Seam sealer for sealing seams in an asphalt paving operation has electric heaters and heats a seam area that includes a narrow strip of previously laid-down asphalt and a narrow strip of the road surface to be paved. A temperature sensor senses temperature of the seam area. A control system adjusts energy level supplied to the heaters, to obtain a pre-determined temperature on the road surface. The pre-determined temperature is close to the temperature of the fresh hot asphalt to be applied. An asphalt paver travels behind the seam sealer and applies fresh hot asphalt to the road surface still to be paved, overlapping it onto the previously laid down asphalt in the seam area. The fresh hot asphalt and the previously laid down asphalt form a molten mass, which is subsequently pressed to a smooth, fused and finished road surface by a road roller.
SEAM SEALER APPARATUS AND METHOD OF SEALING SEAMS ON AN ASPHALT ROAD

BACKGROUND INFORMATION

[0001] 1. Field of the Invention

[0002] The invention relates to road paving equipment. More particularly, the invention relates to a method of sealing pavement seams in asphalt paving material and equipment for practicing the same method.

[0003] 2. Description of the Prior Art

[0004] Applying asphalt pavement to roads frequently requires that the asphalt be applied in sections, because the road is too wide to process in a single pass. Thus, first one section of the road width is paved and then the second section. For reasons of simplicity, width sections will be referred to hereinafter as “lanes,” although it is understood that the actual width of the paving step does not have to correspond to a driving lane on the road. The area where one lane of asphalt overlaps another will be referred to as the “seam area.”

[0005] Typically, a first lane will be paved along a long stretch of road and the second lane paved at a later time, such as the next day or several days or even weeks later. No matter what the time difference is between paving the first lane and the second lane, the asphalt laid down on the first lane will already have cooled to what shall be referred to as “road temperature” by the time fresh hot asphalt is applied to the second lane. “Road temperature” is the temperature of the road surface, and “road surface” may include a portion of the first lane and second lane.

[0006] Asphalt is laid down warm, typically around 250 degrees F., so that it bonds with the substrate. Asphalt as it is being applied to the road surface shall be referred to hereinafter as “fresh hot asphalt,” to distinguish it from asphalt that has previously been laid down and has cooled to road temperature. After the first lane has been paved, fresh hot asphalt is applied to the second lane such that it overlaps a few inches with the asphalt of the first lane in the seam area. Ideally, the fresh hot asphalt overlapping the seam area should bond sufficiently with the asphalt of the first lane, to form a water-impervious seam. A common and well known problem, however, is that, when fresh hot asphalt is laid down on top of asphalt that is at road temperature, the difference in temperature prevents a good bond from forming. As a result, cracks form along the seam. Water then seeps through the cracks under the asphalt and down toward the sides of the roadway. Eventually, cracks form in the surface, which results further progressive deterioration of the asphalt surface.

[0007] Efforts have been made to correct this fault. Some systems have used gas torch heaters arranged so that they move ahead of the paving machinery and heat the bonding edge of the previously laid-down asphalt. One problem with gas heaters is that it is often difficult to control the heater to prevent too much heat from being applied and from being applied too directly. As a result, overheating is a common problem and, if overheated to the flash point, the asphalt can burst into flame.

[0008] What is needed, therefore, is a method of system for heating a road surface for bonding with a fresh hot layer of asphalt. What is further needed is such a system for controlling the heat that is applied to the road surface.

