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METHOD AND APPARATUS FOR LAYING A BITUMINOUS ROAD MAT

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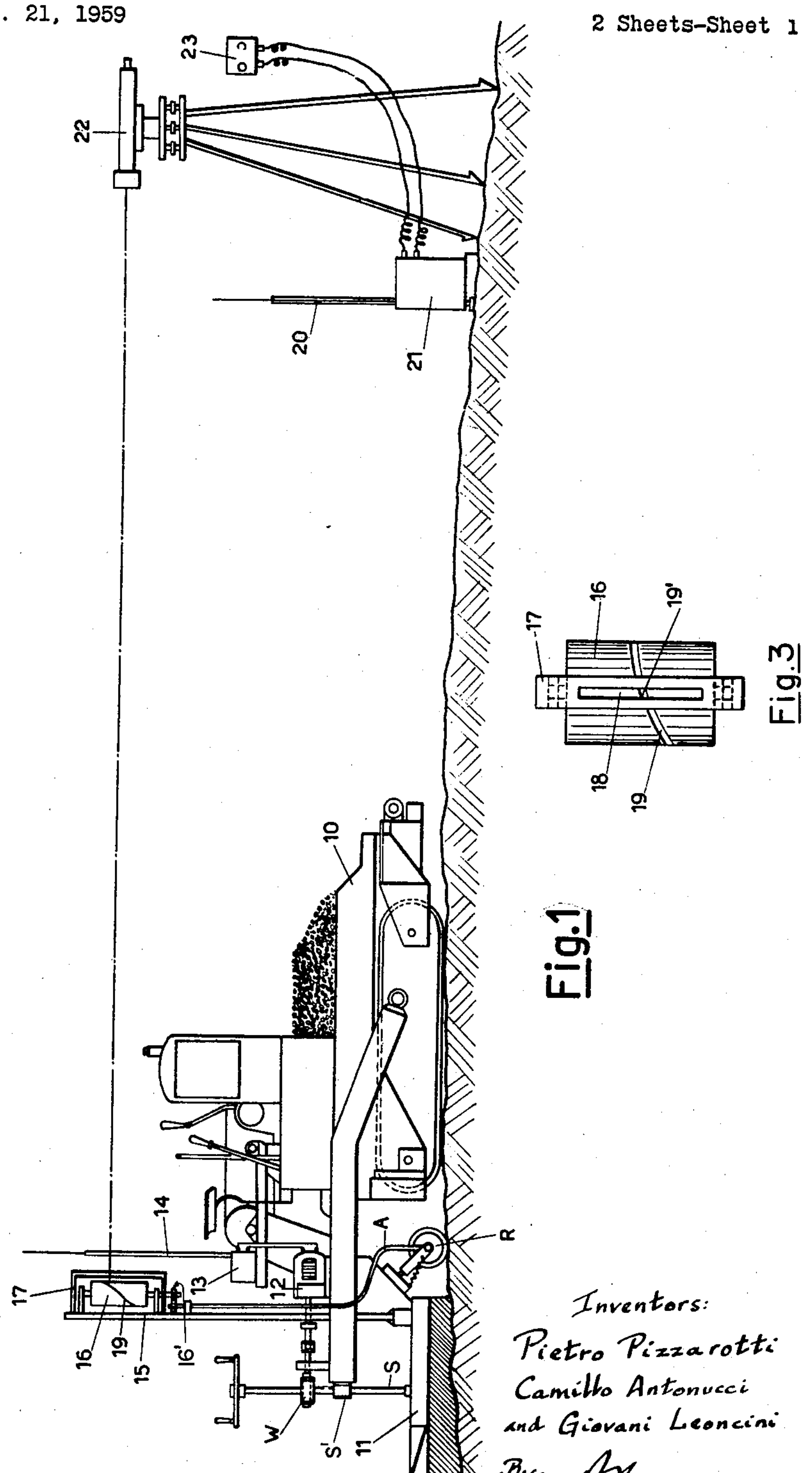

