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APPARATUS FOR BITUMINOUS MIXING

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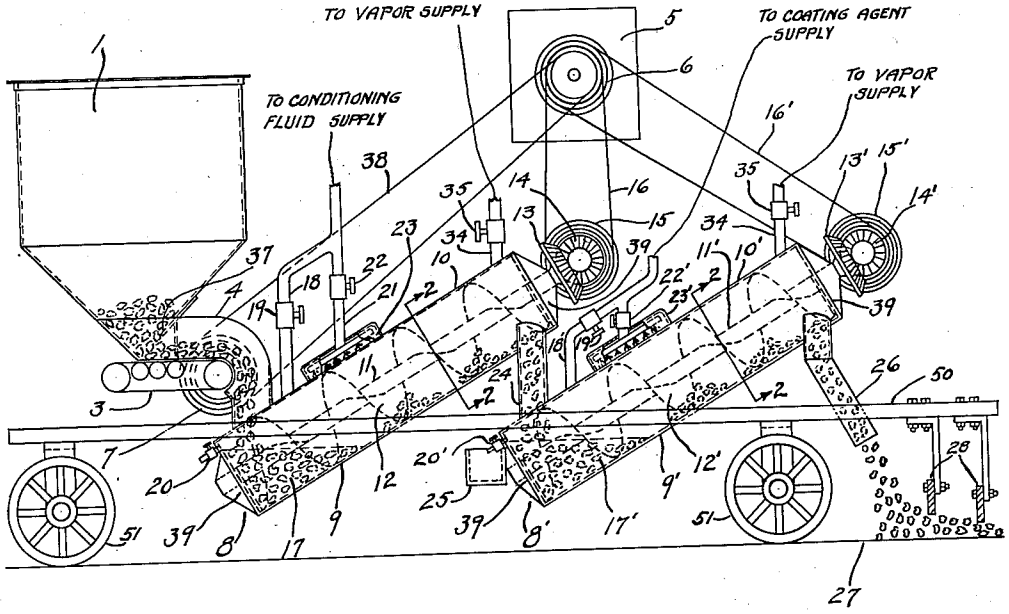


Fig. 1

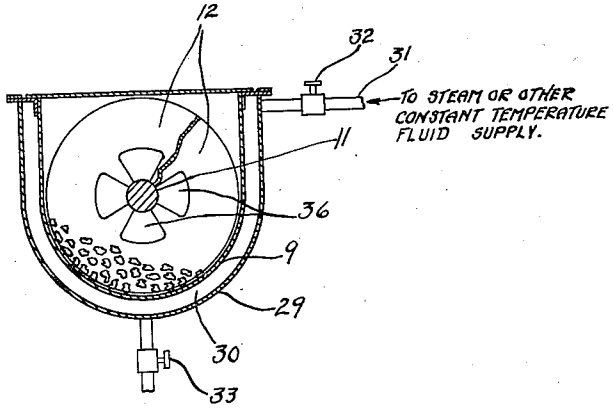


Fig. 2

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APPARATUS FOR BITUMINOUS MIXING

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9 Claims. (Cl. 94—43)

This invention relates to bituminous mixing, and more specifically to methods and apparatus for mixing bituminous binding material with an aggregate of pieces of solid matter. While no limitation thereto is intended, the invention contemplates particularly the coating with a bituminous binding agent of an aggregate of crushed stone, sand, gravel, slag, sawdust, cork or the like, as for the construction of traffic bearing surfaces, playing areas and the like. Such coating is at present carried on either by laying the aggregate in final place and flowing thereon the bituminous binder, by mixing predetermined quantities of the aggregate and binder either approximately in final position or in a mixing plant, or by dipping the aggregate in a bath of the binding agent followed by drainage of the aggregate. These systems may be respectively designated as "penetration", "mix-in-place" or "plant-mix", and "dip" systems; and while our invention is particularly adapted to employment in the last mentioned of these systems, certain aspects thereof are useful with any of them.

