UNITED STATES PATENT OFFICE.

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ART OF MANUFACTURING COMPRESSED ASPHALT PAVING-BLOCKS.

1,007,832. Specification of Letters Patent. Patented Nov. 7, 1911.

No Drawing. Application filed April 23, 1910. Serial No. 557,276.

To all whom it may concern:

Be it known that I, GEORGE E. WHITNEY, a citizen of the United States, and a resident of Yonkers, in the county of Westchester and State of New York, have invented an Improvement in the Art of Manufacturing Compressed Asphalt Paving-Blocks, of which the following description is a specification.

This invention relates to the manufacture of compressed asphalt paving blocks which are commonly made from a mixture of stony ingredients and a bituminous binder, formed in a mold under heavy pressure.

The invention pertains more particularly to the treatment of suitable asphalt block mixtures in molds for purposes of compression and compacting.

The invention may be readily understood by reference to an illustrative method hereinafter described by which it may be practiced in forming asphalt blocks, tiles or the like from a suitable block mixture,—for instance a mixture comprising as a "body material," so-called, crushed and partly pulverized hard stone, together with pulverized softer stone called "fines," and a cementing or binding agent such as a bituminous cement.

The peculiar and characteristic constituents preferred to be used in asphalt block mixtures and the difficulty of treating these constituents and commingling them in a completely homogeneous mass under compression sufficient to form a compact, durable block, have given rise to serious and difficult problems which for many years have commanded careful attention and experimentation by experts in the art in an attempt to produce with commercial rapidity asphalt blocks of such quality as to be practicable for use under all the varying conditions of temperature and traffic. A customary asphalt block mixture comprises as stony ingredients a large proportion of crushed hard rock, for instance trap rock, and a preferably lesser proportion of pulverized stony material, as for instance, pulverized limestone or the like, such stony ingredients being concorporated with a cementitious binding agent such as a bituminous cement. The attention of the experts in the art has been especially directed to the problem of procuring an intimate commingling of these various ingredients, a homogeneous distribution of the cementitious agent and a homogeneous and effective cementation uniting the stony particles under heavy mechanical compression in a mold. It is one of the objects of the present invention to solve certain of these problems peculiar to and characteristic of the art of manufacturing compressed asphalt paving blocks.

In the course of extensive experiments, made with a view to obtaining rapid production of blocks of superior quality on a commercial scale, I have discovered that in subjecting a block mixture comprising the preferred ingredients of crushed hard stone, pulverized stone and a cementitious binding agent to heavy mechanical compression in a mold, it is possible and commercially practicable to secure important and valuable results by more or less interrupting the operation of compressing the asphalt block mixture at one or more intermediate stages, in order to introduce between the initial and final compression, an interval of relative inactivity in the compression of the mixture. This may be accomplished, for instance, by applying the pressure to the block mixture in a plurality of successive steps or stages—as by a first step of comparatively low pressure and a successive step or steps, stage or stages preferably of a higher pressure. A brief rest or dwell may intervene between successive applications of pressure or a lull in the speed of application or the progression of such pressures may be introduced. However the result be accomplished, the invention contemplates an interval of reduced activity during the compression of the asphalt block mixture and preceding the final pressure stage or stages by which the block is finally compacted and compressed. The pressure applied for each separate step or stage is preferred to be a steady continuously increasing pressure as distinguished from a sudden impact or blow.

The substantial and valuable advantages accruing from the practice of this invention pertain particularly to the characteristic ingredients preferred to be used in asphalt block mixtures. For instance, by employing this invention it is practicable to produce such a substantially homogeneous distribution and commingling of the stony and

cementitious ingredients of the block mixture that the finished block has maximum strength, durability and specific density, all of which are highly important qualities in commercial asphalt paving blocks and have been impracticable to procure to the fullest extent, heretofore in the art, because of the peculiar problems encountered in treating characteristic asphalt block ingredients. Moreover, blocks may be produced by the practice of this invention, while retaining all the advantages thereof, with great rapidity.

