b and 10c.

In practice, certain refinements on the process as described above may be desirable. For example, it may be desirable to make preliminary adjustments of the positions of steam conduits 33 in relation to nozzle orifices 31. Bituminous binders vary considerably in physical properties, and it may therefore be desirable to vary the rates of pumping of the binder through the nozzles for different binders. Further, the characteristic of the dispersed foam and the cloud of binder bubbles may be adjusted to the desired degree and character by adjusting the distance between the tip of the steam injector conduits 33 and the nozzle orifices 31. Additional adjustments may be desirable on the steam line, such as at regulator 54 or volume control valve 56, depending upon the particular steam source employed. It is desirable that the steam system operating valve be synchronized with the operating valve of the asphalt system. It may be desired, however, to begin the flow of steam prior to the flow of asphalt, thereby clearing the nozzles of any residual asphalt therein. Similarly, the flow of steam may be continued for a short interval after the liquid flow is terminated to clear the nozzles and form any residual binder in the nozzle tips. The number of nozzles and their arrangement should be such that the dispersed foamed binder is uniformly distributed over the fluffed and agitated particles of the mix. The fluffing and dispersion of the particles by the sieve plates 16 permits ready access of the bubbles of binder to the particles, and gives further assurance that an even distribution of the asphalt will be obtained and that the particles will be completely and thoroughly coated.

The mixes produced by the method can utilize ungraded aggregates in producing suitable bituminous mixes for paving, pavement bases, flooring and other purposes. The apparatus can also be used to produce bituminous mastics for roofing, water-proofing and sealing purposes. Further application is in the preparation of soil stabilization mixes. Such mixes can be prepared more readily and more uniformly because the foamed binder can penetrate more deeply into the mass of material than the same liquid binder. The apparatus can also be used for distributing many types of liquids over the surfaces of finely-divided solids. For example, thermoplastic resins can be coated on solids in this manner; as well as drying fatty oils, etc. The solids can be vegetable or organic materials as well as minerals.

As already indicated, one of the outstanding advantages of the apparatus of this invention is that it provides a means for completely, thoroughly, efficiently coating solids with viscous liquids without requiring the use of high pressures. This is particularly important in the handling of liquids at high temperatures, such as molten asphalt, where the use of high temperatures can be extremely dangerous. This is possible because the efficiency and char-

acter of the coating operation is not determined by the agency of impact between the sprayed liquid and the solid particles. The foamed binder is self-spreading due to the energy of the bubbles. The thinness of the bubble walls provides a further advantage in producing thinner or film-type coatings on the particles than would otherwise be obtained even at high spray pressures. The energy of solid drops of liquids is such that the drops provide an inherent resistance to being distributed on the surfaces of solid particles, and this resistance can only be overcome by bringing the solid drops and particles together at high impact energies and at high temperatures. On the other hand, in the case of liquid bubbles, the natural forces of surface tension and interfacial tension act to produce extremely thin films on a solid particle at the moment it ruptures the bubble. This is highly advantageous since it is recognized that extremely thin films of material will adhere to a surface more tenaciously than thicker films. It can thus be seen that the apparatus of the present invention can be advantageously employed in coating solid particles with any binder or liquid which can be formed into a foam with steam or other gas or foaming agent.

While in the foregoing specification this invention has been described in relation to certain specific embodiments thereof and many details have been set forth for purpose of illustration, it will be apparent to those skilled in the art that the invention is susceptible to other embodiments and that many of the details described herein can be varied considerably without departing from the basic principles of the invention.

I claim:

1. In an apparatus for combining a bituminous binder with an aggregate material, including a casing providing a space wherein said bituminous binder and said aggregate material are mixed, nozzle means for discharging said binder into said space in a foamed condition, said nozzle means comprising a plurality of nozzles, each of said nozzles having a body portion and a tip portion providing a flow chamber therein, said tip portion having a restricted orifice passage communicating with said flow chamber on its inside and discharging to the atmosphere on its outside, said body portion having an inlet for supplying a liquified bituminous binder to said flow chamber, and a steam supply conduit extending to a point adjacent the inside end of said orifice passage, said conduit terminating at an outlet which is within said tip portion and which is oriented towards said orifice.

2. The apparatus of claim 1 wherein said apparatus also includes a rotatable shaft means extending through said mixing space which is provided with a plurality of outwardly-projecting mixing arms, and which apparatus is characterized by the further fact that said mixing arms are equipped with fluffing tips of a perforated, open construction.

References Cited in the file of this patent

UNITED STATES PATENTS

592,708	Howe	Oct. 26, 1897
2,043,599	Waldschmidt	June 9, 1936
2,726,852	Sommer	Dec. 13, 1955