The invention is particularly suited for use with binding agents in emulsion form—i. e., wherein the bitumen particles themselves are held in suspension in a liquid vehicle which separates therefrom under suitable conditions (such for example as exposure to air), leaving the binding agent in a hardened state (this separating action being commonly termed "breaking"). It will be understood, however, that our invention is not restricted to such emulsion binding agents, but contemplates also other binding agents in which the bitumen is contained in a liquid vehicle, such for example as "cut-back" agents—i. e., bitumen particles dissolved in a volatile oil.

In the present practice of the "penetration" and "mix-in-place" or "plant-mix" systems of coating abovementioned it is customary to determine the amount of bitumen proper to be employed in the binding agent for a given quantity of aggregate in accordance with the aggregate volume or weight and with the average size of the aggregate particles. This is done in an effort to base the bitumen quantity on the total aggregate particle area. Such a method obviously fails, however, to take into account the widely varying surface areas of aggregate pieces which may be classified as of the same size by conventional standards (usually screen tests), and requires continuous weighing or other apportioning of aggregate and binding agent. In the "dip" system of coating an attempt is made more directly to base the bitumen quantity on the area of the aggregate, the latter being dipped into a greater quantity of binding agent than required for its proper coating, and thereafter drained. We have found, however, that the "dip" system will accomplish the ultimately desired object—that of coating the aggregate with a uniform quantity of bitumen per unit piece area—only if various conditions prior to, during and following the application of the binding agent to the aggregate are properly established and maintained, and our invention is directed to the establishment and maintenance of these conditions.

Accordingly it is a broad object of our invention to provide improved methods and apparatus for coating aggregate with bituminous material.

It is another object of our invention to provide methods and apparatus for effecting on aggregate a bituminous coating improved in uniformity of bitumen quantity per unit aggregate piece area, independent of variations in the size of the aggregate pieces.

It is a further object to provide improvements particularly adapted to the "dip" system abovementioned.

It is a still further object to provide means and methods for establishing and maintaining suitable conditions of aggregate and binding agent prior to, during and following the application to the aggregate of the binding agent.

Another object is the provision of an improved portable bituminous mixing plant. Allied and subdivisional objects will more fully appear from the following description and the appended claims.

While the most fundamental aspects of our invention transcend the use of particular apparatus, they may be most readily described in connection with apparatus specifically designed for their use, and which is also a part of our invention. Such apparatus is shown in the accompanying drawing, of which

Figure 1 is a view, partly elevation and partly schematic, of a machine for coating aggregate with bituminous material, and

Figure 2 is a cross-sectional view taken along the lines 2—2 of Figure 1, in which certain optional components also appear.

Reference being had to Figure 1, there will be seen a hopper 1 into which the aggregate to be coated may be loaded. The sides of the hopper may be made convergent toward the bottom, and here may be provided a regulable gate 37 whereby the flow of aggregate from the hopper may be controlled. This flow may take place onto an endless belt conveyor 3, at the sides of which

may be provided conventional skirt-boards 4 and which is driven, preferably at regulable speed, from any suitable source of motive power. The speed may be conveniently adjusted so that the aggregate is carried off at a rate less than that at which it tends to flow through the gate. As an example of driving means, and in a schematic manner only, we have shown a motor 5 driving master pulley 6 having sections of a variety of diameters, a multi-section pulley 7 on the conveyor 3, and a belt 38 operable selectively over a variety of combinations of sections in pulleys 6 and 7 and thus providing a regulable speed drive for the conveyor. The function of the apparatus thus far described is to discharge the aggregate in a relatively continuous, regulable flow into the second portion of our apparatus; and it will be understood that there may be substituted for the hopper 1 and conveyor 3 any other suitable means for providing such a flow into this second portion, hereinafter described.

