The present invention relates to the production of a cold-laid sheet asphalt pavement and a method of manufacturing a paving composition adapted to such purpose.

The primary object is to provide a process which is particularly well adapted to the manufacture of a cold-laid paving material in which very hard, stony aggregates are used as the base, or main body, of the composition, which is adapted to resist wear and withstand heavy traffic. Such aggregates as granite, basalt, quartz, certain glacial sands, and so forth, may be employed as the main resistant body of the composition; and preferably materials of this character are employed for this purpose where available to serve as the main aggregate or base aggregate of the composition. Such materials are non-absorptive, and difficulty is experienced in coating the pellets or particles of the hard, stony materials with asphalt. A relatively soft asphalt does not adhere firmly to the surfaces of aggregates of this character, especially to the larger sizes of the aggregate, so that pavements constructed of such materials may have the asphalt more or less washed from the surface. On the other hand, it is possible to obtain improved results by following the process herein described, in which, according to the preferred method, the particles or grains of the hard aggregate are first coated with a relatively hard asphalt at a rather high temperature, and then coated with a relatively soft asphalt at a lower temperature. Certain other steps are employed to put the composition into the best condition for cold-laying and to give the best results in the paving.

In carrying out the invention, it is preferred to employ a base aggregate which is finer than the meshes in a ten-mesh sieve; a filler, such as limestone dust, preferably to the extent of about 25% of the main aggregate; an asphalt binder which comprises a relatively hard asphalt and a relatively soft asphalt, or an equivalent of a mixture thereof; and a highly absorbent lubricant-carrier, such as infusorial earth or kieselguhr, taken in very small percentage, and a small percentage of a substance which will serve as a lubricant for the purpose, which can be taken up by the absorbent carrier. For example, the kieselguhr may be treated with its own weight of light paraffin flux or flux oil. Crank case oil will serve the purpose, when available. Other suitable oil, or substances, which will serve the purpose, may be employed.

A paving material produced in accordance with the present invention is quite friable and can be broken apart by gentle pressure. On the other hand, it will compress easily in the cold (without melting the binder) in the laying of the pavement, will be practically free from voids, and will form a wearing surface which does not "push" and which is highly resistant to wear under the action of traffic.

The grains of any successful cold-laid pavement must be covered with a softer asphalt than that which is used in hot-laid constructions. At the same time, the individual particles constituting the mass of the mixture must be prevented from adhering together too tenaciously before compression into the pavement is effected. If, without using such precautions, a softer asphalt is employed than is ordinarily used in hot-laid construction, the pavement produced will be unstable, with the consequence that the pavement will be subject to ruts and waverness. This tendency towards instability is overcome in the present process by the selection of a mineral aggregate possessing a great inherent stability. Also, preferably, where the very hard, resistant kind of stony material is employed as the main aggregate of the composition, the particles preferably are first coated with a relatively hard asphalt, which will not wash off readily; and a relatively soft asphalt is introduced to give to the material the capability of being compressed in the cold into a pavement; a pulverulent filler, such as limestone dust is employed to reduce the voids; the percentage of asphalt employed is near that which will complete the filling of voids, but preferably stopping somewhat short thereof, and certainly avoiding over-filling, which might tend to cause flowing or moving of the pavement on hot days under heavy traffic conditions; and a lubricant-
carrier, such as kieselguhr (sometimes sold as cellite) is employed to give the desired friability to the materials, both the kieselguhr and the oil or flux carried thereby serving to effect a desirable separation of the particles of the main body of the pavement and prevent premature packing, or sticking together. On the other hand, the kieselguhr and the lubricant, as well as the relatively soft portion of the asphalt, tend to give the necessary mobility and contacting qualities to the paving material, which enables it to be finally compressed into sheet asphalt in the cold.

The following is given as an example of the process:

Take 281 parts of a high stability sand, as for example, that obtained from the Potomac River and now commonly used in asphalt pavements in Washington, D. C.; dry the sand and heat it to a temperature of about 275° F.; mix with the sand in a mixer at said temperature about 13 parts of hard asphalt having a penetration between 23 and 75 A. S. T. M., the mixing operation being carried on until all the grains are covered with a light coat of asphalt; allow the temperature to drop, while continuing the agitation or blowing a blast of air on the mass, to a temperature of about 235° F.; and mix with the mass, at such temperature, about 13 parts of softer asphalt, say an asphalt having a penetration test of between 150 and 250, the mixing operation being continued until a thorough mixture is effected and the previously coated grains become evenly coated with the softer asphalt; then allow the temperature to drop to about 200° F. and introduce into the mixer about 60 parts of fine limestone dust, added in a cold state, the mixing operation being continued until all of the limestone dust is covered so that no white spots appear in the mixture and all grains are uniformly covered with asphalt. This leaves the entire mass in the form of a homogeneous black powder.

