Sept. 12, 1961 C. F. YTTERBERG 2,999,432

ROAD SURFACES

Filed Sept. 25, 1956

FIG. 1.

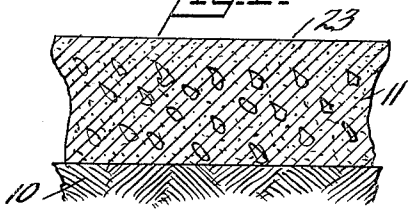


FIG. 2.

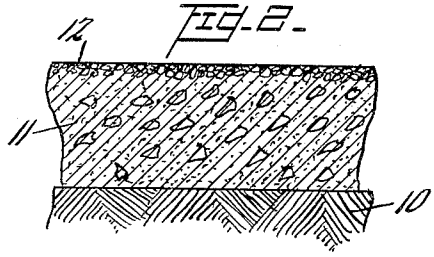
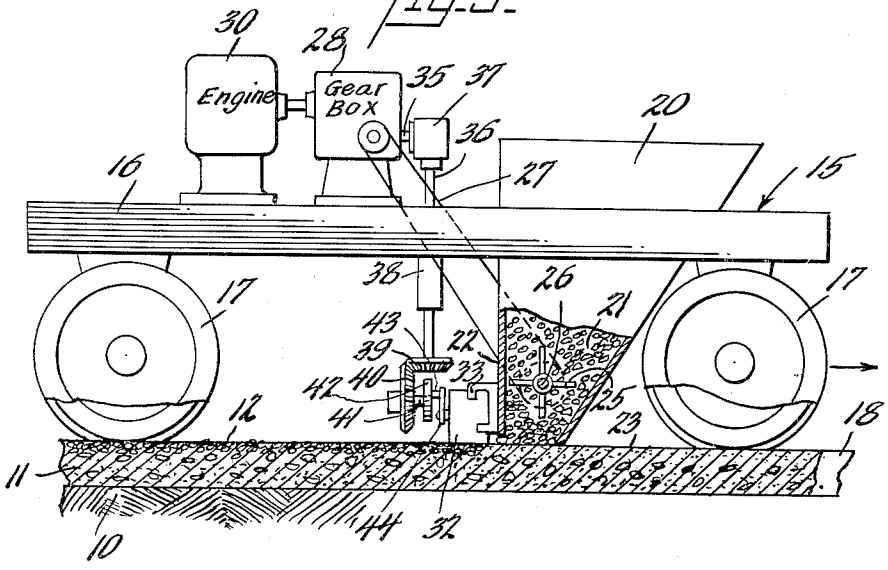


FIG. 3.



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United States Patent Office 2,999,432 Patented Sept. 12, 1961

2,999,432

ROAD SURFACES

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Filed Sept. 25, 1956, Ser. No. 611,941
2 Claims. (Cl. 94—24)

This invention relates to roads or pavements and methods of preparing them, and more particularly to extremely hard and durable surfaces for concrete roadways.

The usual way of laying a concrete road, as the art is practiced today, consists merely in pouring and spreading the concrete in the form of a standard mix comprising gravel or stone, sand, and Portland cement, together with sufficient water to produce a moderately stiff mix. The mix when spread is leveled by means of a screed or other leveling devices and then broomed or dragged with burlap for roughening the traction surface. Ordinary concrete for road building contains a comparatively large percentage of fines, mainly due to the sand content, and these fines with the cement tend to ooze up to the top of the slab, and when the slab is set this forms a surface which is subject to crumbling, erosion, and wear.

Variations in the usual procedure of road building have been suggested but have not been widely adopted for one reason or another. For example, it has been suggested to smooth the surface of a road by vibrating a concrete mix composed largely of fines so as to make a sort of mortar. This causes segregation and gives rise to what is called "boiling" and produces a weak surface.

Frequently, asphaltic layers are spread over a concrete base, but this produces a soft surface and is also dark in color and thus difficult to distiguish from the shoulder or berm at night in the absence of the provision of painted markings.

Other suggestions analogous to certain interior flooring processes include the preparation of a base of ordinary concrete up to say ¾" of the desired level and then spreading an entirely separate layer of topping comprising a "richer" mixture, i.e., one containing more cement, and bonding the topping layer to the previously set base slab; or alternatively depositing the richer topping layer on the base layer before the latter has dried or set.

The present invention has for its general object the provision of a novel road or pavement having an extremely hard wearing surface and which affords increased visibiilty at night but at the same time being without glare in the daylight.

The invention in its preferred embodiment contemplates the provision of a road or pavement comprising a base slab of conventional concrete mix and a hard durable topping zone comprising an aggregate of an optimum predetermined size mixed with Portland cement and worked into the surface of the base slab by vibration, before the base slab has dried and set. The aggregate is preferably mixed with either white Portland cement or with ordinary Portland cement combined with titanium oxide which is brilliantly white in color.