The crushing of the body material above mentioned, which, for instance, may be trap rock, produces particles having rough surfaces and sharp or angular edges and may produce also some pulverized hard rock. A large proportion of the body material is substantially coarser than the fines; for example, the largest particles of the body material are preferred to be of about the size to pass a quarter inch mesh. The body material comprises preferably graded sizes of particles, the size next to the coarsest being intended to enter the interstices between the coarsest as far as practicable, and so down to the smallest particles of the hard rock, the grading being such that each smaller size will enter and fill as nearly as practicable the interstices between the next larger size.

For commercial purposes it is somewhat undesirable to produce the fines from hard rock, such as trap, in sufficient quantities to fill the ultimate interstices between the smallest grade of particles of the body material; the fines are preferably formed by pulverizing a softer rock such as a relatively soft limestone which may be readily ground or crushed to such an exceeding degree of fineness that, preferably, approximately 95% of the fines so produced will pass a 200 mesh screen. The stony materials of the character just described may be mixed with any practicable bituminous cement of a character familiar to those skilled in the art of manufacturing paving blocks. Before mixing the stony ingredients with the cement, the former are preferably heated to about 370° F. to expel the moisture and to bring it into a suitable condition for mixing with the cement. The fines are usually mixed with the substantially coarser body material. A part of the fines may consist of the pulverized hard rock formed in crushing the harder body material, and sufficient additional fines, preferably of the softer rock, are added to suit the requirements of the block mixture as will be understood by those skilled in the art. The fines and substantially coarser body material are preferably thoroughly dry mixed in a mixer, after which a suitable quantity of bituminous cement is added thereto, as for instance, about 8 per cent. to 19 per cent. by weight of the stony material according to the percentage of bitumen in the cement.

In accordance with the preferred practice, only enough bituminous cement should be used to coat every surface of the stony material to form a cementitious film thereon by which each particle of the stony material may be strongly united to adjacent particles. When treated in such proportions as these and heated to the usual high temperature, the mixture of stony ingredients and cement assumes a somewhat granular and viscous consistency which continues at the time of the introduction of the mixture to the mold. Obviously, and as is well understood in the art, it is important that the graded body material and the fines, coated as described with the cement, should be distributed as homogeneously as possible throughout a segregated mass intended to be made into a block, so that the progressively smaller coated particles of the mass shall occupy to the fullest possible extent the interstices between the larger particles, with the result that in the final compression of the block the stony particles will be forced into the closest possible union. One of the objects of this invention is to promote this homogeneous distribution of the stony ingredients to the greatest extent possible and it is found to be a fact that in a block produced by the practice of this invention there is a homogeneous distribution of the components thereof to a degree impossible to be obtained commercially in any manner heretofore attempted.

It will be understood that when the mass of the asphalt block mixture is confined in a mold and subjected to the tremendous pressure usually employed, for instance about 200 tons for a block approximately 12x5x3 inches, (the amount of pressure desired varying with the time the mixture is to be held under compression) each stony particle of the mixture is forced to adjust and readjust itself relative to adjacent particles and to force itself into the closest possible union and engagement with all neighboring particles. This relative distribution and adjustment of the stony particles and also of the cement in the mixture is caused, of course, by external pressure and necessarily requires some period of time to be accomplished. If the commercial necessity for rapid production of blocks would permit, it would be desirable to give the stony particles in a mixture a liberal allowance of time during which to enter the described distribution and readjustment, but it is, of course, an important desideratum in manufacturing asphalt blocks on a commercial scale to increase the speed of production as much as possible and it has been found economical and desirable to compress on one press, at least, from twenty to twenty-five blocks per minute, this speed of production being entirely practicable in the practice of the present invention. It is one of the im-