A very significant factor governing the amount of bitumen coating which will be acquired by each unit area of aggregate particle upon application thereto of the binding agent is the condition of the surface of each particle at the moment of such application in respect of cleanliness, of temperature, and most importantly of surface moisture per unit particle area. According to our invention the aggregate is pre-treated, or pre-conditioned, in a manner substantially uniform with respect to surface area, preferably immediately preceeding the application thereto of the binding agent. An embodiment of this pre-conditioning is the immersion of the aggregate pieces in a suitable liquid followed by their drainage for a predetermined time. The second portion of our apparatus is designed for carrying out this and other embodiments of the pre-conditioning process.

This portion may comprise an inclined screw conveyor 8. This has been illustrated as including a trough 9 with closed ends 39, a cover 10, a shaft 11, and a single continuous helicoid flight or vane 12 carried by the shaft. It will be understood of course that the design of this conveyor may be considerably modified, it being intended to illustrate a device whereby the aggregate may be carried upwardly in a continuous or substantially continuous flow. Thus for example a screw conveyor having multiple helicoid flights, or single or multiple sectional flights, or a conveyor of the inclined drag type might be substituted for the one illustrated. Figure 2 illustrates a cross section of the conveyor 8, and therein will be seen apertures 36 in the flight or vane 12 near the shaft 11 to aid in the drainage of liquid from the shaft and flight and aggregate being thereby moved. The usual slight separation of the periphery of the flight from the inside of trough 9 further aids this drainage. The shaft 11 may be rotated in any suitable manner, preferably at regulable speed; and schematically we have shown a bevel gear 13 carried by the shaft 11 and engaging a bevel gear 14 driven by multi-section pulley 15, which in turn may be driven as through belt 16 from multi-section pulley 6, as in the case of conveyor 3.

In the lower corner of the conveyor 8 formed by the trough 9 and the lower end member 39 may be maintained a constant depth bath, schematically indicated as 17, of the pre-conditioning liquid, as by its introduction in regulable flow through pipe 18 and valve 19 and its overflow or escapement through outlet valve 20. If desired there may also be provided means for spraying the pre-conditioning liquid onto the aggregate at a point in the conveyor above the bath 17, for purposes of the better removal of dirt or other foreign material from the surface of the aggregate pieces. Thus we have shown a pipe 21 leading a flow of pre-conditioning liquid regulated as by valve 22 to a spray system 23, which may conveniently be internally carried by the cover 10.

The aggregate is discharged into the bottom of conveyor 8 and hence into the bath 17. The shaft 11 is being continuously rotated and the flight 12 both agitates the aggregate and carries it out of the bath 17 and up the incline formed by the trough 9, in a relatively uniform and continuous flow. During the travel of the aggregate after leaving the bath 17 drainage thereof is of course taking place; and both the relative uniformity of the flow and the agitation of the aggregate during the flow insure quite similar drainage for all the aggregate pieces. This similar drainage of the several pieces, both in the conveyor 8 and in the corresponding element in the third (or actual coating) portion of our apparatus hereinafter described, we conceive to be a very desirable feature. If the spraying system 23 be employed it will be understood that the effective drainage time will be reduced, but the substantial uniformity of the treatment of the several aggregate pieces will be essentially unimpaired. The actual degree of drainage and hence the surface moisture per unit area of the aggregate as it reaches the discharge tube 24 at the upper extremity of trough 9 may be regulated by adjustment of the speed at which the conveyor operates.

It will be obvious that the effect of our immersion and/or spraying of the aggregate in and/or with pre-conditioning liquid may be described as "super-saturating" the aggregate surface with such liquid, and that a function of the subsequent drainage is the reduction of this excessive surface moisture.

When emulsion binding agents are employed water may very satisfactorily be employed as the pre-conditioning liquid. With "cut-back" binding agents a satisfactory pre-conditioning liquid may be an oil or other liquid such as is employed as the vehicle of the binding agent itself. In other words in either case the pre-conditioning liquid may satisfactorily be similar to the vehicle of the binding agent. As a particularly desirable degree of drainage of a typical aggregate, such as crushed stone, we may mention one which provides surface saturation of the aggregate pieces as discharged through tube 24, but without the presence of free liquid or drippings. It will be obvious that we use the term "surface moisture", and its special case of "surface saturation", as denoting the degree of presence on the aggregate surface of the pre-conditioning liquid, whether or not this be water.