The temperatures stated above are much higher than the melting points of the asphalt employed, and they are such as to keep the asphalt in a thin liquid condition. By way of example, it may be stated that the melting point of the hard asphalt of about forty penetration is about 140° F., while the melting point of a soft asphalt may be around 105—110° F. The purpose of the higher temperatures is to lower the viscosity so as to facilitate the mixing operation. The moderate lowering of the temperature of the mass noted above may be effected in any desired way, as, for example, by proper admixture of materials at suitable temperatures to give the desired resultant temperature. After the coating of hard asphalt has been applied to the graded, hard aggregate, the material should not be allowed to become cold before admix-

ing with the material the molten softer asphalt. In fact, as seen from the example given, the materials are maintained at a high temperature until the time for introducing the limestone dust. It is not desirable, in any case, to allow the temperature to be reduced below 175° F. before the admixing of the softer asphalt with the mass.

A mixture of 4 parts of kieselguhr and 4 parts of paraffin flux, for example, is added in the cold state to the main cooling mixture in the mixer and thoroughly stirred in. The kieselguhr and paraffin flux should be separately heated to a temperature of about 225°, mixed at this temperature, and allowed to cool to air temperature. This gives a suitable mixture for introduction into the main body of the paving mixture. After the final mixture of all the materials has been properly effected, the material is allowed to cool and is ready for use on the street. It may be stored, and it may be shipped in open trucks, open railroad cars, or in bags or barrels.

In the example given above, instead of applying all of the asphalt to the sand, the coating of hard asphalt may be applied to the sand, and the soft asphalt may be mixed in melted condition with the limestone dust at a temperature of 250° F.; the mixture of limestone dust and soft asphalt may be allowed to cool to air temperature and may then be mixed with the coated sand while the latter is at a temperature of about 200° F. The treated kieselguhr may be introduced into the combined mixture or it may be introduced into the coated limestone dust.

Where a more absorbent aggregate is employed, it is feasible to melt the two asphalts together and then effect the mixture with the sand, or a specially prepared asphalt of the same penetration as the mixture, say about a range of 90 to 100 A. S. T. M. may be used; and this may be mixed at suitable temperature with the aggregate in one operation, say a temperature of 240° F. After cooling to about 200° F., the filler (such as limestone dust) may be admixed; and the treated fusorial earth may then be admixed.

Various kinds of hard sands are available, such as the sands from the Potomac River, mentioned above, the asphalt sands now commonly used for pavements in New York city, and so forth. Glacial or pit sands are found in many places in the northern part of America which have a fair degree of sharpness, but whose grading is considerably coarser than the sand ordinarily used for soft asphalt. It is possible to obtain these sands of such mixed grade that the voids in the same are kept near a minimum for sand, resulting in a high stability for the main portion of the paving composition.

Instead of natural sands, quarry tailings, such as limestone fines, basalt, granite, quartz, and the like may be used, properly.
graded. Other sorts of suitable main aggregates are the tailings from mining and milling operations, as for instance, the Joplin chats, and the refuse from copper mining operations in northern Michigan. Industrial wastes, such as hard slags from metal smelting plants, when ground to sufficient fineness, may be used as the main aggregate in improved paving composition. Good, sharp torpedo sand is excellent for the purpose. In this connection, it is to be borne in mind that the harder aggregates are preferable, when available; and it is to be borne in mind that different aggregates vary in their ability to hold the asphalt coatings, and desirable variations in the size of the aggregate particles, the grading and the selection of the asphalt binder will be made, in accordance with the invention, to obtain the best results.

Instead of limestone dust, one may employ other finely pulverulent, stony material adapted to fill the voids between the particles of the main or coarse aggregate; and instead of kieselguhr, one may employ other highly absorbent material, such as finely divided asbestos, wood-flour, and so forth.

The improved pavement, when fully compressed, preferably contains a very small percentage of voids. It is preferred to have the voids not over 24%. They may be lower, but it is desirable to stop short of complete filling of the voids with the asphaltic binder in order to avoid overfilling. By reducing the voids to a very small per cent, water tightness of the pavement is assured and by avoiding overfilling, instability of the pavement is obviated. The total percentage of asphalt used will always be less than that used in hot mixes. The particles of stony material will be pressed closely together in forming the pavement, and stability is gained in this way, notwithstanding the use of an asphalt binder which, as a whole, is softer than that used in hot-laid pavements.

