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FIRE RESISTANT BITUMINOUS COMPOSITION

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The object of this invention is a water-proofing and fire-resistant composition. This application is a division of our abandoned application Serial No. 497,807 filed August 7, 1943.

Heretofore bituminous prepared roofing has been very extensively manufactured using as a base a fibrous web such as roofing felt, impregnating the fibrous web with a bituminous material, and coating the impregnated web with a weather-resistant bituminous coating composition. The bituminous coating composition usually contains a mineral filler such as slate flour or powdered limestone in amounts less than about 40% by weight of the bituminous coating composition. Usually there is applied to the bituminous coating on the surface intended to be exposed to the weather a suitable granular material such as slate granules or more finely-divided mineral surfacing material such as talc or mica. Finely-divided materials such as mica flakes, talc, silica dust or the like may be made adherent to the non-weather exposed surface of the roofing to prevent sticking of adjacent layers of the roofing material in the package.

It is a purpose of this invention to improve the fire resistance of roofings comprising a layer of thermoplastic material such as bituminous material. Thus, for example, we have found that a roofing material which comprises an organic fiber felt base and a bituminous waterproofing coating can be made according to this invention, at the cost of ordinary bituminous roofing material, that is so highly fire-retardant that a three-layer covering on a combustible roof deck will satisfactorily withstand exposure to the Class "A" fire-retardant tests prescribed by Underwriters' Laboratories, Inc. We have found further that such roofing material embodying our invention, when applied so as to provide two layers, will satisfactorily pass the Class "B" fire-retardant tests prescribed by Underwriters' Laboratories, Inc.

The importance of fire-resistant properties for roofing is self-evident. Certain roofings such as asbestos-cement shingles, tile and the like, have high fire resistance but such roofings are very costly as compared with asphalt felt roofings, and for this reason asphalt-felt roofings are very extensively used on all kinds of structures notwithstanding the limited fire protection that is afforded by this type of roofing. According to this invention, asphalt felt roofings can be made without substantial increase in cost which are comparable in fire-retardant properties to relatively much more costly roofing constructions such as asbestos-cement, tile and the like.

Substantially all bituminous roofings comprise a strain-resisting base or foundation sheet such as roofing felt which is coated with a bituminous coating that provides water-proofing and weather resistance. This invention has to do with the coating material rather than the base sheet. While the base sheet might be made of non-combustible material, the non-combustibility of the base sheet does not solve the problem if the bituminous coating itself burns or tends to flow so as to spread the flame. According to the present invention, the waterproofing

coating is rendered highly fire-resistant so that, even when applied to a base sheet of combustible organic fibers, roofing can be made which has the high degree of fire resistance mentioned above.

The highly fire resistant bituminous coating composition of this invention is particularly well suited for the manufacture of roofings such as bituminous shingles (individual or strip shingles), cap sheets and the like, and, likewise can be used in the manufacture of such products as roll roofing, siding, built-up roofing, and the like and generally wherever it is desired to provide roofing comprising a highly fire-resistant bituminous layer.

In our aforementioned Patent No. 2,326,723, we have described and claimed bituminous roofing comprising a bituminous waterproofing composition that, while highly fire resistant, possesses physical properties such as pliability and resistance to flexure that correspond in a general way with bituminous roofings of similar character previously manufactured and sold. The bituminous coating composition of the roofing disclosed and claimed in our Patent No. 2,326,723 contains bitumen having a softening point above 160° F. and of the range 45% to 70% by weight of the coating composition. The coating composition also contains finely-divided solid water-insoluble heat-resistant mineral filler of the range 30% to 55% by weight of the coating composition, at least 30% by weight of the coating composition consisting of such mineral filler which passes a 14 mesh testing sieve and over 50% by weight of which is retained on a 200 mesh testing sieve, and which has a flow resistance value of at least 40 minutes when a bituminous composition consisting of 65% by weight of coating asphalt having a softening point of 230° F. and 35% by weight of such special filler is subjected to the flow resistance test that we have defined and set forth in our Patent No. 2,326,723.

The roofings of the present invention when exposed to fire afford the type of fire-retardant protection that is afforded by the special fire-resistant bituminous compositions that are described in our aforesaid Patent No. 2,326,723, but afford this extremely high fire resistance as a result of different formulation that will be described in detail hereinbelow.

