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ASPHALT PENETRATIVE GROUND STABILIZER

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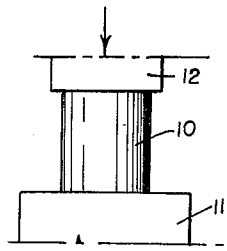


Fig. 1

Fig. 2

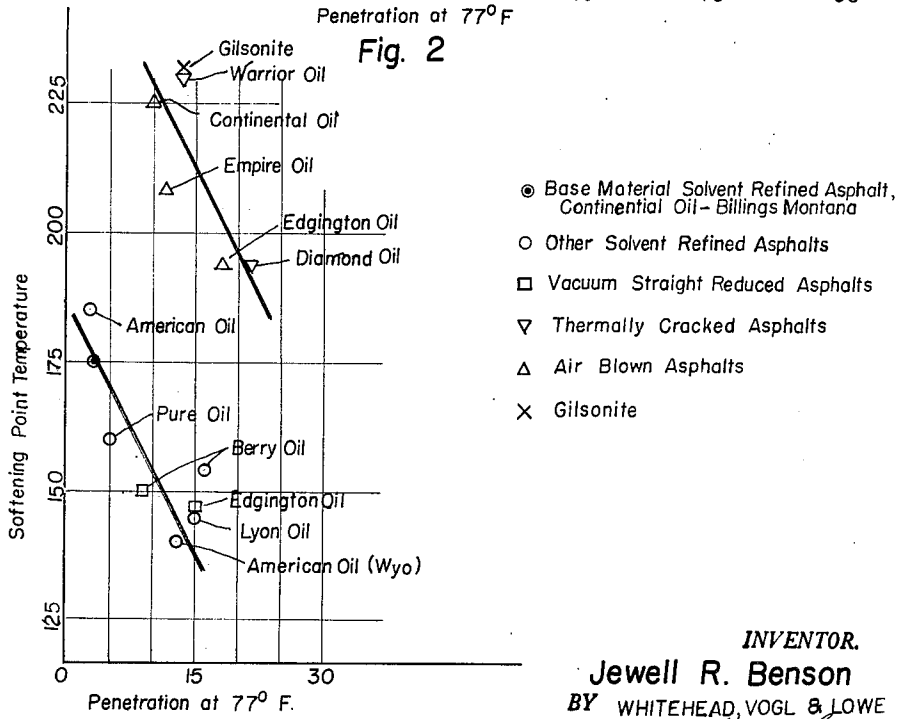


Fig. 3

◉ Base Material Solvent Refined Asphalt, Continential Oil - Billings Montana

○ Other Solvent Refined Asphalts

□ Vacuum Straight Reduced Asphalts

▽ Thermally Cracked Asphalts

△ Air Blown Asphalts

× Gilsonite

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ASPHALT PENETRATIVE GROUND STABILIZER

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3 Claims. (Cl. 94—23)

This application is a continuation-in-part of my earlier application for Asphalt Penetrating Primer, Serial No. 85,511, filed January 13, 1961, now abandoned.

This invention relates to asphaltic road construction and soil stabilization and more particularly to road constructions and stabilized soils which are solidified and bound by a dispersion of asphaltic material throughout the particulate matter constituting the road or soil surface. A primary object of the invention is to provide, through a prime-like application of an improved asphaltic liquid binder material, a novel and improved road construction wherein the earth and rock materials are effectively stabilized and hardened by the binder penetrating and being absorbed into the earth and rock materials forming the road bed and after curing, cementitiously bonding the materials together. As such, the asphaltic liquid binder material will be herein referred to as an asphaltic penetrative binder and the stabilized and hardened road or earth surface will be hereinafter referred to generally as an asphaltic stabilized surface.