BRIEF SUMMARY OF THE INVENTION

[0009] The invention is a seam sealer for asphalt paving and a method of sealing an asphalt-paving seam. The seam sealer comprises an electric heater for pre-heating the road surface to be paved, plus a power supply unit for supplying energy to the heater, and a control system with a heat sensor. The heater may be one or more electric heaters. Certain advantages are provided by using multiple heaters and the description hereinafter will be based on the use of multiple heaters, although it is understood that it may be desirable to use a single heater in certain applications. The heaters are mounted in a moving vehicle and are arranged such that they sequentially travel above the road surface in the seam area and apply heat to the road surface. The seam area is a narrow strip of road surface that spans a few inches of the adjacent edges of the first and second lanes, i.e., a few inches of the lane previously asphalted and a few inches of the lane still to be asphalted. The purpose of the heaters is to heat the road surface in the seam area to a desired temperature that is close to that of the fresh hot asphalt that will be applied. The sensor monitors the temperature of the road surface and adjusts the heater output to maintain the desired temperature on the road surface. The desired temperature may be selected to be some degrees above the temperature of the fresh hot asphalt that is to be applied, so that temperatures of the fresh hot asphalt and the previously laid down asphalt on the road surface are close enough to allow the fresh hot asphalt and the previously laid down asphalt to form a molten mass that fuses together seamlessly when the road roller rolls over it and presses it together.

[0010] The heaters are extendable out from the vehicle, so that they are positioned above the seam area. The heaters may be positioned at varying distances above the seam area. For example, a first heater may be positioned 16 inches above the pavement, a second heater 12 inches, and so on. In this way, the series of heaters applies a graduated heat to the seam area, initially pre-heating it with a low degree of heat, and then applying a progressively higher degree of heat with each subsequent heater. In this way, the road surface in the seam area is heated to the desired temperature in a very controlled manner, thereby eliminating the risk that the previously laid down asphalt in the first lane will combust or chemically break down. Although the progressive application of heat is achieved by setting the heaters to progressively lower distances from the road surface, this may also be achieved by using heaters of increasingly greater output capacities.

[0011] The seam sealer is moved alongside the seam area a pre-determined distance in front of the paving equipment that is applying the fresh hot asphalt, so that an estimated amount of time lapses before the fresh hot asphalt is applied to the second lane. This allows the pre-heated asphalt of the first lane to “cure” or normalize, before the fresh hot asphalt is applied. This curing process allows the heat from the seam sealer to penetrate a certain distance down into the previously laid asphalt of the first lane, so that the asphalt is well heated and not just heated superficially. This heat penetration prior to applying the fresh hot asphalt ensures a better bond, because material from both the previously laid down asphalt and the fresh hot asphalt forms a molten mass, and when pressed together, forms a water-tight, smooth, and seamless bond.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present invention is described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements.

[0013] FIG. 1 is a perspective schematic view of the seam sealer according to the invention, shown moving alongside the seam area of a road ahead of an asphalt paver.
FIG. 2 is a side elevational view of the seam sealer of FIG. 1.

FIG. 3 is a top plane view of the seam sealer.

FIG. 4 is a front elevational view of the seam sealer according to the invention, showing the heaters positioned over the seam area and the paver following behind.

FIG. 5 is a block diagram of the electrical systems.

DETAILLED DESCRIPTION OF THE INVENTION

The present invention will now be described more fully in detail with reference to the accompanying drawings, in which the preferred embodiments of the invention are shown. This invention should not, however, be construed as limited to the embodiments set forth herein; rather, they are provided so that this disclosure will be complete and will fully convey the scope of the invention to those skilled in the art.

FIGS. 1, 2, 3 and 4 illustrate conceptually a seam sealer 1000 according to the invention. The seam sealer 1000 is moving alongside a seam area S in a roadway, in front of an asphalt paver 2000 that is laying down fresh hot asphalt. The seam sealer 1000 is shown being moved along the roadway by means of a tow vehicle V. Both the paver 2000 and the tow vehicle V are conventional equipment and, as such, are not included within the scope of the invention. The seam sealer 1000 may be constructed as a towable platform or trailer that is towed by a tow vehicle V or be incorporated into the moving vehicle itself. As shown in the FIG. 1, a first lane L1 of asphalt has been previously laid down. The asphalt in this first lane L1 is at road temperature, as is the surface asphalt of a second lane L2 that is yet to be paved. The surface of the second lane L2 is not limited to a specific type of surface. It can be old pavement that is being covered with a new layer of asphalt or a gravel substrate. The seam sealer 1000 and the asphalt paver 2000 are moving along the second lane L2. A seam area S is shown comprising a narrow strip along each side of a solid line that extends between lanes L1 and L2. In other words, the seam area S includes a strip of previously laid down asphalt in the first lane and a strip of still to be paved road surface in the second lane. The temperature of the road surface and the previously laid down asphalt in the seam area S is at “road temperature,” i.e., it may ambient temperature or be slightly warmer or cooler than the ambient temperature, depending on the season and the weather.