Generally speaking, the invention of the present application is based upon the selection of certain screen gradings of mica, either by itself or mixed with selected screen gradings of fibrous mineral, so as to provide highly fire-resistant roofings.

We have found that certain screen gradings of mica and of fibrous mineral are extremely effective in providing in a bituminous coating composition for roofings a skeletal mat of high stability and heat-insulating effectiveness. While such screen gradings may advantageously be employed in bituminous compositions wherein the total amount of bitumen is of the range 20% to 65% by weight of the coating composition and the total mineral filler content of the coating composition is of the range 35% to 80% by weight of the coating composition, it is especially advantageous, according to this invention, to employ the selected screen gradings of mica, or of mica together with fibrous mineral, in bituminous coating compositions wherein the total amount of bitumen is of the range 45% to 65% by weight, and wherein the total mineral filler content is of the range 35% to 55% by weight.

As pointed out in our Patent No. 2,326,723, a mineral filler such as slate flour, when used by itself in amounts such as 35% to 55% by weight of a bituminous coating composition for roofing, does not afford substantial resistance of the coating to flowing when exposed to flame temperature of substantial increase in resistance to fire. However, we have found that certain screen gradings

of mica, or of mica together with fibrous mineral, such as asbestos, even when used in very small quantities, such as 5%, or even less, by weight of the bituminous composition, have the surprising effect of stabilizing the bitumen and modifying the flow resistance of the other mineral filler, such as slate flour, that makes up the 35% to 55% total filler, so that the composition as a whole will become of high flow resistance and of high fire resistance. Some screen gradings of mica and of fibrous mineral do not have the extreme effectiveness above mentioned, but, by selecting the proper screen gradings of such mineral fillers one can formulate highly fire-resistant bituminous compositions and can formulate fire-resistant bituminous coating compositions which are distinctly different from those which we have described and claimed in our aforesaid Patent 2,326,723.

In order to afford a better understanding of this invention, it will be described for purposes of exemplification in connection with a typical embodiment. The roofing material of this embodiment is composed of a base of strain-resisting roofing felt, a top weather surface coating of special bituminous coating composition, a surface layer of mineral granules partially embedded in the surface coating, a thinner layer of the special coating composition on the back of the felt base sheet, and finely-divided dusting material adherent to the back layer of the special bituminous coating composition.

In the exemplary embodiment, the base or foundation sheet is ordinary roofing felt made of vegetable and animal fibers, e. g., a roofing felt made from organic fiber stock weighing about 6 pounds per 100 square feet. The felt is impregnated with a suitable impregnating material, e. g., a conventional bituminous roofing saturant having a softening point of about 100° F. to about 170° F. The base sheet as thus composed has little fire resistance, and, when exposed to fire, is consumed quite readily.

A typical example of the special coating composition of this invention is given below. In this example the the screen grading of the mica which passes a 14 mesh testing sieve and is retained on a 20 mesh testing sieve is represented as (−14+20). Other fractions are indicated similarly, and such designation of the screen gradings is employed elsewhere herein. The percentages in the following example and elsewhere herein are percentages by weight.

		Per cent
Asphalt (softening point 225° F. to 235° F.)		50
Slate flour (85% by weight −200)		31
Mica screen gradings (dry ground):		
−14+20	percent	2.0
−20+28	do	3.0
−28+35	do	2.5
−35+48	do	2.0
−48+65	do	1.5
−65+100	do	1.5
−100+150	do	1.0
−150+200	do	.5
−200	do	5.0
Total mica		19

In the foregoing example the screen gradings of mica are set forth in round numbers for convenience in illustration and some finely-divided mica has been included in each grading. At first inspection it may appear that no particular screen grading has been emphasized, but as will be shown more in detail below, some of the screen gradings for the amount present in the composition are much more effective than others and relatively minor variations can have the effect of changing the composition from one which has high fire resistance to one which has low fire resistance. It is the selection of those fractions which are definitive of bituminous compositions having high fire resistance that is the chief object of the present invention.