Subsequent to the filing of my former application for an asphalt penetrating primer, as above set forth, additional suitable materials were found to exist. Also, field and laboratory tests disclosed that the dominating property of the improved asphalt material was its binding power when cured, and that it could be more properly called an "asphaltic penetrative binder," or an "asphalt penetrative ground stabilizer" rather than a penetrating primer although it is conveniently applied to a surface as if it were a priming material. For that reason, the improved material will ordinarily be classed and compared with primers.

Bituminous priming materials are used on soil surfaces, on subgrades, sub-bases and base courses of roads and the like. Priming is especially needed on subgrades and base sources of roadways to properly bond the top wearing surface of the road to the subgrade or base, and as an adjunct the priming will, to a degree, waterproof and stabilize the surface of the treated subgrade or base course. The conventional materials used for such priming operations include cut-back coal tars, soft-base liquid asphalts and soft-base asphalt emulsions. The use of coal tars is very limited for this purpose due to limited availability and their comparative high cost. Also, the use of asphalt emulsions is insignificant because such materials will not readily be absorbed except into coarse, porous material. By far, most priming materials now in use are soft-base liquid asphalts. The Asphalt Institute, the industrial authority on asphaltic specifications, has classified priming materials according to their speed of cure and viscosity designating the same as slow curing and medium curing asphalts having viscosities ranging from a minimum of 75 seconds, Saybolt-Furol, at 77 degrees F. to 200 seconds at 140 degrees F. The penetration of the base asphalts and of the distillation residue of these conventional priming asphalts is greater than 80 at 77 degrees F.

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This penetration is ordinarily designated as A.S.T.M. D5–61 77° F., 100-gram load, 5 seconds. A detailed procedure may be obtained from the A.S.T.M. Standards 1961, part 4, page 1144. All further references to penetration herein and in the appended claims will be based on the A.S.T.M. D5–61 77° F., 100-gram, 5-second test procedure which is the conventional test for designating the hardness of asphalts.

The various types and blends of asphaltic primers commonly available are not always satisfactory because they will give various and often unpredictable results when applied to a given surface. The surfaces which are to be primed will vary considerably. In the first place, they may be formed with selected, imported materials or they may be shaped from the natural soils at hand. The materials which are to absorb the primer may be of any type of soil, or aggregate, ranging from coarse gravels to silt and even clay and may include a combination of any such materials. In some instances the primers will not only coat the surface but will penetrate the material in a desirable manner to bond with the material and stabilize it as the primer cures.

However, at best, the degree of stabilization is slight, and in the large proportion of applications, conventional primers will not effectively penetrate a surface material. When the material forming the treated surface will not readily absorb the primer, the primer will cure as a scum on the surface. In practice, except under ideal conditions, a penetration in excess of one-fourth inch is difficult to obtain although a substantially greater penetration is desirable. Moreover, it has been shown that where a conventional primer has been diluted to a lower viscosity to obtain penetration, the thinly distributed soft-base asphalt in the primer will, after curing, have little or no stabilizing effect. Even in some soils where penetration is good the conventional primer asphalts when cured have little bonding power but actually appear to lubricate the particles forming the material to produce a "rotten" condition, the material then being soft, friable and sometimes forming an oily dust.

Priming has never been used to produce a finished wear-resistant, well-bound road or like course. Nevertheless, there is a real and definite need for an improved type of material which may be applied to a road surface or the like as a liquid which has both good penetration ability and binding and stabilizing properties after the material is cured. It must be possible to dilute the binding liquid to the point where it will penetrate tight soils and bases without losing its effectiveness after it is cured. There is especially a need for an improved binding material which may be combined, by a priming application, with soils or like base materials which are characterized by a deficiency of natural bonding or cementitious substances to give a final product having cohesion and strength. There is also a need for an improved binding material which may be combined and absorbed, through a priming application, with soils and base materials which have natural bonding or like cementitious substances which are adversely effected by water to give a final product which has cohesion and strength and is resistant to the effects of water.

There is a further widespread need, which has not been fully appreciated until field applications in accordance with the present invention demonstrated the possibility of

doing so, for the manufacture of finished roadway surfaces and other surfaces by the application of an asphaltic penetrative binder to the surface as if it were a priming liquid.