The amount of kieselguhr and flux used will be governed by the grading and characteristics of the main aggregate and the filler. Finer aggregates require somewhat more of these materials. Ordinarily, the percentage of each of the materials, kieselguhr and flux, will be between 1 and 2% of the weight of the paving mixture. The flux or oil may be somewhat less than the kieselguhr; and the kieselguhr ordinary should be kept below 3%.

In the example given above, the proportions are by weight. The test of the asphalt is in accordance with that established by the American Society for Testing Materials.

When a less ductile asphalt binder, such as Cuban asphalt, gilsonite or pitch, is used with asphaltic flux, or the short asphalt obtained by the blowing of soft Mexican or Gulf Coast residues, or that obtained as the residue in the distillation of oils from the American mid-continent field, is employed, a single asphalt or asphalt cement with a penetration of from 60 to 150 may be used.

When using any of these asphalts, with the exception of the Cuban, 231 parts of the sand, 60 parts of the filler and 26 parts of asphalt of the character specified, are separately heated and mixed together at a temperature of 250° F.; the temperature is then cooled to about 200° F. and the mixture then receives the addition of the treated kieselguhr. The resulting mixture, while not exactly the same in appearance as in the examples given above, being less granular, is satisfactory and can be used for cold-laid pavement. When Cuban asphalt cement is used, the proportions given will be changed to allow for the impurity in the asphalt, necessitating increasing the amount of asphalt and decreasing the amount of filler somewhat.

The grading of sand preferred is one in which 12% passes 100 mesh, being retained on 200 mesh; 13% passes 80 mesh and is retained on 100 mesh; 48% passes 40 mesh and is retained on 80 mesh; and 28% passes 10 mesh and is retained on 40 mesh.

It is obvious that changes in proportion and grading within the spirit of the invention may be made and will be desirable, depending upon the materials used.

The improved composition may be economically prepared in a suitable, properly located plant; and the prepared material may be transported to any point where it is to be used. The prepared material possesses a texture which enables it to be cut with a spade and broken into bits. The composition is dry enough to enable it to be shoveled and handled with facility, is somewhat pliable, is not friable in some degree, but, nevertheless, is well bonded. Accordingly, it is suitable to enable it to be shoveled and spread upon the street and raked in such a manner as to secure a fairly even distribution. After being thus spread upon the street, it may be rolled under a heavy roller and the particles thoroughly bonded to the existing pavement and to each other. It has been found that the composition thus applied becomes virtually a part of the existing pavement, and the repaired portions of pavement will withstand heavy usage.

While the improved composition is particularly adapted to the purpose of repairing asphalt pavements, it will be understood that it may be used for repairing any pavement, or even for producing pavements, sidewalks, etc. It is well adapted, for example, to the purpose of filling chuck-holes in macadam pavements, and, when so employed freely, will tend to give an asphaltic character to the macadam pavement.

It is possible, of course, for example, in freezing weather, to warm the improved composition before rolling it, in effecting a street.
repair. This is unnecessary, however, as the composition is of a suitable character and sufficiently plastic to enable it to be compacted together and bonded to the pavement without the use of artificial heat. This is especially true where the repair is effected in a warm climate, or, in the summer time, in temperature climates. Heating above 100°F., even in cold weather, tends to deteriorate the compound, and should be avoided.

It may be added that the asphalt in the paving compound hardens with time. Apparently, it slowly becomes polymerized, finally resulting in a compound having a high crushing strength.

A sealing layer over the pavement is unnecessary. It is common practice to use such a layer where desired. Obviously, such a layer may be laid over the improved paving here described, if desired. Such a layer may consist of asphalt of about 100 penetration. This may be melted and, in melted condition, 2 parts by weight may be mixed with 1 part weight of gasoline. The resultant composition may be sprinkled or sprayed on the pavement and this may be sprinkled over with sand or the like. In cases where the improved pavement comprises extremely hard aggregate, such a sealing layer may perhaps be employed with advantage.

If desired, the two-coating method may be employed by first applying to the particles of the main aggregate a hard, ductile asphalt, such as an oil asphalt or Trinidad or Bermudez asphalt cement having a penetration of 25-75; and by then applying a softer, less ductile asphalt, such as Cuban asphalt, of 150-250 penetration.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, but the appended claims should be construed as broadly as permissible, in view of the prior art.

What I regard as new, and desire to secure by Letters Patent, is:

1. A process of producing a paving material capable of being stored, shipped and cold-laid which comprises: coating with molten hard asphalt the particles of a stony aggregate; reducing the temperature moderately and coating the particles with a molten softer asphalt; and introducing a small percentage of a lubricant and an absorbent carrier therefor.

