United States Patent [19]

Ohlson

[11] **3,857,552**

[45] **Dec. 31, 1974**

[54] **ASPHALT MIXING PLANTS FOR MAKING ASPHALT CONCRETE MIX**

[76] Inventor: **Karl Gunnar Ohlson,** 28015 Finja Kyrkby, Sweden

[22] Filed: **Mar. 27, 1973**

[21] Appl. No.: **345,409**

[30] **Foreign Application Priority Data**

Mar. 28, 1972 Sweden 3988/72

[52] **U.S. Cl.** **259/156,** 259/154, 222/54

[51] **Int. Cl.** **B28c 7/04**

[58] **Field of Search** ..... 259/149, 154, 155, 156, 259/157, 164, 165, 168; 222/54, 146 H

[56] **References Cited**

UNITED STATES PATENTS

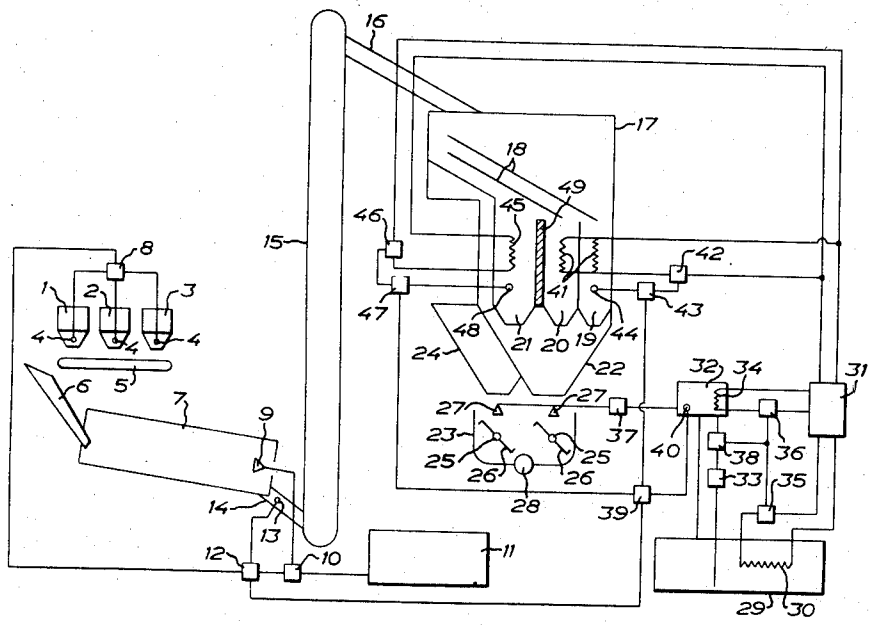
2,772,083	11/1956	Parker	259/156
3,110,421	11/1963	Matthias	259/154
3,554,498	1/1971	Laycock	259/159
3,741,532	6/1973	Farnham	259/155