Through a series of studies and tests, an improved asphaltic penetrative binder was discovered which meets these several needs in a variety of different materials and soil types. In its simplest aspect, the present invention uses and takes advantage of the special properties of certain classes of hard base types of asphalt. The asphalt industry measures the various degrees of hardness in asphalts by penetration tests, by which tests base materials and cured materials may be classified as being hard or soft. The hardness of cured asphalt materials is considered as being equivalent to the hardness of the distillation residue which is obtained by heating the material to 680 degrees F. as per A.S.T.M. Test Method D–402. A priming material within the scope of this invention will be a type which has a distillation residue penetration of 25 or less at 77 degrees F. 100 grams, 5 seconds, based upon A.S.T.M. Test Method D5–61. It is to be noted that the penetration of the distillation residue will be approximately four points greater than the penetration of the uncut base asphalt which is used.

Heretofore, hard-base asphalts have not been used for and were, and are still not recommended for highway construction purposes. In the first place, these materials, when produced by methods other than solvent refining are usually difficult to produce economically and frequently are difficult or impossible to flux or dissolve into homogeneous solutions or dispersions. The residues of the other refining processes have physical properties which vary greatly and it is difficult to obtain a product having specified, uniform properties.

More important, hard base asphalts have not been used as primers, for producers and users alike have concluded that such asphalts are unsuitable for primers and especially because such asphalts normally represent and appear to be similar to other types of asphaltic materials in advanced stages of weathering and deterioration. The common practice, as evidenced by all current highway construction specifications prohibits the use of hard base materials, not only for primers but also for other highway purposes. Except for a limited use as powdered asphalt and for production of certain soft-base asphalts, hard-base asphalts, in themselves, have no commercial value.

Although solvent refining of asphalt has been known for some time, large scale commercial use of the process is recent. Solvent refining is used primarily to recover lubricating stocks from certain crude oils. The dominant feature of the process is the ability to recover and remove heavy oils and leave as a residue a hard-base asphalt. The process further permits an accurate control of the physical properties of the asphalt residue when it is desirable to do so. Moreover, in striking contrast with many other types of hard base asphalts, it was discovered that solvent refined, hard-base asphalts would readily dissolve and flux with ordinary petroleum solvents without sludging or separating as commonly occurs with many asphalts of similar hardness made by other methods.

Through an extended investigation involving a number of hard-base asphalts, some of which were solvent refined asphalts and others of which were produced by other refining processes, it was discovered that all solvent refined asphalts tested were suitable for a stabilizing primer according to the present invention, that most of the other types would not be suitable but that a few of these other types would be suitable. Further investigation revealed that these few other suitable types had certain important characteristics which were substantially the same as the characteristics of the solvent refined asphalts, all as hereinafter set forth in detail.

It follows that a further object of the invention is to provide a novel and improved asphaltic penetrative binder which advantageously uses a hard-base solvent-refined asphalt or a hard-base asphalt having certain properties similar to a solvent-refined asphalt.

Another object of the invention is to provide a novel and improved asphaltic penetrative binder which is especially capable of being thinned or cut by solvents to the point where, when applied to earth surface it may deeply penetrate into and be absorbed by a large variety of soils and surface materials, and of being thinned or cut to a degree sufficient to permit penetration into tight materials without losing the ability to cementitiously bond and waterproof the materials.

Another object of the invention is to provide a novel and improved asphaltic penetrative binder which takes advantage of the adhesion, hardness and strength of selected types of hard-base asphalt which, when cured from a liquid state, will bond and stabilize materials which are deficient in natural bonding and cementitious properties.

Another object of this invention is to provide a novel and improved asphaltic penetrative binder which takes advantage of the inherent fluidity of selected types of hard-base asphalts when fluxed to effectively penetrate, coat and waterproof water susceptible cementitious substances in a soil or like material.