The discharge through tube 24 may take place into the third portion of our apparatus. This may conveniently comprise another conveyor similar to a form available for conveyor 8, and we have therefore shown a screw conveyor 8' with portions 9', 39', 10', 11', 12', 13', and 14' respectively analagous to the correspondingly numbered portions of conveyor 8. A multi-section pulley 15' and a belt 16' may for example supply motive power at regulable speed to the conveyor 8'. In the angular bottom thereof may be maintained a constant depth bath, schematically indicated as 17', of the binding agent, as by the

introduction of the agent in regulable flow by pipe 18' and valve 19' and its overflow or escapement through outlet valve 20'. In the case of the pre-conditioning liquid in conveyor 8 it may be desirable to maintain a constant outflow of the liquid through outlet valve 20, in order to carry off impurities which may be washed by the pre-conditioning liquid from the aggregate surface. In the case of the binding agent in conveyor 8', however, it is desirable to adjust the inflow, as by valve 19', so that the normal level of the path 17' may be maintained without appreciable outflow through valve 20'. Such overflow as may occur may be salvaged in receptacle 25. A spraying system 23' similar to the system 23 on conveyor 8 may be provided in conveyor 8' if desired, as an optional substitute for or addition to the inlet pipe 18'.

The pre-conditioned aggregate being discharged into the bath 17' of binding agent and the shaft 11' of conveyor 8' being continuously rotated, the flight 12' both agitates the aggregate and carries it upwardly out of the bath as in the case of conveyor 8. Further as in that case substantial uniformity of drainage of the several aggregate pieces is obtained. The adjustment of the speed of operation of conveyor 8' will determine the condition of the coating on the aggregate as discharged through outlet 26 located at the upper extremity of the trough 9'. The speed may therefore be established according to the condition of the coating desired for the work being performed—e. g., in the case of emulsion binding agents the adjustment of speed of conveyor 8' will determine the degree to which "breaking" of the coating on the discharged aggregate has proceeded.

While the speeds of operation of the individual portions of our apparatus have been severally discussed, certain limitations on relative speeds between them should not be exceeded. Thus in the case of either of the screw conveyors 8 and 8' operating at a given speed, a high rate of inflow of aggregate, although actually somewhat below the absolute clogging limit, may tend to impair the uniformity of drainage in that conveyor. After determination of the speed of conveyor 8' as above outlined the speed of conveyor 8 may be adjusted in the light of this limitation; if too great a degree of drainage occur in conveyor 8 by reason of an enforcedly slow speed, the spray system 23 may be called on to reduce the effective drainage time. Upon adjustment of the speed of conveyor 8 the inflow thereto is readily regulated to an appropriate rate by adjustment of speed of belt conveyor 3, and finally the hopper gate 37 may be adjusted to a sufficiently open position to insure the desired flow onto the last mentioned conveyor.

The discharge of coated aggregate through the outlet 26 may if desired take place merely into convenient receptacles. We have illustrated our entire apparatus, however, as a unit mounted on platform 50 which in turn is mounted on wheels 51. The entire assemblage while in operation may therefore be moved along a surface which it is desired to cover with the coated aggregate, such as schematically indicated road surface 27. The discharge from outlet 26 may then take place directly onto this surface and be levelled by spreaders, such as 28 which are shown carried by the platform 50 and therefore moved integrally with the rest of the apparatus.