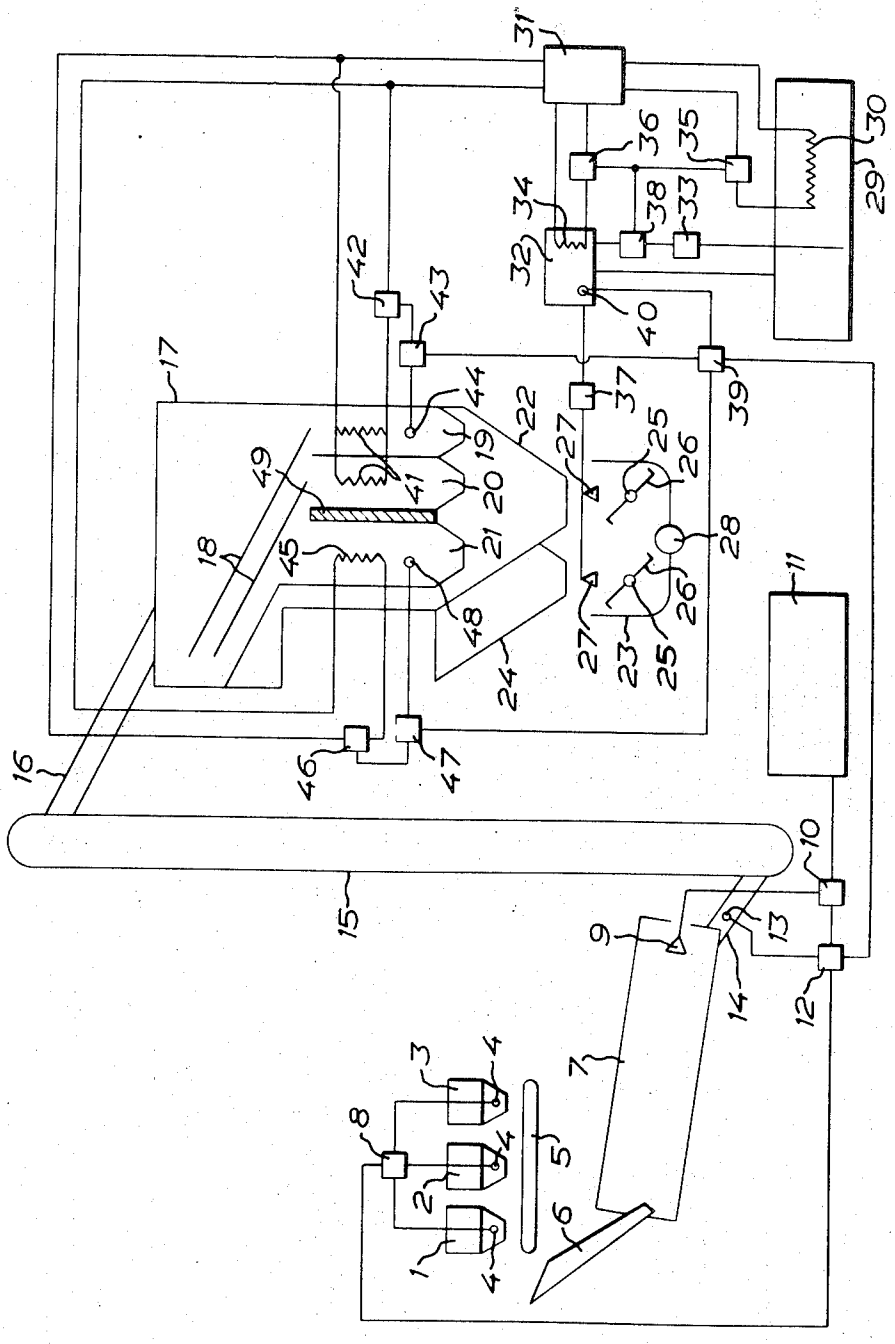
Primary Examiner—Robert W. Jenkins
Assistant Examiner—Robert Pous
Attorney, Agent, or Firm—Browne, Beveridge, DeGrandi & Kline

[57] **ABSTRACT**

In an asphalt mixing plant for making hot asphalt concrete mix the bituminous binder supplying means is provided with viscosity sensing means and temperature sensing means for sensing the viscosity and the temperature of the binder to be introduced into the mixer, said viscosity sensing means controlling regulating means for the heating means of the binder supplying means and said temperature sensing means controlling regulating means for the mineral aggregate supplying and heating means.

3 Claims, 1 Drawing Figure




31
30
29
36
35
34
38
33
32
40
42
43
39
37
17
44
22
27
25
26
49
41
19
20
21
28
18
45
48
24
23
11
16
46
47
10
15
9
13
14
12
7
3
4
8
5
2
6
1

ASPHALT MIXING PLANTS FOR MAKING ASPHALT CONCRETE MIX

This invention relates to an asphalt mixing plant for making asphalt concrete mix having mineral aggregate supplying and heating means, a mixer for receiving the heated mineral aggregate, and binder supplying means including heating means for introducing heated bitumen into the mixer.

In asphalt mixing plants of this type the temperature of the mineral aggregate upon mixing has been kept constant by thermostat-regulated control of the aggregate heating means. The binder has also been kept heated to a constant temperature — different for different asphalt grades — or the plant operator has varied the binder temperature in the manner he has deemed suitable.

At a thorough investigation of the circumstances associated with the making of the asphalt concrete mix and how these circumstances affect the quality and particularly the strength and durability of pavings laid with said mix it has been found that the viscosity of the binder at the mixing thereof with the mineral aggregate in the mixer is of surprisingly great importance to the quality of the pavings and that the conventional asphalt mixing plants and the methods of utilizing them do not satisfy the requirements that must be put on the viscosity of the binder during mixing to attain the highest quality of the pavings laid, or anyway do not satisfy them automatically while eliminating the human factor, that is the plant operator's discretion.