Another object of this invention is to provide an improved asphalt-stabilized material having a dispersion of a selected type hard-base asphalt within the body of the material, and which extends through pores and on to and between the particle surfaces in the material.

Another object of the invention is to provide a novel and improved asphaltic penetrative binder which takes advantage of the inherent high solubility of selected types of hard base asphalt to permit multiple applications upon a given surface and to permit the use of higher viscosity material after an initial application with a low viscosity material.

Another object of the invention is to provide a novel and improved asphaltic penetrative binder which is especially useful to stabilize and waterproof unimproved dirt and gravel surfaced roads and form an asphalt bonded road surface without the necessity of otherwise mixing and blending the materials.

Another object of the invention is to provide a novel and improved asphaltic penetrative binder which is especially useful in rejuvenating asphalt road surfaces and road surface materials without unduly softening and by actually hardening the asphaltic constituents of the existing road surface.

Another object of the invention is to provide a novel and improved asphaltic stabilized road or like surface, and an improved method of forming the same by application of a penetrative binder to the prepared surface thereof.

Further objects of the invention are to provide a novel and improved asphaltic penetrative binder which is low-cost, easily manufactured, versatile product and which used widely available asphaltic residues having little market value at the present time.

With the foregoing and other objects in view, my invention comprises certain combinations and blends of constituents and elements as hereinafter described and set forth in the appended claims and with certain properties the material being illustrated in the accompanying drawing in which:

FIGURE 1 is a diagrammatic view of a testing setup adapted to establish the strength of selected specimens according to a procedure devised by applicant.

FIGURE 2 is a graphic representation of the strength-penetration relationship for various asphaltic materials formed as specimens and tested in a manner suggested at FIG. 1.

FIGURE 3 is a graph showing a relationship between

the softening point temperature and the penetration for the various types of asphalt enumerated in the test at FIG. 2.

As one specific example of the invention, I use a hard-base solvent-refined asphalt obtained from Continental Oil Company at Billings, Montana. This asphalt is a by-product refined from crude oil obtained from Wyoming fields. The hard-base asphalt is at a penetration between 3 and 5 indicating that only a very small proportion of oily constitutents remained in the asphalt. The softening point temperature was 174 degrees F. It is to be noted that this is far less than softening points of most asphalts of similar penetrations produced by other methods or resulting from normal oxidation and weathering and suggests that such an asphalt with this unusual penetration-softening point relationship may have certain special properties which will be hereinafter set forth in detail. To obtain an asphalt with such a low penetration by other methods which rely upon heat and also oxidation, the characteristics responsible for the advantageous behavior hereinafter noted are lost. Heat will crack and coke the asphalts and will produce insoluble substances all of which are evidenced by a comparatively large increase in softening point.

Not only does this solvent-refined asphalt have a lower softening point than other comparative types of asphalts of similar hardness, but it also dissolves and fluxes easily in ordinary petroleum solvents. This material was first diluted with a blend of kerosene and naphtha, in the proportions of 82% kerosene and 18% naphtha, a standard combination, and, for convenience, the blend contained approximately 45%, by volume, diluent to give a Saybolt-Furol viscosity of 137 seconds at 122 degrees F. So blended, this penetrative binder can be used on normally absorbent earth material in warm weather. The distillation residue of this blend was determined to be approximately 9 penetration.

By the addition of kerosene, approximately five percent (to provide approximately 50% diluent), the viscosity was decreased to 41 seconds at 122 degrees F. This second blend was suitable for use as a primer on a tight dense soil material under favorable weather conditions.

By the further addition of kerosene, approximately four percent (to provide approximately 54% diluent) the viscosity was reduced to 26 seconds at 122 degrees F. This third blend was suitable as a primer on a tight dense soil material under unfavorable weather conditions.

By the further addition of kerosene, approximately 6 percent (to provide approximately 60% diluent), the viscosity was reduced to 21 seconds at 90 degrees F. and approximately 15 seconds at 122 degrees F. This fourth blend is especially sutiable for use as a pre-primer whose essential purpose would be to pre-wet the material and produce an oily phase to permit more rapid absorption of other applications of a more viscous primer.