It may be noted in connection with the foregoing example, that the bituminous composition only contains 14% by weight of mineral filler retained on a 200 mesh testing sieve, namely, mineral filler of the size range (−14+200). This is significanct, for, in our Patent No. 2,326,723, we have specified the employment of a bituminous composition that contains at least 30% by weight of mineral filler which passes a 14 mesh testing sieve and over 50% of which is retained on a 200 mesh testing sieve. In other words, in the composition which is prescribed in our Patent 2,326,723, there must be present over 15% by weight of mineral filler (−14+200). The foregoing is a typical illustration of a bituminous coating composition which can be formulated by proper selection of screen gradings of mica so that the composition will have very high fire resistance without, however, utilizing over 15% by weight of filler of the size range (−14+200). However, before setting forth the particulars as to what we have termed the "screen factor" of the different screen gradings of the finely divided mica contained in the composition as a whole, the further particulars as to typical roofing, according to this invention, will be set forth.

In preparing the special bituminous composition, the asphalt is heated to a heat-liquefied condition and the above described mineral filler materials are mixed therewith. It is important that the bitumen and finely-divided mineral filler be thoroughly mixed together so that the filler becomes distributed uniformly throughout the mass, and the composition should be applied to the base sheet while in a thoroughly mixed condition so that the filler occurs uniformly in the coating both as to amount and distribution and so that the resulting layer is substantially uniform in consistency and thickness. In this typical embodiment herein described, the coating is applied to the felt base sheet at the rate of about 45 pounds per 100 square feet. Before the coating cools to atmospheric temperature, a conventional surfacing material, such as slate granules, can be applied to the surface for weather exposure and these granules are partially embedded in the layer of special bituminous composition. The granular surfacing material is preferably non-combustible and, while employed, is not relied upon to impart fire resistance to the roofing. On the opposite side of the roofing material, there may be employed a thin coating of bituminous coating material, e. g., an asphalt having a softening point of about 200° F. to 240° F., so as to weigh about 5 pounds per 100 square feet, and finely divided dusting material, such as talc or mica dust or similar anti-stick material, may be applied and partially embedded in the back coating. Preferably, for maximum fire resistance, the back coating should be special coating composition embodying our invention.

The roofing thus prepared may be packaged in sheet form, or alternatively, may be cut into sections suitable for individual or strip shingles. The roofing weighs about 95 pounds per 100 square feet. Of this weight, about 30% by weight is in the form of mineral granules adherent to one side and finely-divided dusting material adherent to the other side, the balance of the roofing being the felt, the bituminous-impregnating material and the bituminous coating composition.

The special bituminous coating composition may be advantageously be mixed and applied to the manner mentioned in our Patent 2,326,723.

The roofing material above described can be made up into suitable roofings and roofing structures, description of typical and exemplary roofings and roofing structures being fully described and set forth in our Patents Nos. 2,326,723, 2,326,724, 2,424,234 and 2,490,430 to which reference is hereby made.

The high fire-resistance of the special bituminous coating composition is due to a combination of factors. The effect of the relatively small amount of mica in stabilizing the entire bituminous mass when it is exposed to flame has been mentioned above. However, the presence of the slate flour as a diluent filler is essential in that if

the diluent filler were omitted the small amount of mica by itself would have an inadequate effect in stabilizing the bitumen. On the other hand, the slate flour in the amount used has virtually no effect in stabilizing the bitumen. However, when these filler materials are used in combination the ratio of mica to bitumen and of total filler to bitumen is increased, so that, the critical point at which the bitumen becomes stabilized is exceeded. We have found that a filler material, even when it comprises mica, has little effect upon the stability of bituminous compositions unless the critical point is reached at which a stable skeletal mat is formed in the bituminous composition. However, by utilization of the proper screen gradings of mica in the proper ratio to the bitumen, together with the proper amount of total filler within the limits set forth, satisfactory stabilization of the bitumen and high fire-resistance are obtained. The bitumen that is present in the bituminous composition likewise cooperates with the skeletal mat of fiber and other filler for upon exposure of the composition to flame it tends to carbonize without excessive combustion to form a cementitious binder for the skeletal mat of filler material so that the filler is held in place as a coherent layer or mat that not only resists combustion, but also has extremely high heat insulating effectiveness.