It is preferred to first wet the aggregate, which has first been graded to the proper size range, and then mix with the dry cement, only enough water being used to cause the cement to adhere to and coat the particles of aggregate. The base slab has previously been poured and spread up to grade (or to within say about ⅛" of grade), and then the topping is worked into the surface of the base slab by vibrating means, whereby the topping layer is firmly embedded in and knit to the base layer, and without substantially increasing the grade level, thus greatly increasing the density of the upper or surface portion of the pavement.

Other objects and features of novelty will be apparent from the following specification when read in connection with the accompanying drawings in which one embodiment of the invention is illustrated by way of example.

In the drawings:

FIGURE 1 is a fragmentary vertical sectional view through a road pavement after the pouring and spreading of the base slab;

FIGURE 2 is a similar view showing the pavement structure after the application of the topping layer to the base slab; and

FIGURE 3 is a schematic or diagrammatic view of certain generic apparatus suggestive of means for applying and vibrating the topping or surface layer.

In the drawings, the numeral **10** designates the subgrade which has of course been rolled or compacted for the support of the pavement, and the usual concrete slab layer is indicated by the numeral **11**. This layer may be of any accepted concrete mix with a slight preference toward a rather low water ratio. The base slab **11** may be poured and spread in the conventional way either up to the desired ultimate grade level or not much more than say ⅛ inch lower than said grade level.

While the base slab **11** is still wet, the hard topping surface **12** is applied. This topping surface is composed of extremely hard rock or stone aggregate, the individual pieces ranging in size from about one inch mesh down to about ¼ inch mesh, but preferably not any finer. For best results the preferred range would be just larger than ⅜ inch mesh up to about ¾ inch mesh. The aggregate is first wet with water only sufficiently to cause dry Portland cement to adhere to them. The wet aggregate is then mixed with dry white Portland cement or a mixture of ordinary Portland cement with titanium oxide, in order to give the surface of the road a white coloration. The amount of cement used is only sufficient to coat the wet particles of aggregate, and should not exceed about one-half the quantity of aggregate. If the mix of the main slab is of high quality, then the cement used for covering the stones of the aggregate can be somewhat reduced. As to the amount of stone to be spread on the base layer, it is suggested that approximately one and one-half cubic feet to about three and one-half cubic feet of aggregate be used for each 100 square feet of area. In case titanium oxide is used for whitening the mix, it is suggested that an average percentage would be from about two to ten pounds per hundred square feet of surface, depending on the degree of whiteness desired, short of that which would produce glare in the sunlight.

It might appear anomalous to add this quantity of aggregate which in itself includes pieces of ¾ inch mesh more or less, to a base which has already been brought up to grade or to about ⅛ inch of grade and expect the grade level to be maintained; however, during the application of the topping layer as will be described, the material is embedded in the base slab and so fills up the voids in the upper portion of the base slab as to render the topping or surface zone and the zone of union of the two portions extremely dense and compact, and not raising the total grade level to any great degree. Obviously, in applying the topping layer the larger pieces of aggregate, say the ¾ inch sizes will be embedded relatively deeply in the base slab surface while the smaller pieces down to the ⅜ inch size will be set in the surface to a lesser degree. However, the entire hard topping surface will be knit and bonded to the slab quite firmly and tenaciously, and at the proper time the final surface may be broomed or burlapped in the usual way, without danger of displacing the particles of the topping surface. From this it will be seen that the boundary between the base

slab portion and the topping portion of the road is quite indefinite, and it is somewhat anomalous to refer to these portions as layers in the completed structure, so this terminology has reference only to the order or steps by which the ingredients are applied.

Of course, any suitable machinery may be used to apply the topping surface and the particular devices employed may form parts of already known machines or may be entirely new mechanism. For purposes of illustration, there is shown in FIGURE 3 of the drawings, a wheeled device of a diagrammatic generic nature which will be effective for the purpose, but which may be varied widely in actual practice.

The surfacing machine designated generally by the reference numeral 15 comprises a frame 16 supported upon the flanged wheels 17 which in turn travel upon the metal side forms 18. The vehicle 15 supports a hopper 20 in which the aggregate mix 21, composed of the wetted particles coated with dry cement or mixture of cement and titanium oxide, is contained and distributed. The rear wall 22 of the hopper terminates above the initial surface 23 of the base slab a sufficient distance to permit the largest particle of aggregate to clear it. For purposes of feeding or evenly distributing the aggregate a rotary device 25 may be employed which consists of arms or vanes carried by the shaft 26 which may be driven by means of a belt 27 from a gear box 28 comprising transmission from the engine or source of power suggested at 30. This will effectively distribute the topping layer of aggregate and cement over the surface 23 of the base slab 11.