These blends were applied to prepared specimens, dry, wet and damp, of salt-treated, silty-clay soil having a relatively high density and low porosity. They were obtained from a highway section in Weld County, Colorado. Considerable difficulty is encountered in the highway constructed in this region, especially and because of the inability to obtain adequate priming of the subgrade and base course soils. When the blend having 45% diluent was applied at the amount of 0.5 gallon per square yard, the required time period was approximately eight hours for penetration to a depth of approximately one-half inch.

With the second stated blend, having 50% diluent, an application of 0.5 gallon per square yard required approximately three hours for complete absorption and so additional applications were made using 0.5 gallon per square yard and when 1.75 gallons per square yard had been added and absorbed, the total depth of penetration of material exceeded two inches. This material was cured approximately two weeks and after curing the resulting combination was firm, solid and stable and immune to the action of water.

The third and fourth stated blends were applied on similar surfaces in the amount of 0.5 gallon per square yard to note the rate of absorption. The third blend, 54% diluent, required approximately two hours and the fourth blend, 60% diluent, required approximately 30 minutes. Kerosene, having a viscosity of 9 seconds at 90 degrees F. required approximately twelve minutes for absorption of 0.5 gallon per square yard, demonstrating the tightness of the material, for in most materials kerosene will be absorbed in less than thirty seconds.

As a further test the primer formed by the second stated blend, thinned with 50% diluent, was applied to an aged asphalt road surface which was excesively porous and permeable to water. The use of a conventional primer in such types of road surfaces generally results in softening the asphaltic constituents to the point where the road surface is unstable and will distort under traffic. However, by priming with the improved primer, the final result was the opposite. The surface was improved with the asphaltic constituents being much tighter and well bonded. Moreover, this was accomplished without softening but actually hardening the asphaltic constituents of the road surface.

It appeared that the hard-base solvent-refined asphalt, when absorbed by and amalgamated with the other previously laid and aged asphalts in the road surface will create a harder and more stable product. This led to a further test to apply the solvent-refined hard-base asphalt primer to a road surface in which the asphaltic constituents were too soft to make a good, stable road surface. After the thinner evaporated and the asphalt was cured, the desired result of a harder road surface was obtained. The actual proportions could not be noted but it appeared that any proportion of thinner desired could be used depending upon the porosity of the road surface. The final product was a road surface having, in addition to its usual rock and earth materials, and an aged soft-base asphalt, a further constituent, the hard-base asphalt amalgamated therein as a bonding and hardening agent.

The blend of the diluent used in this example consisted of kerosene and naphtha in the preferred proportions of approximately 82% kerosene and 18% naphtha. However, it was ascertained that the blend could be all kerosene but if more than 25% naphtha were used the curing rate would be excessively high. It was found that the use of gas oils and fuel oils to obtain a slow curing blend, as with many soft-base asphalts, would not be advantageous for these oils, which will evaporate only very slowly, will not permit the desirable characteristics of a hard-base asphalt to develop.

The value of the asphaltic penetrative binder was fully confirmed and demonstrated by field applications, made by the Empire Petroleum Company of Denver, Colorado, using the several blends of solvent-refined asphalt obtained from the Continental Oil Company as hereinabove described in detail. These applications, made in the late summer and fall of 1961 were observed through the 1961–1962 winter season and their condition noted in the spring of 1962.

The first planned use for the penetrative binder was as a deeply-penetrating prime treatment for the base course of a road. A salt-treated base course of the Adams County road north of Strasburg, Colorado, was treated with two applications of the penetrative binder having approximately 45% diluent. The applications included a first treatment of 0.2 gallon per square yard followed by 0.3 gallon per square yard thirty minutes later. This treated base course was then covered with a conventional asphalt-gravel seal coat, and the road is at present in excellent condition.