The present invention has for its object to overcome this deficiency. To this end, the invention relates to an asphalt mixing plant of the type outlined in the foregoing, which is characterized in that the binder supplying means are provided with viscosity sensing means adapted to sense the viscosity of the heated binder and thereby to control regulating means for the heating means of the binder supplying means and that temperature sensing means are adapted to sense the temperature of the binder in the binder supplying means and thereby to control regulating means for the mineral aggregate supplying and heating means.

Binder is delivered to the asphalt mixing plant in various qualities. Even within one and the same quality from one and the same supplier the viscosity of the binder at a certain temperature may vary considerably from one delivery to another. Since the binder added to the mixer in an asphalt mixing plant of the type outlined in the foregoing comes from a heated supply the amount of binder in said supply may also in time change its viscosity that is bound to a certain heating temperature because readily volatile components evaporate at said heating temperature. To attain as high a quality as possible of the pavings or like coverings to be laid with the asphalt concrete mix prepared in the asphalt mixing plant it has proved very important that the binder at the mixing thereof with the mineral aggregate in the mixer possesses a certain viscosity. This viscosity shall be such as to guarantee as far as feasible in the mixing operation that the large particles of the aggregate are completely covered with a thin film of binder, and to bring the small particles of the aggregate to adhere to and sink into said binder film on the large particles without being agglomerated or forming lumps of small aggregate particles. The present invention makes it possible to adjust the viscosity of the binder in the

binder supplying means at the desired viscosity value and by control of the temperature of the mineral aggregate in dependence on that of the binder in the binder supplying means to realize that the binder will have a viscosity suitable for the mixing operation in the mixer, irrespective of variations in the viscosity properties of the batches of binder supplied to the asphalt mixing plant and irrespective of changes in the composition of the binder in the binder supplying means by reason of the evaporation of readily volatile components of the binder.

With conventional mixing when all mineral aggregate is added at one and the same time to the mixer for mixing with the binder, it is not possible fully to attain said ideal state in which all surfaces of the coarse aggregate particles are completely covered with a thin film of binder and the fine aggregate particles are sunk into said film on the coarse aggregate particles without agglomeration. Recently, however, a method has been developed which is described in my copending U.S. continuation-in-part application Ser. No. 193,205 filed Oct. 27, 1971 and which permits attainment of the ideal state. In said recently developed method a coarse-grained fraction of the mineral aggregate is first mixed with the binder in the mixer before a fine-grained and residual fraction of the mineral aggregate is supplied to the mixer under continued mixing. The present invention is of particular importance in connection with the last-mentioned method.

The invention will be more fully described hereinbelow with reference to the accompanying drawing which diagrammatically shows an asphalt mixing plant equipped in accordance with the present invention.

The drawing illustrates a preferred embodiment of the invention as applied to a conventional type of asphalt mixing plant the known parts and function of which need not therefore be described in detail to those skilled in the art. In this preferred embodiment, mineral aggregate for making asphalt concrete mix is kept in three storage containers **1** to **3**. Each of them contains one of three particle size fractions of the mineral aggregate required for the asphalt concrete mix. By means of suitable supply devices **4** of conventional nature, such as shutters and electromechanical vibrators, aggregate is discharged from the three containers **1** to **3** in definite relative proportions to a conveyer **5** which delivers the aggregate through a hopper **6** or inlet to one end of a rotary drying and heating drum **7**. The supply devices **4** are connected to a control means **8** which in a known manner regulates the supply devices in such a way that the aggregate fractions from the three containers **1** to **3** are delivered to the conveyer **5** in the desired relative proportions and in the requisite amounts per unit of time.

The mineral aggregate introduced at one end of the drum travels while being tumbled to the other end of the drum and is exposed during its travel to the hot gases from an oil burner **9** which is disposed at said other end of the drum and supplied with oil from an oil supply tank **11** by means of a pump **10**. A thermostat **12** which can be set at a desired temperature is arranged to permit heating of the aggregate to a definite, desired temperature in the drum **7**, and the sensing means **13** of said thermostat **12** is adapted to sense the temperature of the aggregate heated in the drum **7** at some suitable point. In the present instance the sensing means **13** is disposed in a tube **14** through which the ag-

gregate leaves the drum 7 to be transferred to the lower end of a vertical conveyer 15. The thermostat 12 controls the temperature of the aggregate by regulating the oil pump 10 (to adapt the heat energy generated by the burner 9 per unit of time) and/or adjusting the adjustable control means 8 (to adapt the amount of aggregate supplied to the drum 7 per unit of time). As indicated in the drawing the thermostat 12 in the embodiment chosen is connected both to the pump 10 and the control means 8.