FIG. 4 is a front elevational view that shows the seam sealer 1000 with the heaters 200 positioned over the seam area S, including an overlap dimension D, with the asphalt paver 2000 following some distance behind it.

The seam sealer 1000 comprises an electrical heater 200, a sensor 400, a control system 500 for controlling the heaters 200, and a power supply 600 for powering the heater 200 and other devices. The heater 200 will generally include two or more heaters, because this allows heat to be applied progressively to the road surface, although it is understood, that the number and/or the capacity of the heaters in the series of heaters 200 may vary according to a particular application. For purposes of illustration, the heater 200 as described herein shall be a series of four heaters 201, 203, 205, 207, each of which may include multiple individual heaters. For example, the capacity of the heater is too small for the desired heat output, two or more heaters may be provided within each heater, so as to create sets of heaters. In this way, the heaters 200 may now include, for example, four pairs of heaters 201-208, as shown in these FIGS. It is also possible that the first two heaters 201 and 203 may each comprise a single heater and the last two heaters 205 and 207 may each comprise a double heater 205/206 and 207/208.

The heaters 200 may be positioned at varying distances to the ground surface. For example, the first heater 201 or 201/202 is a first height H1, the second heater 203 or 203/204 a second height H2, the third heater 205 or 205/206 a third height H3, and the fourth heater 207 or 207/208 a fourth height H4 from the surface of the seam area S. The heaters 200 are preferably infrared heaters and preferably mounted on arms 220 that are hydraulically adjustable. Infrared frequency changes as the distance between heater and surface changes and providing the heaters 200 at varying heights “seasons” or cures the heat into the pavement at different infrared frequencies. Examples of suitable heights H1-H4 are sixteen inches, twelve inches, eight inches, and four inches. The heaters 200 have a heating head that provides a heat-radiating surface area that is great enough to provide radiation over the seam area S. The seam area S is shown in FIG. 1 as the area between two dashed lines and the solid line that indicates the edge of the asphalt layer in the first lane L1. FIG. 3 shows the heating heads of the heaters 200 extending into the first lane L1 for a distance that corresponds to the overlap dimension D. An example of a suitable overlap dimension is nine inches. Thus, the road surface in the seam area S, i.e., a narrow strip of the sub-surface in the second lane 2 and a narrow strip of the previously laid down first lane L1, are heated to the same temperature, this temperature being close to the temperature of the fresh hot asphalt that is to be applied to the second lane L2.

Other types of electric heaters may be used and the heaters do not necessarily have to be positioned at varying distances to the ground surface. Doing so provides certain advantages, discussed above, but it is also possible to provide a series of electric heaters that are positioned at the same height relative to the ground surface. It is also possible to provide a series of heaters, all set at the same height above the road surface, but that vary in the heat output, so as to emulate the effect of the infrared heaters that are positioned at varying heights. The invention has determined that it is most efficient to provide progressively greater heat to the road surface, in order to heat it to the desired high temperature, yet avoid the danger of the asphalt combusting or from breaking down. A particular advantage of electric heaters is that the heat is radiated in a straight path through air and, thus, in contrast to gas heaters, windy conditions will not significantly diminish the amount of heat that is radiated onto the pavement. Providing heat over a period of time from the series of heaters 200 also ensures that the heat penetrates to a depth that is necessary to obtain a good bond with the fresh hot asphalt that is being laid down.