In order to firmly embed the topping layer in the surface of the slab, vibrating means may be employed. These means may vary widely and the direction of vibration may be either horizontal or vertical. It is preferred that the vibration applied be of small amplitude and high frequency. One suggested rate of vibration is approximately 10,000 cycles per minute. One acceptable means for effecting the vibration of the topping layer for firm embedment in the slab to provide the exceedingly dense and hard ultimate surface is suggested in FIGURE 3 where a horizontal beam 32 is mounted for vibration in a horizontal transverse direction in the guides 33 which may be carried by the rear wall 22 of the hopper, or by any other supporting means depending from the vehicle frame 16.

For an example of how the device may be operated, a transmission is suggested in FIGURE 3 which comprises a shaft 35 extending from the gear box and serving to drive a vertical shaft 36 through gearing which may be contained in the housing 37, the shaft 36 being supported in a guide 38 carried by the frame 16 and terminating in a bevelled gear 39 which meshes with a mating gear 40 carrying a shaft 41 upon which is carried a rotating disc 42, these parts being rotatably supported from the frame by any suitable means. The disc 42 has a crank pin 43 which is connected to the vibrating beam 32 as by means of the link 44.

So far as a dagrammatic showing will indicate, FIGURE 2 depicts the way in which the hard aggregate topping layer 12 is embedded in the surface 23 of the slab 11 densifying this surface and interknitting the aggregate particles with the surface firmly and permanently.

It is possible to vibrate the topping surface into firm embedment by other means that those suggested by the mechanism in FIGURE 3; for example, a roller could be employer rather than a flat surface, such roller while vibrating being permitted to roll freely on the surface, or the roller may be itself driven. In some cases the vibration may be dispensed with and simple rolling or pressing pursued.

The pursuit of the present invention in preparing durable wear surfaces for concrete roadways has many advantages among which may be cited the following:

(1) With the use of the present process there is less crumbling of the ultimate surface. In the case of the earlier methods the fine topping material has been inclined to crack or fritter off at the top surface. The coarser aggregate of the present arrangement is held in place much better than the fine material of the previous road toppings, however they are applied. Some portions of these previously applied road toppings have been swept away or dislodged even during the brooming or burlapping of the final surface.

(2) Greater strength is afforded to the roadbed due to the addition of cement only to the stone aggregate which latter is of fairly coarse nature; no sand or particles less than ¼ inch being used in the topping layer, and preferably greater than ⅜ inch.

(3) The introduction of titanium oxide or the use of white Portland cement alone, in the topping layer, produces a road surface light in color which increases visibility greatly at night and reflects heat off of the surface in the daytime. However, it is not sufficient to produce glare in the daytime. Of course, within the broader aspects of the invention, regular Portland cement can be used, but for lightening the surface for increased visibility the white Portland cement or the titanium oxide will result in a concrete surface of a much lighter appearance.

(4) The density of the wearing surface of the road is increased greatly due to the consolidation of a greater mass of hard material worked into substantially the same space by vibration, during which voids are eliminated and the surface zone filled with extremely hard surfacing material.

It is understood that changes and modifications may be made in the invention as illustrated and described herein without departing from the scope thereof as defined in the following claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. The method of constructing a concrete pavement for roads and streets subject to heavy vehicular traffic as opposed to interior flooring constructions, which method consists of the steps of pouring and spreading without the application of vibration a concrete base slab of substantially the standard gravel, sand and cement mix, containing the usual proportion of voids, but being of a relatively low water content, up to a level of substantially the final desired grade; grading a quantity of hard road-metal aggregate selected from the group consisting of gravel and broken stone or hard rock, to size ranging from about three quarters of an inch to about three eighths of an inch in diameter; mixing said aggregate with dry Portland cement after having slightly wetted the aggregate with water only sufficiently to cause a coating of the dry cement to adhere to the particles of aggregate; then spreading a layer of said dry-coated aggregate directly upon the top surface of the base slab, without the interposition of any other material, while the concrete comprising the slab is still somewhat wet; then vibrating this overlay of aggregate to embed the coated aggregate particles in the surface of the base slab replacing the natural voids in said base slab to the extent that the upper portion of the base slab is densified without substantially increasing the over-all height of said desired grade; the process thus described serving to obviate the presence of fines in the top surface of the pavement which fines could be dislodged by a finishing treatment such as brooming or the like.

2. The method of constructing a concrete pavement for roads and streets subject to heavy vehicular traffic as set forth in claim 1 in which the vibration of the added aggregate is effected at low amplitude and an extraordinarily high frequency of approximately 10,000 cycles per minute.

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