In using this material for stabilizing the base course, two outstanding features became manifest. First, the depth of penetration of the asphalt into the base course was as

much as ¾ inch which was considered remarkable by the County highway department. Secondly, the short time which was required for the material to dry sufficiently for another application and sufficiently to permit traffic on the road was unheard of in the use of conventional types of primers.

A repair of an existing asphalt road was effected on the Adams County highway east of Orchard Corners. This road was generally in bad shape including many potholes where the original asphalt had been lost. Amounts of from 0.5 to 0.7 gallon per square yard of binder were applied to the surface of the road, and because traffic had to pass through almost immediately, the surface was blotted with sand. Not only did the penetrative binder penetrate the old asphalt road surface to bind and harden the surface, but also an unexpected result was obtained, for a portion of the penetrative binder soaked into and set up the sand blotting cover. This hardening and stabilizing of the sand cover placed a finish coat over the road and it was observed that when the potholes were filled with loose sand, the penetrative binder not only soaked into the potholes but also into the sand, filling them, and that when the penetrative binder cured, the potholes were solidly filled with a stable binder. A very effective pothole repair system was thereby developed which has produced superior results to any system heretofore used.

In actual use, it was contemplated that the penetrative binder would be used in roads to stabilize base courses and that other protective materials such as an asphaltic seal coat would cover the base course. Three blocks of roadway in the city of Boulder, Colorado, were prepared for such an operation by a first application of 0.4 gallon per square yard and a second application of 0.3 gallon per square yard. Due to an inadvertence, the planned covering, a seal coat was not immediately applied. It was discovered that the roadway was holding up very well under heavy traffic without the seal coat. To see how good this new type roadway, manufactured by application of a penetrative binder according to a novel concept, really was, it was exposed to heavy traffic over the severe 1961–1962 winter period and it was found to be in good shape. As a result, the city of Boulder and other agencies now plan road building and paving operations where one or two applications of the penetrative binder are merely sprayed on the road surface and it is then considered a finished, paved surface.

A similar incident occurred at the Columbine Airport at Littleton, Colorado. The soil at this airport varied from sand to silt to clay and maintenance of the runways was extremely difficult. Only a part of the runway surface had been paved with conventional material and it was in bad condition. Application of the penetrative binder followed by a seal coat topping was planned. The binder was applied as a single application of 0.7 gallon per square yard on the main runway and 0.5 gallon per square yard on the taxiways. After application, plane traffic had to use the airport within 48 hours and since the binder-stabilized material appeared to withstand the traffic, no further protective coatings were added. After being exposed to heavy traffic over the 1961–62 winter, the airport runways were inspected and found to be in excellent shape. This was considered a new development in surface treatment for it was obtained at a fraction of the cost which would be required for conventional surfacing treatment. The plan to cover the runways with a protective top surface was abandoned.

Specialized surface stabilizing treatments using the penetrative binder were made with considerable success. The Colorado State Highway Department commenced using the material for priming cement treated soil bases in a large scale project near Cheyenne Wells, Colorado, having previously established that conventional priming asphalts were worse than useless for this purpose, but that the penetrative binder was producing remarkable results.

It was next demonstrated to the Nebraska Forest Service that deep priming using up to three gallons per square yard was possible with this material, an amount far exceeding that ever used with conventional materials, and that when cured the hardness of the final product approached that of concrete.

As a surface-stabilizing treatment, to provide erosion control, the sandy slopes and other reaches at the Rio Grande Railroad Industrial Park at Blakeland, Colorado, were sprayed with an application of from 0.5 to 0.7 gallon per square yard, the penetration was ½ to ¾ inch and the surface was hardened and stabilized, with a winter season demonstrating that the desired erosion control was obtained.

The national parks of Zion and Bryce Canyon have discovered that the stabilizing binder makes excellent stabilized horse and foot paths and the first type of priming material that has been found satisfactory for this purpose.