The control system 500 and temperature sensor 400 control the amount of energy that is supplied to the heater 200 by the power supply 600. The temperature sensor 400 is mounted such, that it extends into the overlap dimension D close to the asphalt surface or generally into the seam area S. The temperature sensor 400 measures the surface temperature and sends corresponding signals to the control system 500. If the measured temperature varies from the set point for the pre-determined or desired temperature, the control system 500 adjusts the power to be sent from the power supply 600 to the heaters 200 accordingly. Various types of sensors may be suitable for this application, but one particularly suitable sensor is a laser temperature probe. The combination of controlling the amount of power supplied to the heaters and control-
ling or adjusting the distance of the heating heads from the surface of the pavement to be heated enables a close control of the road surface temperature.

[0024] In conventional paving systems, the previously laid down asphalt in the first lane L1 is heated by a road roller during the rolling process, that is, after the asphalt for the second lane L2 has been applied. Heating the road surface ahead of the paver 2000 with the seam sealer 1000 has the advantage of allowing the heat to be applied such that it penetrates farther into the pavement and, ideally, completely through the layer of the previously laid down asphalt in the first lane L1 and through the top layer of substrate in the second lane L2. Although this is by no way intended to be limiting, use of the seam sealer 1000 in a paving operation will be somewhat as follows: The paver 2000 travels at 50 ft/min and, ideally, somewhere between 50 and 75 feet behind the seam sealer 1000. Following the paver is a conventional road roller R that rolls over the seam area S and presses the seam to a smooth finished surface. Prior to applying the fresh hot asphalt in the second lane L2, the road surface in the seam area S, which includes previously laid down asphalt in the first lane L1 and the existing road surface or substrate in the second lane L2, will initially be at road temperature. The seam sealer 1000 heats the road surface in the seam area S to a pre-determined temperature that is selected such that the temperature of the road surface will be hot enough to allow the fresh hot asphalt from the paver 2000 and the previously laid down asphalt in the first lane L1 to form a molten mass, which is then pressed into a smooth, finished and seamless surface by the road roller R. The pre-determined temperature is adjusted according to the parameters of the specific paving operation. For example, on cool windy days, the seam area S may be heated a greater number degrees above the temperature of the fresh hot asphalt in the paver 2000, to ensure that the road surface in the seam area S is at the proper temperature when the fresh hot asphalt is applied. On hot windless days, the seam area S may be heated to just the temperature of the fresh hot asphalt, or even to a temperature that is a few degrees lower, if it is known that the temperature of the heated road surface will still be hot enough when the fresh hot asphalt is applied to it to allow the fresh hot asphalt and pre-heated previously laid down asphalt to form the desired molten mass.

[0025] The power supply 600 is preferably a diesel generator, which generates the electrical power for the heaters 200, a lighting system, if one is provided, the sensor 400 and the control system 500. Additional sensors 700 may also be provided. For example, the Department of Transportation (DOT) has specific guidelines on the temperature of the asphalt that is applied. A GPS receiver 701 may be integrated into the sensor 400 and control system 500, so as to allow data that correlates temperature and GPS data points to be gathered and stored for future analysis. Similarly, a motion sensor 702 may also be incorporated into the sensor 400 and linked to the control system 500, to control the energy output of the heaters 200 as a function of the speed of travel. For example, a certain energy output is required when moving at 50 feet/hour, the desired speed of the paving operation. When the speed of the seam sealer 1000 slows down or stops, because of some obstruction down the line, the energy output of the heaters 200 may be reduced, to prevent the asphalt from overheating, yet keep the heaters warm enough to very quickly get up to the desired heating level, as soon as the seam sealer 1000 is in motion again.