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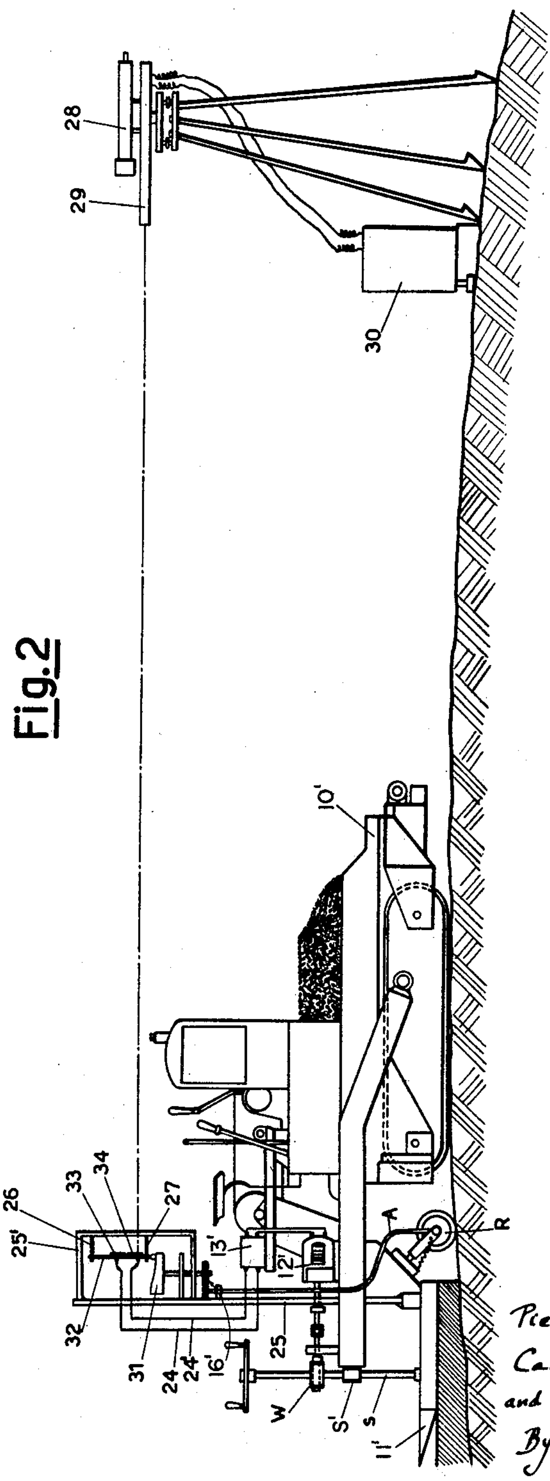

Fig.2

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METHOD AND APPARATUS FOR LAYING A BITUMINOUS ROAD MAT

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In our copending application Serial No. 727,684 a method had been described for obtaining vertical curves in laying of bituminous mats with asphalt spreading finishing machines.

For curves of very great radius (for instance 10,000 metres) it would have been necessary, with the method and apparatus of our copending application mentioned above, to proceed with successive levels (spaced by about 20 metres apart) each of which represented a secant line of an arc of the vertical curve to be reproduced on the ground. In orther words, one would have had to substitute, for the vertical curve, the polygonal of its secants and, therefore, to obtain satisfactory accuracy, it would have been necessary to provide the levels as close as possible to one another, thereby unduly mulitplying the number of setting operations for the topographical control instruments and the guide, beyond limits acceptable in practice.

It is an object of the present application to provide a method for obtaining in a continuous manner curves of vertical profile with bituminous mats on roads, by means of road finishing machines. Another object of the present application is to provide a method for obtaining vertical curves with the highest fidelity to the profile of design.

It is a further object of the present application to provide apparatus suitable for the practicing of the method.

Other objects and advantages of the invention will appear from the following detailed description of some preferred embodiments of the method and of the apparatus for practicing it.