Our invention non-limitatively contemplates substantial constancy of the humidity of the atmosphere from which the aggregate is discharged into the binding agent, whereby the uniformity of the pre-conditioning is enhanced, and constancy of the humidity of the atmosphere in which the coated aggregate drains, whereby the uniformity of degree of "breaking" or hardening of the coating is improved. Looking toward the maintenance of this constant humidity in these two cases we have provided the conveyors 8 and 8' with covers 10 and 10' respectively, so that the circulation of outside air therein is reduced to a reasonable minimum. The humidity within each conveyor then tends to be established by the evaporation (from bath 17 or 17' as the case may be and from the draining aggregate) taking place in the particular temperature prevailing within the conveyor. We alternatively or additionally contemplate, however, a more positive control of humidity. Thus we have shown in Figure 1 a pipe 34 and valve 35 leading into each of the conveyors 8 and 8' by which uniformly moist vapor may be introduced in regulable flow.

It is to be noted that if a constant, relatively high humidity be maintained in the conveyor 8' the degree of "breaking" or hardening of the coating of the aggregate as discharged will be relatively slight, which is a usually satisfactory condition; at the same time "breaking" or hardening of the binding agent which may tend to adhere to the interior parts of the conveyor will be minimized, aiding in the drainage of the binding agent from these parts and reducing the frequency with which cleaning thereof will be required. As to conveyor 8, the maintenance of such a humidity will of course decrease the effective drying of the aggregate during drainage.

Optional elements of our invention are the control of the temperature of the aggregate as introduced in the bath of binding agent, whereby the aggregate is still more uniformly pre-conditioned; the control of the temperature of the coating bath, whereby its viscosity is most uniformly maintained; and the control of the temperature of the aggregate while draining after the bath, whereby the most uniform degree of "breaking" or hardening of its coating before final use is obtained. It may be noted that with a pre-conditioning liquid supply of constant temperature the first of these controls is inherently at least partially effected. As further and/or alternative means of effecting these controls, however, we have shown in the cross-sectional Figure 2 a member 29 surrounding and in spaced relation to the trough 9 and forming a jacket 30 thereabout. Into this jacket, preferably near the top of the incline, may be introduced steam or other constant temperature fluid (air or water of controlled temperature for example) as through pipe 31 and valve 32. Outlet valve 33, preferably located at the bottom of the incline, may carry off condensation and excess.

Such a jacket and fluid supply may be employed with either or both the conveyors 8 and/or 8'. The employment thereof with conveyor 8 not only will serve to control the temperature of the aggregate as introduced into the coating bath, but will also make more flexible the control of surface moisture per unit area of the aggregate at this point. It will be understood that such temperature control with the conveyor 8', in the case either of emulsion or "cut-back" binding agents, will increase not only the uniformity of binding agent viscosity but also the uniformity of condition of the coating on the aggregate as discharged through outlet 26.

Preferably in either of these cases a moderate temperature is maintained by the control.

While we have indicated the functions of the various controls contemplated by our invention and have suggested desirable adjustments thereof for use in particular cases, the wide variations in nature of aggregate, in types and characteristics of binding agents and in nature and thickness of coatings desired for particular purposes, make it necessary that the controls be adjusted in the light of all these circumstances as they may exist in a particular case. It will be understood, however, that upon determination of any desirable adjustments of drainage times (e. g., conveyor speeds), humidities, temperatures, etc., for a particular coating, this coating may be duplicated at any time by a duplication of those adjustments. Thus these various factors may be predetermined and particular coatings repeatedly duplicated, without the necessity of making allowances for outside temperatures and other atmospheric conditions as they may exist at the time of coating, and as they may have existed for a space of time prior thereto (with consequent effect on the surface characteristics of unconditioned aggregate).

While we have described and illustrated our invention in terms of specific embodiments thereof, we do not intend any limitation thereby, but rather indicate by the following claims the intended scope of our invention.

We claim:—

1. In combination in a machine for coating aggregate with a liquid vehicle bituminous binding agent: means for imparting a uniform surface moisture to the aggregate comprising aggregate surface super-saturating means, conveyor means for draining the aggregate while conveying the same from said super-saturating means, and aggregate agitating means included in said draining means; and means for applying the binding agent to the surface of the aggregate, said draining means being connected directly with said applying means for the discharge thereinto of surface moist aggregate.