[0026] The following information is provided for enablement purposes only. Information as to size and type of heater and size and type of generator is not intended to be a limitation on the scope of the invention. An embodiment of the seam sealer 1000 according to the invention is as a four-wheeled trailer pulled by a tractor with a three-point hitch. The trailer may be pulled from each end. To this end, the temperature sensor 400 is mountable on each end of the trailer, so that the trailer may be towed in both directions. The tractor provides the hydraulic power to operate the hydraulic controls for the controlled heaters 200. A series of heaters are spaced along one side of the trailer. In the embodiment shown, four paired sets of infrared heaters 201-208 were used, each set of heaters being positioned a progressively shorter distance from the road surface. For example, the sets of heaters 201,202, 203,204,205,206, and 207,208 are set to sixteen, twelve, eight, and four inches, respectively, above the surface of the overlap area. It is understood that the series of heaters may include any number of heaters and that the heaters do not have to be paired sets. The size of each heater 201-208 is 5400 Watts. The heating heads of the heaters 201-208 have a heat-radiating surface area that will heat a sufficiently wide seam area A and, in the embodiment shown, is 18×12 inches, so that the overlap onto each lane L1 and L2 is nine inches. An example of a suitable infrared heater is a medium wavelength V-Series heater from Solar Products, Inc. of Pompton Lakes, N.J. The generator has a 10 kW output capacity. An example of a suitable generator is a Kohler Emergency Standby Diesel Generator Set, Model 10REOEB, from Kohler Generators of Wakefield, Mass. The hydraulic power for operating the hydraulically driven arms for the heaters 200 is a conventional system that is typically available on tractors. Hydraulic systems are well known and the specifics of the hydraulic arms for positioning the heaters 200 are not included within the scope of the invention and are not described herein in detail. The heaters 201-208 are adjusted up and down to best fit the particular paving application. Once the height is adjusted, the amperage is adjusted to achieve the desired exit temperature. The pre-heated, previously laid down asphalt in the first lane L1 has time to normalize or cure, in other words, for the temperature penetrate into the asphalt, asphalt will now bond together in a molten state, resulting in a water-tight, smooth, seamless bond when the road roller presses it together.

[0027] FIG. 5 is a block diagram, illustrating the various electrical components of the seam sealer 1000. Examples of the electrical components are as follows:

[0028] 9 heater head relay 1 & 2
[0029] 10 heater head relay 3 & 4
[0030] 11 heater head relay 5 & 6
[0031] 12 heater head relay 7 & 8
[0032] 13 200 amp main circuit
[0033] 14-17 50 amp circuit breakers
[0034] 18-21 20 amp circuit breakers
[0035] 23-240 V power feed relay
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[0036] 26 hydraulic pump
[0037] 27 reset machine relay
[0038] 28 master control relay
[0039] 29 spot light
[0040] 30 12 V LED lights
[0041] 31 battery from generator
[0042] 32 120 V ground fault resettable 4xreceptacle
[0043] 33 USB communication port
[0044] 34 5 V LED temperature display
[0045] 35 SW1 start generator enable switch
[0046] 36 SW2 enable 240 V feed from generator switch
[0047] 37 SW3 on/off heater heat switch
[0048] 38 SW4 on/off light switch
[0049] 39 SW5 reset machine switch
[0050] 40 SW6 emergency stop switch
[0051] 41 SW7 LED lights on/off switch
[0052] 42 SW8 on/off hydraulic pump switch
[0053] 43 FL1 fusible link
[0054] It is understood that the embodiments described herein are merely illustrative of the present invention. Variations in the construction of the seam sealer may be contemplated by one skilled in the art without limiting the intended scope of the invention herein disclosed and as defined by the following claims.

We claim:

1. Apparatus for sealing a seam on an asphalt roadway, said apparatus comprising:
   a power generator;
   a series of electric heaters;
   a temperature sensor for sensing temperature on a roadway surface; and
   a control system for controlling heat output of said series of heaters;
   wherein said power generator supplies power to said series of electric heaters, said control system, and said temperature sensor;
   wherein said control system receives a temperature input from said temperature sensor, compares said temperature input with a pre-determined value and adjusts said power supplied to said heaters by said power generator, so as to achieve and maintain a temperature that corresponds to said pre-determined value.