portant results of the invention that it provides for a proper correlation of the pressure necessary to initiate the described readjustment, and of the time required for such readjustment. This important correlation is so effected that an adequate allowance of time is practicable while maintaining a high rate of production. For example, the preliminary pressure application contemplated by the invention effectively initiates the readjustment of the stony particles in the mixture, after which, and while the adjustment is taking place, the compressing operation is more or less interrupted in order to introduce an interval or stage of reduced activity in the positive compression of the mixture, during which the particles may readily slide or flow in relation to each other under the conditions induced by the initial pressure application. In other words, the initial compressing action may set up a tendency for the particles to rearrange themselves and enter into their final compacted relations, while the subsequent period of less activity affords an interval during which this tendency can operate easily by a sort of viscous flowing action. Finally the ultimate compressing pressure is applied and by my herein described process is of the fullest effect to compact the particles into their proper relationship.

It is a well known fact that in uniting any two bodies by cement or the like, it is desirable to combine the direct pressure of the cemented surfaces toward each other, with a slight shifting of position in order somewhat to thin the cement body and force the cemented surfaces into as intimate engagement with each other and the cement as is practicable. This general rule holds in respect to the stony particles of an asphalt block mixture in that the desirable combination of direct compression with the lateral movement or shifting of the parts provided for by introducing the interval of reduction in activity in the compressing operation, secures the best possible adhesive effect between the particles and at the same time thins the cement union between the particles whereby the lesser cohesion of the cement itself is relatively and substantially reduced in favor of the adhesive action thereof which is known by those skilled in the art to be of substantially greater strength than its cohesion.

It is found that the fines in a block mixture which heretofore have been likely in some degree to segregate in masses or to ball up, are, in the practice of this invention, caused to distribute themselves with a viscous flowing action in and with the cement and are thus more thoroughly disseminated throughout the block, thereby contributing substantially to the desired homogeneous structure thereof, and affording the fullest opportunity for the introduction of the cement between the particles of fines and the resultant effective adhesion and cohesion of components of the block.

The ordinary asphalt block mixture, in its granular and viscous condition, contains more or less air in the interstices of the mixture; tests have shown that the air spaces in a mixture may constitute about 33 per cent. of the entire volume. By methods of compression heretofore employed, the air usually contained in the mixture has been but partially expelled, a considerable proportion of it being permanently imprisoned and leaving distributed in the interior of the block, a number of air filled pockets each of which is, of course, a point of weakness and reduces the specific density of the block. One reason for this, I believe, resides in the fact that the continuous uninterrupted application of initially applied high pressure does not so compact the mass as to effectually eliminate the air pockets. When, however, as contemplated by this invention, the compression is more or less interrupted to increase the compactness of the mass, the confined air is found to be expelled. Whatever the correct theory, it is true as a matter of fact, that blocks formed by the practice of this invention are of maximum specific density and contain a very small aggregate of air pockets.

I have found by tests that the above described advantageous results may be obtained even though maintaining some pressure upon the mixture in the mold during the entire course of the compressing operation from beginning to end and including the interval of less activity, and by applying final compression at the end of such an interval at substantially the maximum degree of the initial pressure preceding said interval. The interval of reduced pressure may be of such short duration as would be hardly perceptible, nevertheless such interval will suffice to furnish an opportunity for the stony particles to rearrange and readjust themselves to best fill the interstices and to distribute the cement to the highest advantage. In order also to produce blocks of the greatest durability there should be the proper proportions of the properly graded body material and the fines, heated to the proper temperature, preferably 370° F., thoroughly mixed with the proper proportion of bituminous cement of the proper penetration heated to the proper temperature, preferably 370° F. All these qualities affect materially the durability of the block, also the mobility of the composition and its action under compression. In fact, any material variation in the proportion of the different grades of the body materials, the proportion of the body materials to the fines, or material variation in the temperature of

the stony materials, requires a corresponding variation in the amount or character, or both, of the bituminous cement which is employed as the binding agent.