2. In combination in a machine for coating aggregate with a liquid vehicle bituminous binding agent: means for imparting a uniform surface moisture to the aggregate comprising aggregate surface super-saturating means, conveyor means for draining the aggregate while conveying the same from said super-saturating means, and aggregate agitating means included in said draining means; means for applying the binding agent to the surface of the aggregate, said draining means being connected directly with said applying means for the discharge thereinto of surface moist aggregate; and conveyor means for draining the aggregate while conveying the same from said applying means.

3. In combination in a machine for coating aggregate with a bituminous binding agent in emulsion form: means for imparting a uniform surface moisture to the aggregate comprising means for super-saturating the aggregate surface with water, conveyor means for draining the aggregate while conveying the same from said super-saturating means, and aggregate agitating means included in said draining means; means for applying the binding agent to the surface of the aggregate; and aggregate discharging means leading directly into said applying means from a point in said draining means at which the aggregate is surface moist but devoid of free liquid and drippings.

4. In combination in a machine for coating aggregate with a bituminous binding agent in emulsion form: means for imparting a uniform surface moisture to the aggregate comprising means for super-saturating the aggregate surface with water, conveyor means for draining the aggregate while conveying the same from said super-saturating means, and aggregate agitating means included in said draining means; means for applying the binding agent to the surface of the aggregate; conveyor means for draining the aggregate while conveying the same from said applying means; and aggregate discharging means leading directly into said applying means from a point in said first-mentioned draining means at which the aggregate is surface moist but devoid of free liquid and drippings.

5. In combination in a machine for coating aggregate with a liquid vehicle bituminous binding agent: means for imparting a uniform surface moisture to the aggregate comprising an inclined screw conveyor adapted to move aggregate upwardly while agitating and draining the same and arranged to receive an inflow of aggregate at its lower extremity, and means included in a lower portion of said conveyor for super-saturating the aggregate surface; means for applying the binding agent to the surface of the aggregate; and discharging means leading directly from the upper extremity of said conveyor into said applying means for the discharge thereinto of surface moist aggregate.

6. In combination in a machine for coating aggregate with a liquid vehicle bituminous binding agent: two inclined screw conveyors each adapted to move aggregate upwardly while agitating and draining the same, means included in a lower portion of a first of said conveyors for super-saturating the aggregate surface, means included in a lower portion of the second said conveyor for applying the binding agent to the aggregate surface, means for introducing aggregate into the lower extremity of said first conveyor, and aggregate discharging means leading directly into the lower extremity of said second conveyor from an upper portion of said first conveyor whereat the aggregate remains surface moist.

7. A bituminous mixing plant comprising two inclined screw conveyors; means for maintaining a bath of a pre-conditioning liquid in the lower portion of a first of said conveyors; means for maintaining a bath of liquid vehicle bituminous binding agent in the lower portion of the second of said conveyors; means for introducing aggregate into the lower portion of said first conveyor; an outlet for conducting aggregate from the upper portion of said first to the lower portion of said second conveyor; an outlet for discharging aggregate from the upper portion of said second conveyor; and flights forming parts of said conveyors respectively and adapted to move aggregate in each upwardly out of the respective said bath to the respective said outlet, while agitating the aggregate and permitting the drainage thereof.

8. A bituminous mixing plant according to claim 7 including a carriage supporting said conveyors and adapted to be moved along a surface to be covered with coated aggregate; and spreaders secured to said carriage and adapted to level off aggregate discharged by said discharging means.

9. In a machine for coating aggregate with a bituminous binding agent in emulsion form: a

substantially enclosed inclined screw conveyor adapted to move aggregate upwardly while agitating the same, means for introducing aggregate into the lower extremity of said conveyor, means included in a lower portion of said conveyor for applying the binding agent to the aggregate surface, means for discharging aggregate from an upper portion of said conveyor, and means for introducing moist vapor into said conveyor whereby to retard breaking of emulsion coatings within said conveyor.

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