2. The apparatus of claim 1, wherein said heaters in said series of heaters are positioned at varying heights relative to said roadway surface.

3. The apparatus of claim 2, wherein said series of heaters includes at least two infrared heaters and wherein a first infrared heater is a first distance from said roadway surface and a second infrared heater is a second distance from said roadway surface.

4. The apparatus of claim 2, wherein at least one heater in said series of heaters comprises a set of heaters that includes two or more individual heaters.

5. The apparatus of claim 1, wherein said power generator is a diesel-fueled generator.

6. The apparatus of claim 1, wherein said temperature sensor is a laser temperature sensor.

7. The apparatus of claim 1, further comprising an additional sensor.

8. The apparatus of claim 7, wherein said additional sensor is a GPS receiver.

9. The apparatus of claim 7, wherein said additional sensor is a motion sensor.

10. (canceled)

11. (canceled)

12. (canceled)

13. (canceled)

14. A method of sealing a seam in a roadway, comprising the steps of:
   - heating a previously laid section of roadway with a plurality of heating units;
   - placing a new section of roadway in substantial proximity to the preheated roadway;
   - creating a molten mass between the preheated and new section of roadways; and
   - applying a force to the molten mass to create a seamless section of roadway.

15. The method of claim 14, wherein each heating unit comprises an infrared electric heater.

16. The method of claim 15, further comprising the step of:
   - applying a pre-determined quantity of heat by said plurality of heating units, wherein each subsequent heating unit of said plurality applies a greater quantity of heat than the previous heating unit.

17. The method of claim 16, further comprising the step of:
   - positioning each heating unit of said plurality a pre-determined distance from the roadway, wherein each subsequent heating unit is positioned a smaller distance from the roadway than the previous heating unit.

18. The method of claim 17, wherein each heating unit is disposed to be individually calibrated in relation to the distance of each heating unit from the roadway.

19. The method of claim 18, further comprising the steps of:
   - providing a power supply for each heating unit; and
   - providing a control system for monitoring the power supply to each heating unit.

20. The method of claim 19, further comprising the step of:
   - selecting a temperature level in the control system to provide for the power supply of each heating.

21. The method of claim 20, further comprising the step of:
   - providing a temperature sensor for sensing a temperature of the roadway.

22. A method of sealing a seam in a roadway, comprising the steps of:
   - heating a previously laid section of roadway with a plurality of heating units within a singular heating cycle;
   - placing a new section of roadway in substantial proximity to the preheated roadway, wherein a portion of the new section is disposed to overlap with a portion of the previously laid section;
   - creating a molten mass between the preheated and new section of roadways; and
   - applying a force to the molten mass to create a seamless section of roadway.

23. The method of claim 22, wherein each heating unit comprises an infrared electric heater.

24. The method of claim 23, further comprising the step of:
   - applying a pre-determined quantity of heat by said plurality of heating units, wherein each subsequent heating unit of said plurality applies a greater quantity of heat than the previous heating unit.

25. The method of claim 24, further comprising the step of:
   - positioning each heating unit a pre-determined distance from the roadway, wherein each subsequent heating unit is positioned a smaller distance from the roadway than the previous heating unit.
26. The method of claim 25, wherein each heating unit is disposed to be individually calibrated in relation to the distance of each heating unit from the roadway.

27. The method of claim 26, further comprising the steps of:
   - providing a power supply for each heating unit; and
   - providing a control system for monitoring the power supply to each heating unit.

28. The method of claim 27, further comprising the step of:
   - selecting a temperature level in the control system to provide for the power supply of each heating.

29. The method of claim 28, further comprising the step of:
   - providing a temperature sensor for sensing a temperature of the roadway.

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