It appeared that when the penetrative binder soaked or wicked into a soil base course and subsequently cured, the material acquired considerable hardness and compressive strength and was comparable with a hot-mix asphalt course or even a Portland cement. Certain tests indicated that in many instances the final cured stabilized material would have a compressive strength as large as 1000 pounds per square inch.

Such strength establishes its properties as being those of a binder and not merely a primer. However, in order to get an idea of the mechanics of the asphaltic penetrative binder, a test system was set up by making cylinders of a 20–30 grade standard Ottawa sand, A.S.T.M. designation C–190, the sand being of a type which had absolutely no cohesive power within itself. The sand was mixed with various asphalts in the proportion of 2% asphalt by weight and then molded into cylinders. Referring to FIG. 1 of the drawing, these cylinders **10** were made of a standard size, each being one inch high and one inch in diameter. They were subjected to loading in a conventional press indicated at **11–12** at a regulated speed of 400 pounds per minute and their breaking strength was thereby measured.

A series of Continental Oil asphalt samples were obtained having a penetration at 77 degrees F. ranging from 3 to 96, the latter being a standard paving grade asphalt of a type commonly used as a base for conventional primers. The relationship of strength to the penetration appeared as a regular curve with maximum strength of the sample being 170 pounds for a penetration of 3 and 18 pounds for the 96 penetration asphalt. Field tests demonstrated that when this material had a penetration greater than 25, it would not be satisfactory as a penetrative binder and it was immediately apparent that if a cylinder made according to the above size would not resist approximately 100 pounds, the material from which it was made was not satisfactory as a penetrative binder.

At the time the penetrative binder was first proposed and introduced, applicant induced the Colorado State Highway Department to also try blends with Gilsonite, a natural asphalt material having characteristics very similar to the Continental solvent-refined asphalt. The highway department rejected the Gilsonite as an inadequate penetrative binding material for when the Gilsonite cured out, the materials tested were friable and lacked strength. A test cylinder manufactured according to the above description showed that the Gilsonite had a strength of not more than fifty pounds. Comparatively, this test further verified that the test cylinders should have a strength of at least approximately 100 pounds if the asphalt was suitable for use as a binder.

A number of commercial hard-base asphalts as set forth in the following table were then tested to ascertain generally, the properties of an asphalt which could be used as an asphaltic penetrative binder according to the concepts of the invention.

Source	Type	Penn at 77° F.	Soften Point, °F.	Strength of Spec., Pounds
Continental Oil, Billings, Montana	Sol. refined	3	175	170
Lyon Oil, El Dorado, Arkansas	do	15	145	128
Warrior Oil, Tuscaloosa, Alabama	Thermally cracked	14	230	42
Edgington, Long Beach, California	Vacuum straight reduced.	15	145	148
Gilsonite, Utah	Natural material	14	230	53
Pure Oil, Naches, Texas	Sol. refined	5	160	214
Continental, Billings, Montana	Air Blown	10	225	61
American Oil, Casper, Wyoming	Sol. refined	13	140	210
Empire, Denver, Colorado	Air Blown	11	200	49
Berry, Magnolia, Arkansas	Vacuum straight reduced.	9	160	148
Diamond Oil, Chinook, Montana	Thermally cracked	23	194	50
Edgington, Long Beach, California	Air Blown	18	194	52
Berry, Magnolia, Arkansas	Sol. refined	16	156	127
American Oil, Salt Lake, Utah	do	3	185	175

As set forth in the table and clearly illustrated at FIG. 2, those hard-base asphalts which were manufactured by a solvent-refined process and which were manufactured by a vacuum reducing process, appeared to have sufficient strength to fit within the criterion above set forth. Indeed, some samples indicated a very high strength. Almost as if they were different materials, the cylinders of asphalts manufactured by thermal cracking or by air blowing have a low strength same as with Gilsonite, all being within a strength range of fifty pounds.