As stated in our aforesaid Patent No. 2,326,723, the property of a filler or filler mixture of imparting flow resistance to a bituminous composition, when the bituminous composition containing it is exposed to flame temperature is a definite property and is a property that is capable of accurate measurement. However, since this property of filler materials and its use in imparting fire resistance to bituminous compositions were not known prior to our invention, we have described in our said Patent No. 2,326,723, the apparatus and procedure by which the property of "flow resistance" may be accurately determined. When a filler material, or a particular grade of filler material is stated herein and in the claims to have a "flow resistance value" of 40 minutes or greater than or less than 40 minutes, the "flow resistance value" as measured by the test described in our Patent No. 2,326,723 is intended.

As aforesaid, the different screen gradings of a filler, such as mica, have been found by us to differ considerably in their effectiveness in imparting flow resistance to a bituminous coating composition. Thus, when the screen grading of mica is (—28+35) a composition consisting of substantially 12% by weight of this screen grading of mica, 23% by weight of slate flour, and 65% by weight of asphalt of softening point about 230° F. will have a flow resistance value of about 40 minutes. If the screen grading of mica is (—14+20) only about 7% by weight of mica (the balance of the composition being 28% of slate flour and 65% of asphalt) will achieve a flow resistance value of 40 minutes. On the other hand, it requires about 25% by weight of the screen fraction of mica (—48+65) to achieve a flow resistance value of about 40 minutes. In view of these differences in effectiveness of the different screen gradings of mica, we have, in order to indicate more definitely the amount of mica of given screen gradings that is required to effect stabilization of a bituminous composition, assigned to the different screen gradings what we have called the "screen factor" for each of the different gradings. Thus if the screen grading (—28+35) is taken as having a screen factor of unity, any screen grading that requires half the amount as compared with the screen grading (—28+35) will be twice as effective and will have a screen factor of 2. On the other hand a screen grading that requires twice the amount as compared with the screen grading (—28+35) will only have half the effectiveness and will have a screen factor of 0.5. In like manner screen factors can be assigned to each of the other screen gradings.

The above described test for measuring the flow resistance value of a filler in a bituminous composition affords a convenient basis for setting up the screen factors of mica on a definite scale, and when the screen factor of a given screen fraction of mica is referred to herein the screen factor, as determined in the following manner, is intended. The test for determining the flow-resistance value is carried out using the test apparatus and procedure above described, except that in all cases the total filler is 55% by weight of the bituminous composition. The asphalt in all cases is air-blown (oxidized), straight-run asphalt having a softening point of about 230° F. Slate flour, at least 85% by weight of which passes a 200 mesh testing sieve, is used in all cases as the standard diluent filler, and the amount by weight of the particular screen grading of fibrous mineral to achieve the flow resistance value of about 40–45 minutes, as ascertained by the average of a plurality of test runs, is determined. Each sample is prepared using the impregnated organic fiber felt above specified. As a standard, dry ground roofing mica of the type known as Muscovite and of the screen grading (—28+35) is taken as having a screen factor of unity and the factor for each of the other gradings is calculated by this standard. By way of concrete example, it being the case that substantially 5% by weight of the bituminous composition of the above-mentioned variety of mica having the screen grading (—28+35) (the total filler being 55% as aforesaid) is required to afford a flow-resistance value of substantially 40 minutes, and it also being the case that only about 3.5% by weight of the bituminous composition of the aforesaid mica which has the screen grading (—14+20) (the total filler being 55%) also affords a flow-resistance value of about 40 minutes, the screen factor of the mica having the screen grading (—14+20) is seen to be about 1.4.

By way of further illustration, the screen factors of the different screen gradings of a typical variety of dry ground mica on the basis above mentioned are as follows:

Screen grading:	Screen factor
—14+20	1.4
—20+28	1.2
—28+35	1.0
—35+48	.7
—48+65	.5
—65+100	.3
—100+150	.2
—150+200	.2
—200	.1

It may be noted that in the case of the screen grading —200 the amount required to achieve a flow-resistance value of 40 minutes was about 40% by weight of the bituminous composition. In the case of any screen grading of mica which requires about 55% or more by weight of the composition of the screen grading in question, to obtain a flow-resistance value of 40 minutes, the screen factor 0.1 may be assigned thereto. Similarly, in the case of the screen grading of any fibrous filler, such as the fibrous minerals mentioned hereinbelow, which, when employed to the extent of about 55% or more by weight, attains a flow-resistance value of 40 minutes, is to be regarded as having a screen factor of about 0.1.