In the rapid commercial manufacture of these blocks, it has been found heretofore extremely difficult to determine, while the material is under compression in the mold, whether the various conditions considered requisite for a perfectly uniform or desired product actually obtain. I have, however, discovered that material differences in the mixture may be readily detected and compared if the action of the mixture be tested when in a partially compressed state. This test preferably is one of the mobility of the mixture. A continuously progressive compression affords no observable opportunity for testing the mobility of the mixture in a partially compressed state, but by compressing the blocks in steps or stages, as hereinbefore described, an opportunity may be had for accurately determining the mobility of the mass.

With the compressing operation divided into steps or stages, even when such steps or stages follow each other in rapid succession, it is possible practically to observe the action, mobility or compressibility of the material which is in the mold or press at an intermediate step or point of compression or while the mixture is in a partially compressed condition, so as to permit a comparison of the action, mobility or compressibility at that stage with a known or given standard of action, and thus determine whether or not the material is in the desired condition. If, for instance, the compression during the first step or stage progresses further than normal, it indicates, for example, too high a temperature of the material, or a too fluid or a too mobile condition of the composition. If, on the contrary, the compression during the first step or stage is less than normal it indicates, for example, too low a temperature of the material or insufficient fluidity or mobility of the composition. In either of the above events the error should be promptly corrected.

It is to be understood that this invention is not limited to the specific details and sequence of operations of the above described illustrative method. On the contrary the invention may be variously practiced within the scope of the subjoined claims.

Claims:

1. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by heating crushed stone particles; mixing said heated stone particles with heat-softened bituminous cement and thereby providing each of said particles with a heat-retaining bituminous coating tending to develop different temperatures at different portions thereof; preliminarily compressing a segregated batch of the stone and bituminous cement so mixed, by relatively low pressure, to effect a partial compacting of said batch; following such preliminary compression by a period of comparative inactivity in compression of the batch, permitting conduction of heat throughout the batch to establish more uniform temperature in the bituminous cement and thereby to render the latter more uniformly fluid and of more homogeneous consistency and adhesiveness; and subsequently applying relatively high pressure to force the stone particles and bituminous cement into closer relation as a unitary block.

2. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by mixing hot graded crushed stone, fines, and a hot bituminous binding cement, introducing the same into a mold and there adjusting the relative positions of the hot graded crushed stone, fines, and the hot bituminous cement by subjecting the same to preliminary relatively low pressure; following such adjustment by a period of comparative inactivity in compression of the material; and then subsequently subjecting it to an ultimate relatively high pressure to produce a uniformly blended homogeneous mass of graded stony material with its stony pieces and particles separated and united by a permanent bituminous binding filler.

3. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by mixing hot, graded, crushed stone, fines, and a hot bituminous binding cement, introducing the same into a mold; and there adjusting and shifting the relative positions of the hot graded crushed stone, fines, and the hot bituminous cement by subjecting the mixture to a plurality of compressions with a period of comparative inactivity of the material between them, to produce a uniformly graded homogeneous mass with its stony pieces and particles separated and united by a permanent bituminous binding filler.

4. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by mixing a batch of hot stone particles, fines, and a bituminous cement and subjecting a segregated portion of the batch so mixed to a plurality of compressions in a closed receptacle; permitting a period of comparative inactivity of the material between such compressions.

5. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by subjecting the block composition while hot to a preliminary relatively low pressure; following such low pressure by a period of comparative inactivity of the block composition; and

subsequently to an ultimate relatively high pressure whereby the character of the block composition may be determined by the relative compressive effect of the lower and higher pressures.

6. That improvement in the art of manufacturing compressed bituminous paving blocks which is characterized by mixing a batch of hot stone particles, fines, and a bituminous cement, and subjecting a segregated portion of the batch so mixed to a plurality of compressions with interrupted compressive readjustment in a closed receptacle.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

GEORGE E. WHITNEY.

Witnesses:
PRESTON UPHAM,
ROBERT H. KAMMLER.