The relationship between the penetration and softening point temperature appeared to be the only consistent index which could be used to predict whether or not an asphalt would have strength when diluted and used as a penetrative binder. FIG. 3 shows this relationship. For hard-base asphalts suitable for use as a penetrative binder, the softening point temperature lies between 140 and 185 degrees F. For unsatisfactory types of hardbase asphalts, the softening point temperature is greater than 185 degrees F. Actually the data appears as two separate groups with a difference of approximately 75 degrees between satisfactory and unsatisfactory asphalts of any given pentration. The data showing the relationship between penetration and softening point further suggests that as the penetration increases from a minimum value, the softening point temperature decreases in a relationship where the softening point temperature in degrees F. is approrimately 185 minus three times the penetration. Where the asphalt has a penetration of 10, the softening point temperature is approximately 155 degrees F.

In the final analysis using a hard-base asphalt, the preferred blends for a given type soil material can quickly be determined by simple tests to determine the absorption rates, the binding power and the impermeability of the final product. It was found that hard-base asphalts having a penetration, as hereinbefore described, less than 10 were preferred but that asphalt having a penetration up to 25 can be used as a hard-base asphalt according to the disclosure herein and that asphalts having an evaporation residue of as much as 30 presented suitable materials.

While the samples herein described used a minimum diluent of 45 percent it was ascertained that the diluent could be reduced to 30 percent and absorption could still be obtained in highly porous surfaces.

While I have now described my invention in considerable detail, it is obvious that others skilled in the art can blend and compound and produce alternate and equivalent products and compositions which are nevertheless within the spirit and scope of my invention. Hence, I desire that my protection be limited, not by the specific examples herein, but only by the proper scope of the appended claims.

I claim:

1. A method of making a stable ground surface base out of an absorptive non-stable ground surface comprising the steps of:

(a) spreading a fluid penetrative binder consisting essentially of a hard base asphalt and a diluent over said non-stable ground surface, said hard base asphalt being characterized by a penetration of less than 25 at 77° F. and a softening point temperature in degrees F. of approximately 185 less three times the penetration, said diluent consisting essentially of a petroleum solvent having a volatility not substantially less than that of kerosene, said diluent being present in said binder in an amount between 30 and 70 percent by volume; and,

(b) allowing at least substantially all of said diluent to evaporate after permitting said binder to penetrate said non-stable ground surface such that, at least the major part of said binder penetrates into and is absorbed by said ground surface, so that the evaporation residue as absorbed by said ground surface forms with the ground surface material a stable base.

2. A method of rehabilitating an existing asphalt road surface, comprising a mixture of soil and aggregate materials and soft base asphalt, comprising the steps of:

(a) spreading a fluid penetrative binder consisting essentially of a hard base asphalt and a diluent over said road surface, said hard base asphalt being characterized by a penetration of less than 25 at 77° F. and a softening point temperature in degrees F. of approximately 185 less three times the penetration, said diluent consisting essentially of a petroleum solvent having a volatility not substantially less than that of kerosene, said diluent being present in said binder in an amount between 30 and 70 percent by volume; and,

(b) allowing at least substantially all of said diluent to evaporate after permitting said binder to penetrate said road surface, such that, at least a major part of said binder penetrates into and is absorbed by said ground surface, so that the evaporation residue as absorbed by said road surface forms with the road surface a stable base.

3. A method of rehabilitating an asphalt road surface having potholes therein, consisting in the steps of:

(a) filling said potholes with a fluid penetrative binder consisting essentially of a hard base asphalt and a diluent, said hard base asphalt being characterized by a penertation of less than 25 to 77° F. and a softening point temperature in degrees F. of approximately 185 less three times the penetration, said diluent consisting essentially of a petroleum solvent having a volatility not substantially less than that of kerosene, said diluent being present in said binder in an amount between 30 and 70 percent by volume;

(b) filling the potholes with sand before the asphalt diluent is completely absorbed into the road surface

so that at least a portion of the asphalt diluent is absorbed into the sand; and,

(c) allowing at least substantially all of said diluent to evaporate after permitting a portion of said binder to penetrate said pothole and a portion of said binder to be absorbed into the sand.

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