For practicing the method, one must prepare a graph of the vertical curve desired, that is, a graph representing the path of a mat to be laid on a given arcuate portion of a vertically curved road, and wherein the abscissae are proportional to the progressive distances over which the finishing machine moves, computed on the chord of the arc of curve to be obtained, and the ordinates are equal to the distances of every respective point of the curve from the chord. Since the absolute values of the progressive distances are comparatively great with respect to those of the distances of the points of the curve from the chord, it will be convenient that the abscissae should be a certain fraction of the true progressive distances, while the ordinates will be of natural magnitude (scale 1:1).

According to a preferred embodiment, the graph representing the vertical curve is supported on a cylinder rotatable around a vertical axis; and a very limited portion of the grap on said cylinder is collimated by a topographic instrument. The rotation of the cylinder around its axis is controlled by a wheel, rigid with the spreading machine, rolling on the ground, so that to an arc of rotation of the cylinder there corresponds a determined portion of road on the ground. The cylinder is rigid with the members for adjusting the thickness of the mat laid down by the spreading machine whence the collimation of the successive points of the graph must be obtained by displacing said thickness control members vertically. That is obtained by means of a remote control as will be described more in detail hereinafter.

According to another embodiment, the reference line is a beam of light generated by a source placed in front of the spreading machine; and said point of reference is a means responsive to a gradient of illumination placed on said thickness control members and limitedly movable with respect thereto in vertical direction and the vertical strokes whereof are made to vary according to a continuous function geometrically similar to the level to be obtained. In practice, a cylindrical cam is used, on the periphery of which there is secured the graph of the curve to be obtained, and a pair of photoelectric cells are provided which have vertical strokes that are controlled by said cam. The frame supporting the cam and the cells is rigid with the members for adjusting the thickness with which the spreading machine is equipped. A source of light external to the machine projects a beam of light rays onto the two cells which are contiguous and vertically superimposed and every gradient of illumination of the two cells causes the actuation of a servomotor which lifts or lowers the members for adjusting the thickness of the bituminous mat until the gradient of illumination between the two cells becomes nil.

The invention will now be described in detail with reference to the accompanying drawings which illustrate some preferred embodiments of the method and of the apparatus:

FIG. 1 represents a first embodiment of the method and related apparatus; FIG. 2 represents a second embodiment of the method and the apparatus adapted to practice it; and FIG. 3 is a detailed view of the rotatable cylinder which carries the graph in the embodiment illustrated in FIG. 1.

Now with reference to the accompanying drawings, FIG. 1 represents a spreading machine **10**, equipped with a plate **11** which is mounted on the lower end of a vertically adjustable shaft *s*. Shaft *s* is externally threaded along at least a portion of its length and threads through a projection *s'* on the machine frame so that rotation of the shaft shifts plate **11** vertically. Plate **11** is thus used for adjusting the thickness, while it is laying a bituminous mat. The vertical curvature of the road has been somewhat exaggerated in the drawing in order to make the representation clearer. To the plate **11** is rigidly fixed a vertical upright **15** supporting a generally rectangular frame **17**, which in its front portion has a slit **18**. The upright **15** supports a rotatable cylinder **16** on which there is wound a paper bearing the graph **19** of the curved profile to be traced. The abscissae of the graph, as already said, represent the distances covered by the spreading machine **10** as it proceeds, while the ordinates are equal to the vertical distances of the points of the profile to be traced, measured from the horizontal chord of the arc of the road. The slit **18** in the frame **17** permits collimating a limited portion **19'** (virtually point-shaped) of the graph **19**. The cylinder **16** is adapted to be rotated around its own vertical axis, and said movement is of an amplitude proportional to the distances covered by the spreading machine **10**: in fact to the spreading machine **10** there is affixed a wheel R rolling on the ground by friction; and the movement of R, through a flexible shaft A, is transmitted to the cylinder **16** by way of reduction gears designated generally at **16'** in the drawing.

It is apparent that, by selecting conveniently the radius of R and the ratios of transmission, the rotation of the cylinder **16** can take place in a certain ratio with respect to the speed of rotation of R.