2. A paving material capable of being stored, shipped and cold-laid comprising: a main aggregate of graded stony material, substantially all of which passes a ten mesh sieve, the grains of said aggregate being coated with an asphalt preparation corresponding with an asphalt having a penetration of 90 to 160 A. S. T. M.; a void-filling, stony material of pulverulent character and which constitutes approximately 25% of the main aggregate; and a small percentage of lubricant and an absorbent lubricant-carrier intimately admixed with the other materials and each constituting less than 5% of the compound.

3. A paving material adapted to be stored and transported in condition ready for laying comprising: a hard, stony, graded aggregate, substantially all of the particles of which will pass a ten mesh sieve, the particles of which are coated with asphalt; a void-filling, pulverulent stony material constituting less than 50% of the main aggregate and intimately mixed with the coated main aggregate; and a minor percentage of a lubricant and a carrier for said lubricant comprising infusorial earth, each comprising less than 5% of the compound.

4. A friable paving material adapted to be stored and transported in condition ready for laying comprising: a hard, stony, graded aggregate, substantially all of the particles of which will pass a ten mesh sieve, the particles of which are coated with asphalt; a void-filling, pulverulent stony material constituting less than 50% of the main aggregate and intimately mixed with the coated main aggregate; and less than 5% of a pulverulent absorbent material, such as kieselguhr.

5. A paving material adapted to be stored and transported in condition ready for laying comprising: a hard, stony, graded aggregate, substantially all of the particles of which will pass a ten mesh sieve, the particles of which are coated with asphalt; a void-filling, pulverulent stony material constituting less than 50% of the main aggregate and intimately mixed with the coated main aggregate; and less than 5% of a pulverulent absorbent material, such as kieselguhr.

6. A process of producing a paving material adapted to be stored and transported in condition ready for laying which comprises: coating with molten hard asphalt the particles of a main graded stony aggregate all of which passes a 10-mesh screen and about 75% of which is retained on about an 80-mesh screen; reducing the temperature moderately and coating the particles with a molten softer asphalt; and mixing with the double-coated main aggregate a void-filling pulverulent stony material constituting about 25% of the main aggregate and also a small percentage of an infusorial earth.

7. A process of producing a paving material adapted to be stored and transported in condition ready for laying which comprises: coating with highly heated, thinly fluid, hard asphalt the particles of a main graded stony aggregate all of which passes about a 10-mesh screen and about 75% of which is retained on about an 80-mesh screen; mixing with the coated aggregate a heated, thinly fluid, softer asphalt at a lower temperature; and mixing with the resultant mixture a void-filling pulverulent stony material and a minor percentage of a lubricant and a
minor percentage of an absorbent pulverulent carrier for said lubricant, the void-filling pulverulent stony material constituting about 25% of the main aggregate.

8. A process of producing a paving material adapted to be stored and transported in condition ready for laying which comprises: mixing a graded, hard aggregate and a hard asphalt at such elevated temperature as to maintain the asphalt in thinly fluid condition; lowering the temperature moderately and mixing with the mass a substantially softer asphalt in thinly fluid condition; mixing with said materials a void-filling dust-like material constituting less than 50% by weight of the first-mentioned aggregate and obtaining a resultant product of lower temperature; and mixing with the last-mentioned mixture a minor percentage of a lubricant and a minor percentage of absorbent pulverulent carrier for said lubricant.

9. A process of producing a paving material adapted to be stored and transported in condition ready for laying which comprises: mixing a graded, hard main stony aggregate; heated asphalt in thinly fluid condition; and a void-filling dust-like stony substance; and incorporating in the mixture 1% to 3% of a lubricant and 1% to 4% of an absorbent carrier for said lubricant.

10. A process of producing a paving material adapted to be stored and transported in condition ready for laying which comprises: coating with highly heated thinly fluid asphalt a main graded hard stony aggregate, substantially all of whose particles pass a 10-mesh screen; incorporating a void-filling dust-like stony substance equal to about 25% of the first-mentioned aggregate; and incorporating in the mixture 1% to 3% of a lubricant and 1% to 4% of an absorbent carrier for said lubricant.

11. Doubly coating a main graded hard stony aggregate first with heated thinly fluid hard asphalt and then with heated thinly fluid soft asphalt at a lower temperature; incorporating in the mixture a void-filling pulverulent stony material; and incorporating in the mixture a minor percentage of a lubricant and a minor percentage of an absorbent pulverulent carrier for said lubricant.

12. Preparing a mixture comprising a void-filling pulverulent material and a main graded stony aggregate doubly coated first with hard asphalt and then with soft asphalt; and mixing therewith before the mixture becomes cold a small percentage of a lubricant and a small percentage of an absorbent carrier therefor.

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