In determining the screen fractions or gradings of fibrous or other mineral fillers that are referred to herein, 8 inch diameter testing sieves of the W. S. Tyler Company sieve series, meeting A. S. T. M. Standard E11–39, Sieves for Testing Purposes, have been used. A quantity of filler to be screened ranging from 200 to 300 grams is placed in the uppermost of a series of testing sieves and subjected to suitable agitation as in a standard W. S. Tyler Company Ro-Tap sieve shaking machine for a period of five minutes in order to separate the original filler roughly into fractions retained on the different testing sieves. This operation is repeated if necessary in order to obtain about 100 to 200 grams of the desired screen fraction, which

fraction is then individually rescreened for 15 minutes using the Ro-Tap sieve shaking machine or its equivalent in order to remove any fines contained therein. The resulting screen fraction is material that has passed the coarser screen and is retained on the finer screen.

The foregoing is seen to afford a convenient way of knowing and defining the flow-resistance effectiveness of a filler such as mica. Given the percentage by weight of each of the screen gradings of mica contained in a bituminous composition, the percentage by weight of each, multiplied by the screen factor for each gives what we term herein and in the claims as the "grading index" for each of the screen gradings; and by adding the grading indices for the several screen gradings together, the grading index for the total mica filler in the bituminous composition is readily determined. By way of illustration, the grading index of the mica component of the above-mentioned typical embodiment of this invention is as follows:

Screen Grading	Percent by Weight of Bituminous Composition		Screen Factor	Grading Index
−14+20	2.0	×	1.4	2.8
−20+28	3.0	×	1.2	3.6
−28+35	2.5	×	1.0	2.5
−35+48	2.0	×	.7	1.4
−48+65	1.5	×	.5	.8
−65+100	1.5	×	.3	.4
−100+150	1.0	×	.2	.2
−150+200	.5	×	.2	.1
−200	5.0	×	.1	.5
Total grading index for mica in composition				12.3

It is apparent that, in the formulation of a bituminous composition one can, from the screen analysis of a filler such as mica, determine the grading index of the mica filler employed, and thereby determine the effectiveness of the mica in the amount used in stabilizing the bitumen in the coating composition. We have found that for bituminous compositions for roofings the grading index of a mica filler should be at least about 5 when the total filler content of the composition is about 55% by weight, and preferably is at least about 10. When, however, the total filler content is only about 35% of the bituminous composition, a higher grading index is required, and should be at least about 12 and preferably at least about 18. For a total bitumen content ranging between 45% and 65%, the grading index for permissible and preferred values varies proportionately between the figures above given. In other words, the grading index of the mica for suitable fire-resistant bituminous composition is a function of the ratio of the grading index to the percent by weight of bitumen in the composition, as determined by the amount of total filler. Thus, somewhat more generally, it is desirable in the obtaining of a highly fire-resistant bituminous coating composition that the ratio of the grading index to the percent by weight of bitumen in the bituminous composition be at least 1 to 6 and preferably be about 1 to 4. Referring to the foregoing example in the practice of this invention, it is apparent that the composition therein set forth wherein the mica has a grading index of 12.3 more than meets the foregoing requirements for, when the composition contains 50% by weight of asphalt, the lowest grading index permitted is about 8 and the minimum grading index for preferred coating compositions is about 12.

For a total filler content above 55% by weight of the bituminous composition, it is also advantageous to employ selected screen gradings of a mineral filler, such as mica, so that high flow-resistance and fire-resistance can be obtained. In the case of total mineral filler content of over 55% by weight in the bituminous composition, it is preferable to employ a filler, such as mica, so that the ratio of the grading index of such filler to the percent by weight of bitumen in the bituminous composition will be at least 1 to 6. However, the ratio of the grading index of a filler, such as mica, to the percent by weight of the bitumen in the composition can be somewhat less in the case of highly mineralized bituminous coating composition containing over 55% by weight of total filler. More specifically, when the total filler content is of the order of 55%–65% by weight of the bituminous composition, it is desirable that the ratio of the grading index of a filler, such as mica, to the percent by weight of bitumen in the bituminous composition be at least 1 to 8 and preferably be at least 1 to 6. For still more highly mineralized coating compositions, wherein the total filler content is between 65% and 80% by weight of the bituminous composition it is desirable that the ratio of the grading index of a filler, such as mica, to the percent by weight of bitumen in the bituminous composition be at least 1 to 10 and preferably at least 1 to 8.