On the spreading machine there is also a radioreceiver set **13** provided with an antenna **14**. The set **13** is electrically connected by conventional means of the type disclosed, for instance, in our above-noted copending application, with a servomotor **12** (reversible) and the latter, through for instance a mechanism, such as the helical worm gear wheel W and its mating worm, rotates shaft *s* in one direction or the other and thereby causes the lifting or lowering of the plate **11**.

In front of the spreading machine, at a distance corresponding to the length of the arc of curve to be obtained (for instance 150 m.), there is provided a sighting telescope **22**, the sighting line of which should always be kept in collimation with the portion **19'** of the graph **19** visible in the slit **18**.

A radio transmitter set **21**, equipped with an antenna **20** and controlled by a push-button key-board **23**, emits pulses which are received by **13** through the antenna **14**. The key-board **23** is provided with two push-buttons so as to enable sending pulses of opposed signs corresponding then to the two directions of rotation of the motor **12** and, therefore, to the lifting or lowering of **11**. The push button control transmitter set **21** is adapted to control motor **13** through conventional means such as the type illustrated in FIGS. 7 and 8 of our above-noted copending application. So when the operator in sighting with the telescope **22** sees, while the spreading machine **10** progresses, that the portion **19'** visible at a certain instant through the slit **18** is not in collimation with the sighting line of **22**, he promptly intervenes by means of the key-board **23** by emitting pulses (positive or negative) until the collimation relationship is re-established. In that way the ideal profile **19** will be reproduced with great accuracy and in continuous manner, while avoiding repeated setting of topographical instruments: in other words, the curve **19** is reproduced on the ground point by point and not as a polygonal of its secants.

The internal circuits of the radiotransmitter and radioreceiver sets have not been described because any known types may be adopted for the purpose indicated.

FIGURE 2 describes another embodiment of the invention: also in this figure, the curvature of the road profile in the vertical plane has been considerably exaggerated in order to show it clearly.

In FIG. 2 is visible a spreading machine equipped with a plate **11'** for adjusting the thickness: the vertical movements of the plate **11'** are controlled by a reversible motor **12'**, through the helical gear W and a mating worm. The worm is driven by said motor **12'**. The helical gear is integral with an internally-threaded nut that engages the threaded portion of the shaft *s* to adjust the plate **11'** vertically.

To the plate **11'** there is rigidly connected an upright **25** supporting a frame **25'**: hence to the vertical displacements of the frame **25'** with respect to the sight line there correspond displacements of equal amplitude and direction of the plate **11'** and viceversa. The frame **25'** supports, as visible in FIGURE 2, the cylindrical cam **31** one end face of which reproduces the desired profile. The cylindrical cam **31** can turn around its own vertical axis.

The movement of rotation of the cam **31** is derived from the wheel R, through the flexible shaft A and a train of reducing gears in a manner perfectly analogous to what has been said in the description of FIG. 1.

The rotation of the cam **31** controls the vertical movement in one direction or in the other direction of the slidable rod **32** which can slide in the stirrups **26** and **27** fixed to the frame **25'**. In FIG. 2 it is visible that the slidable rod carries two photoelectric cells **33** and **34** contigous and vertically superimposed to each other.

A source of light, for instance a projector **29** fed by a battery **30**, projects a beam of rays of light, the axis of which is clearly visible in FIG. 2, onto the cells **33** and **34**. For the preliminary sighting of the source of light **29**, a telescope such as **28** is useful.

The cells **33** and **34** are connected with a circuit **24**, **24'**, a control group **13'** and a reversible servomotor **12'** in a manner similar to that disclosed in FIGS. 2 to 5 of our above-noted copending application.

As already said, the gradient of illumination between the cells **33** and **34** should be nil while the machine **10'** progresses and the cam **31** turns: this is the essential condition which, alone, warrants the true reproduction on the field, of the vertical curve to be obtained. In this case in