The dried and heated aggregate supplied through the tube 14 to the lower end of the vertical conveyer 15 is raised by the conveyer to a discharge tube 16 through which the aggregate enters a grading chamber 17. In this chamber a set of screens 18 again separates the entering aggregate into three fractions, viz. a fraction formed by the largest particles which are collected in a storage bin 19, a fraction formed by average-sized particles which are collected in a storage bin 20, and a fine-grained fraction collected in a storage bin 21. At their bottoms the bins 19 to 21 are provided with shutter-regulated discharge openings for letting aggregate fall down from the bins to a hopper 22 equipped with a weighing machine, in which suitable amounts of the three aggregate fractions from the storage bins 19 to 21 are weighed to form an aggregate batch which is then permitted to fall through a shutter-regulated discharge opening at the bottom of the hopper into a mixer 23. If filler, i.e., particularly fine-grained aggregate, shall be incorporated in the asphalt concrete mix, such filler is supplied to the mixer 23 through a special hopper 24 which is supplied with filler separately, i.e., from elsewhere than from the conveyer 15 and the chamber 17.

The mixer 23 is formed by a vessel in which two shafts 25 with blades 26 are rotatable for mixing the aggregate supplied from the hoppers 22 and 24 with heated binder which is supplied to the mixer through nozzles 27. After a batch of asphalt concrete mix has been prepared the finished batch is discharged from the mixer 23 through a discharge mechanism 28 at the bottom of the mixer. The nozzles 27 are supplied with heated binder from the following device. A supply of binder for the asphalt mixing plant is kept in a large storage tank 29 in which the binder is kept heated by means of a heating device 30 connected to a source of power 31. A small supply tank 32 is connected to the storage tank 29 through a supply conduit and a return conduit, and a pump 33 inserted in the supply conduit constantly maintains a circulation of heated binder from the storage tank to the supply tank and back to the storage tank. The supply tank suitably also comprises a heating device 34 which is connected to the source of power 31 to keep the binder heated in the supply tank 32. The heating effect of each heating device 30 and 34 is variable by regulating means 35 and 36, respectively. The source of power 31 may be for instance a source of electric power, in which case the heating devices 30, 34 may be electric resistance heating elements and the regulating means 35, 36 may be connectors for connection of larger or smaller parts of the resistance heating elements. Alternatively, the source of power 31 may be a source of hot oil, in which case the heating devices 30, 34 are heating tube coils and the regulating means 35, 36 are valves. As need arises heated binder is fed from the supply tank 32 to the nozzles 27 by means of a pump 37.

The parts of the asphalt mixing plant as hitherto described are conventional. The part of the asphalt plant that is improved according to the invention includes viscosity sensing means 38 which sense the viscosity of the heated binder circulating in the tanks 29, 32. These sensing means may be connected in the tank 29 or the tank 32 or in the conduits connecting these two tanks. It would seem most suitable, as shown in the drawing, to connect the viscosity sensing means 38 in the supply conduit between the pump 33 and the supply tank 32. The viscosity sensing means 38 may be of any suitable prior-art type whatever which can measure the viscosity of the heated binder and deliver say an electrical signal which indicates whether the measured viscosity exceeds or is lower than a value at which the sensing means have been set. The viscosity sensing means may be for instance of the prior-art rotation viscosimeter type. The signal delivering element of the viscosity sensing means 38 is connected to the regulating means 35 and 36 which are controllable by means of the signal in order to increase the heating effect of the heating devices 30, 34 when the viscosity of the binder is too high, and to reduce the heating effect thereof when the viscosity is too low. By this arrangement the viscosity of the binder circulating in the tanks 29, 32 can thus be kept at the value set with the aid of the viscosity sensing means by alteration of the temperature of the binder.

In order that the asphalt concrete mix prepared shall have the best possible quality the mineral aggregate supplied to the mixer 23 shall have the same temperature as the supplied binder or a slightly lower temperature than said binder. For this purpose the temperature of the heated binder circulating in the binder supply device is sensed by a temperature sensing means 39 the sensing element 40 of which is disposed at some suitable location in the path of circulation of the binder, preferably as shown in the supply tank 32. The temperature sensing means 39 is of a prior-art type and delivers say an electrical signal the magnitude of which is dependent upon the sensed temperature of the binder. The signal delivering element of the temperature sensing means 39 is connected to the adjusting means of the thermostat 12 for adjusting the thermostat in a known manner at such a temperature that the aggregate when reaching the mixer 23 has the same temperature as the binder supplied to the mixer, or a slightly lower temperature.