When reference is made herein to the "screen factor" or to the "grading index" of a mineral filler, such as mica (or of a fibrous mineral filler) the reference is made to these values when determined as hereinabove described.

Given the screen factors of the screen gradings of mica, one can formulate various compounds which differ considerably in amount and screen gradings of mica filler, but which have high flow resistance value and high fire resistance. In our Patent No. 2,326,723, we have specified the employment of a bituminous coating composition containing at least 30% by weight of a mineral filler which passes a 14 mesh testing sieve and at least 50% by weight of which is retained on a 200 mesh testing sieve and which has a flow resistance value of at least 40 minutes. According to the present invention, by proper selection of the screen gradings of mica filler, one is able, due to the effectiveness of certain of the screen gradings of mica, to formulate other coating compositions that have extremely high fire resistance. The above-mentioned typical example of this invention in an instance of this sort, namely, is illustrative of a highly fire-resistant composition which contains less than 15% by weight of particles of the screen grading (−14+200).

By way of further illustration, a bituminous composition while containing more than 15% by weight of an ineffective mineral filler of the grading (−14+200), may be formulated by the employment in combination therewith of a small amount of mica of the most effective screen fractions so that it will have high fire resistance even though the bituminous composition contains less than 30% by weight of a mineral filler that passes a 14 mesh testing sieve and that has a flow resistance value of at least 40 minutes. For example, a bituminus composition which consists of asphalt and about 35% by weight of limestone dust passing a 14 mesh testing sieve and containing a major proportion of particles retained on a 200 mesh testing sieve, and which has virtually no fire resistance as compared with ordinary coating compositions, can be rendered highly fire-resistant merely by the incorporation in the composition of a small amount, say 5% by weight of the composition, of mica of the size range (−14+20) or by the addition of a slightly greater amount of mica that is retained on a 35 mesh testing sieve. The foregoing also applies to ineffective fillers other than limestone dust.

Thus, the mineral filler may be ineffective even though the mineral filler contains mica, if the mica is of excessively reduced particle size. For example, a bituminous composition containing 10% by weight of mica all passing a 35 mesh testing sieve, together with 25% by weight of limestone dust and 65% by weight of asphalt, which composition is lacking in fire resistance, can be rendered highly fire-resistant by a relatively small addition of mica retained on a 35 mesh testing sieve and even without increasing the total mica of the screen grading range (−14+200) to more than 15% by weight of the composition and without including 30% or more by weight of mica in the composition.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A bituminous composition consisting of about sixty percent of asphalt of a softening point of about 230° F. and about 35% limestone dust passing a 14 mesh testing sieve, a major proportion of the limestone dust particles being retained on a 200 mesh testing sieve and which composition has been rendered highly fire resistant by the incorporation therewith of about 5 percent by weight of the composition of mica of a size range —14+20.

2. A bituminous composition consisting of about sixty percent of asphalt of a softening point of about 230° F. and about 35% limestone dust passing a 14 mesh testing sieve, a major proportion of the limestone dust particles being retained on a 200 mesh testing sieve and which composition has been rendered highly fire resistant by the incorporation therewith of about 5 per cent by weight of the composition of mica of a size range —14+35.

References Cited in the file of this patent

UNITED STATES PATENTS

88,516	Russell	Mar. 30, 1869
376,290	Busse	Feb. 10, 1888
634,818	Hayward	Oct. 10, 1899
655,130	Thompson	July 31, 1900
1,167,195	Matter	Jan. 4, 1916
1,773,131	Eckert	Aug. 19, 1930
1,861,408	Fischer	May 31, 1932
1,960,463	Taylor	May 29, 1934
2,078,727	Jackson	Apr. 27, 1937
2,096,876	Bitzer	Oct. 26, 1937
2,157,696	Greider et al.	May 9, 1939
2,326,723	Fasold	Aug. 10, 1943
2,384,671	Fratis	Sept. 11, 1945

FOREIGN PATENTS

3,920	Great Britain	of 1878