fact the point of reference is the small space between the two photoelectric cells and so, when the beam of light is symmetrically arranged with respect to them, the gradient of illumination is nil and the motor **12'** does not turn; while if there is a gradient of illumination between the cells, there arises an electromotive force in the circuit **24**, **24'**, **13'**, of positive or negative sign according to whether the one or the other of the cells is more intensively illuminated. In FIGURE 2 the beam of light (of which only the axis is visible) has been represented as incident completely upon the lower cell **34**: this is obviously a limit condition represented in the figure in exaggerated manner. In practice in fact the axis of the beam of light must fall between the two cells and the deviations are compensated by the actuation of the servomotor **12'**. In the position of FIG. 2, the medial axis of interspace between the two photoelectric cells is much higher than it should be (namely in correct position it ought to correspond to the axis of beam of light); hence the plate **11'** should be lowered until the gradient of illumination between the cells becomes nil again. Hence it will suffice that the sign of the electromotive force due to the gradient of illumination is made conveniently to be in accord with the direction of rotation of the motor **12'**: this is easily obtainable in ordinary electrotechnics. When the gradient of illumination is nil, therein zero electromotive force in the circuit **24**, **24'**, **13'** and, therefore, the motor **12'** stops: the machine **10'** is following accurately the profile commanded.

We claim:

1. A method for laying a road mat on a vertically curved road bed with a road machine which is equipped with a road mat leveling member and with means for adjusting said member vertically to control the thickness of said mat and the location of its upper surface, said method comprising providing an optical line of reference extending parallel to the chord of an arcuate portion of said road bed, moving a controlling member, which is mounted on said leveling member and which has a controlling curved surface, the ordinates of which represent the vertical contour of said arcuate portion, past a vertical plane containing said reference line at a rate proportional to the rate of travel of the machine along the road, and moving said leveling member up or down as required to cause successive points on said curved surface to lie on said reference line as the machine travels along the road.

2. A method for laying a road mat as claimed in claim 1, wherein said optical reference line is the sight line of a topographic instrument placed in front of the machine, said point is on a graph which is geometrically proportioned to the grade level desired, and which is moved in proportion to the rate of travel of the machine along the road.

3. A method for laying a road mat as claimed in claim 1 wherein two vertically spaced light-responsive elements are provided which are connected to said curved surface on said controlling member to be moved vertically thereby in response to the shape of said curved surface, said optical reference line is a beam of light generated by a source placed in front of the machine, and moving said light-responsive elements vertically in proportion to change in vertical curvature of the road as the machine travels over the road.

4. A machine for laying a road mat according to a desired grade, comprising a vertically movable road leveling member, control means mounted on said member for vertical movement therewith and including a cylinder mounted to rotate on a vertical axis and having a curve thereon in proportion to the desired grade shape, means for rotating said cylinder as said machine moves along the road in proportion to the rate of travel of the machine therealong, and remotely-controlled means for adjusting said leveling member to maintain the curve constantly in a predetermined relation to an optical reference line.

5. A machine for laying a road mat according to a desired grade, comprising a road leveling member, control means mounted on said member for movement therewith and including a cylinder mounted to rotate on a vertical axis and having a graph thereon proportioned to the grade curve desired, means for rotating said cylinder as said machine moves along the road and in proportion to the rate of travel of said machine therealong, said cylinder-rotating means including a roller having a horizontal axis and mounted to roll on the road during the travel of the machine, a screen positioned in front of said cylinder which has a narrow vertical slit therein, so that the portion of said graph which registers at any time through said slit can be viewed by a topographical instrument, which is placed in front of the machine and whose line of sight constitutes an optical reference line, and remotely-controlled means for adjusting said leveling member to maintain said portion of said graph coincident with said reference line.

6. A machine for laying a road mat according to a desired grade, comprising a road leveling member, control means mounted on said member for movement therewith and including a rotary cam whose active surface has an active shape proportioned to the grade shape of the road mat to be laid, a carrier, a pair of vertically superimposed photoelectric cells mounted on said carrier, means connecting said cam to said carrier to move said cells vertically upon rotation of said cam, means for rotating said cam as said machine travels over the road and in proportion to its rate of travel, and remotely-controlled means for adjusting said leveling member, said remotely-controlled means being operative to move said carrier vertically as said vehicle travels, so that equal amounts of light fall on both said cells from a light beam coming from a source of light which is placed in front of the vehicle, said beam constituting an optical reference line.

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