This control of the temperature of the aggregate in dependence upon the temperature of the heated binder by means of the adjustable thermostat 12 is sufficient in certain cases, but it is possible to realize a further control of the temperature of the aggregate by also heating the aggregate in a controllable manner in the storage bins 19 and 20 and/or the bin 21. A device for this purpose is illustrated in the drawing. The bins 19 and 20 have two parallel connected heating elements 41 of the type earlier described, which are connected to the source of power 31 via a regulating means 42 which is controllable by means of an adjustable thermostat 43, the sensing element 44 of which senses the temperature of the aggregate in the bins 19, 20. The temperature adjusting means of the thermostat 43 is connected to the temperature sensing means 39 in order to be set by the signal thereof at a temperature suitable with respect to that of the heated binder. The storage bin 21 suitably also has a heating element 45. Although this might be connected in parallel with the

elements **41** to be controlled by the thermostat **43,** it is sometimes suitable, as shown in the drawing, to connect the element **45** separately to the source of power **31** via regulating means **46** controlled by an adjustable thermostat **47,** the temperature sensing element **48** of which senses the temperature of the fine-grained aggregate fraction in the storage bin **21.** The temperature adjusting means of the thermostat **47** is connected to the temperature sensing means **39** in order to be set by the signal thereof at a temperature suitable with respect to that of the heated binder.

This separate control of the temperature of the fine-grained aggregate fraction in the storage bin **21** is advantageous in that it permits keeping said fine-grained fraction at another and usually lower temperature than the more coarse-grained aggregate fractions contained in the storage bins **19** and **20.** To facilitate maintenance of a temperature in the storage bin **21** other than that in the storage bins **19** and **20,** the bin **21** may be heat-insulated in relation to the other bins, as is indicated in the drawing by a heat insulation **49** between the bin **21** and the bin **20.** This arrangement of a separate temperature control of the fine-grained aggregate fraction in the storage bin **21** has proved to be of particular importance upon application of the method according to U.S. Pat. application Ser. No. 193,205, and now abandoned, in which method the coarse-grained aggregate fractions from the storage bins **19** and **20** are first mixed in the mixer **23** with the entire amount of binder required for the batch to be mixed, before the fine-grained aggregate fraction from the storage bin **21** to be admixed to said batch is introduced into the mixer under continued mixing. In this method the fine-grained aggregate fraction in the storage bin **21** should be kept at a slightly lower temperature than the aggregate fractions in the storage bins **19** and **20** in order that the best results possible may be attained.

If filler is to be introduced into the mixer **23** from the hopper **24,** the filler need not be controlled as to its temperature. It is usually added in cold or relatively cold condition.

What I claim and desire to secure by Letters Patent is:

1. In an asphalt mixing plant for making asphalt concrete mix having mineral aggregate supplying and heating means, a mixer for receiving the heated mineral aggregate, and binder supplying means including heating means for introducing heated bitumen into the mixer, the improvement comprising viscosity sensing means for sensing the viscosity of the heated binder, binder temperature regulating means for controlling the heating means of the binder supplying means, said binder temperature regulating means being operatively connected to said viscosity sensing means for controlling the temperature of the binder in relation to the viscosity of the binder, binder temperature sensing means for sensing the temperature of the binder in the binder supplying means, and aggregate temperature regulating means for the mineral aggregate supplying and heating means, said aggregate temperature regulating means being connected to said binder temperature sensing means for controlling the temperature of the mineral aggregate in relation to the temperature of the binder.

2. The improvement claimed in claim **1,** in which the mixing plant is arranged first to supply a coarse fraction of mineral aggregate and the binder to the mixer and to mix them, before a more fine-grained and residual fraction of the mineral aggregate is introduced into the mixer under continued mixing, wherein means forming part of the supplying and heating means for the aggregate and determining the temperature at which the coarse fraction of the aggregate and the more fine-grained fraction of the aggregate, respectively, is supplied to the mixer, are provided each with regulating means individually controllable by the binder temperature sensing means to permit supplying the coarse aggregate fraction to the mixer at a temperature other than that of the more fine-grained fraction.

3. The improvement claimed in claim **1** in which the supplying and heating means for the mineral aggregate are controlled by means of one or more adjustable thermostats adapted in said asphalt plant to sense one or more temperatures determinative of the temperature of the mineral aggregate as it arrives in the mixer, wherein the binder temperature sensing means are adapted to adjust the thermostat or thermostats.

* * * * *