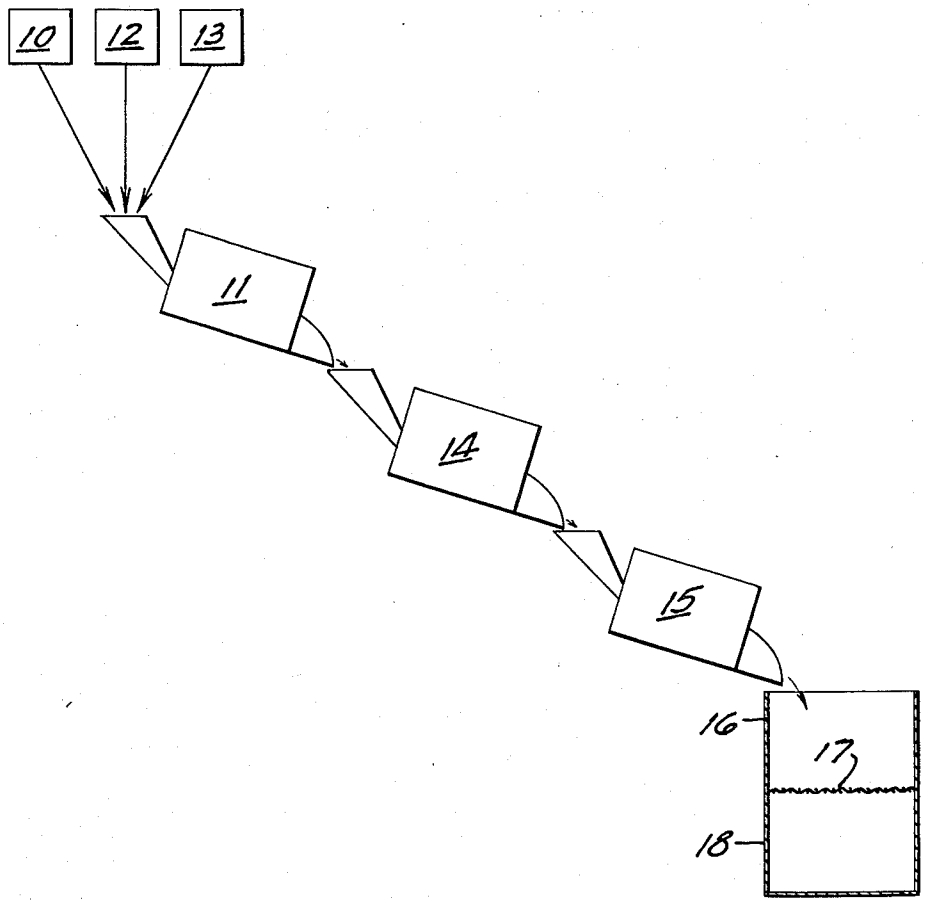
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PROCESS FOR COLORING COARSE AGGREGATE

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PROCESS FOR COLORING COARSE AGGREGATE

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The present invention relates to the uniform artificial color-coating of coarse aggregate such as is employed in connection with the production of built-up roof surfaces.

Asphalt base shingles or roll roofing containing surface coatings of artificially colored mineral granules are customarily employed on roof surfaces having substantial pitch. For flat or nearly flat roof surfaces, built-up constructions are preferred. These built-up constructions are generally prepared by first covering the roof surface with hot asphalt. Mixed aggregate, often artificially colored and of a size somewhat larger than that employed in roll roofing or shingles is then spread over the soft surface and, by rolling, is embedded in the asphalt. Particles of large aggregate, in the order of 1 to 2 inches in size, are then often "spotted" on the surface in spaced relation, e.g. about six inches apart. When the resulting roof is viewed from an angle slightly above the level of the roof, a highly pleasing illusion results. The roof appears to be laid with cobblestone. This type of construction is highly desirable in such buildings as multi-level office or hotel buildings and the like where roof surfaces of lower levels of the buildings are often in full view of occupants situated in higher levels. The large aggregate particles are merely set on the roof. No agent is employed to retain them, their own weight being sufficient.

Heretofore, this large coarse aggregate has primarily consisted of naturally occurring rock materials, that is, materials which have not been treated or artificially colored in any manner. The color selection available in these materials is necessarily limited and variable. On the other hand, artificially colored embedded aggregate, which serves as sort of a background for the large aggregate, is readily available in many colors. Thus, it is often extremely difficult to match the natural large materials, as desired, with the color of the embedded aggregate. Artificially colored large aggregate, available in many colors, is therefore in great demand for use on built-up roof surfaces.

The coloring of roofing granules of the conventional sizes has conventionally been accomplished by processes involving the preliminary uniform mixing of the granules in rotary-type equipment, with a liquid binder composition containing colored pigments, followed by drying and insolubilizing of the wet-coated granules in a kiln. Attempts to artificially color-coat large aggregate having particle size ranges in the order of 1 to 2 inches or larger by these previously known and employed techniques have proven highly unsatisfactory. Indeed such attempts have largely met with complete failure. When the large aggregate is tumbled in this equipment during attempts to color-coat it, the particles exhibit a milling action on one another and grind and break each other up. At best the resulting color-coated particles are badly scarred or scuffed. The coating is extremely non-uniform permitting the natural granule color to show through where portions of the original particles have been broken off. Further, excessive amounts of relatively costly pigments and binder are required rendering the cost of the product prohibitive, particularly in view of the quality of the product obtained.

The present invention therefor has for an object the provision of novel relatively large aggregate which is artificially color-coated. Another object of my invention is to provide processes whereby such large aggregate is uniformly color-coated on a highly economical basis. An additional object of the present invention is to provide large particles of aggregate which are artificially color-coated with inorganic pigments and binders customarily employed in the roofing granule industry.

The manner in which these and additional objects and advantages are attained in the present invention will now be shown.

Referring now to the accompanying schematic drawing of a process by which the granules hereof are color-coated, a first quantity of the coarse aggregate is added from a supply source 10 to a rotary mixer 11 customarily employed in the color-coating of small aggregate. A quantity of finer aggregate, the particles of which have screen size less than any of the particles added from source 10, is added to the mixer 11 from a supply source 12. Also added to the mixer, from supply source 13, is a quantity of aqueous pigment and binder coating composition. The three components may be added in any order or they may be added concurrently. In the rotary mixer 11 the additives are thoroughly mixed and the coating composition is uniformly coated over the surfaces of all the aggregate. The wet-coated mass is then predried to a free-flowing state by the passage of air through the mixer 11. The dried aggregate is then transferred to a continuous rotary kiln 14 where it is fired and the color-coating on the particles thereby insolubilized.

After firing, the mixture of color-coated aggregate is transferred to a rotary cooler 15 where the mass is cooled by water sprays. The amount of spray employed is such that the particles emerge from the cooler dry, all the moisture having been evaporated by the heat liberated from the particles. From the cooler the mixed color-coated aggregate is transferred to a separating screen, for example, a trommel section, here represented by a container 16 having a screen bottom 17, where the aggregate is separated, as desired, into fractions. The coarser fraction is retained in the container 16 while the smaller fraction passes through the screen 17 into the receptacle 18.

In the color-coating of aggregate of conventional sizes, minimum amounts of binder and the relatively expensive pigment, consistent with the attainment of uniform color values in the product, are employed in the interests of economy. Under most effective operation the pigment is found, under microscopic examination of the granules, to be distributed over most but not all of the particle surfaces. Distribution of the pigment is, however, uniform. The resulting appearance indicates complete uniformity of color-coating. Where amounts of pigment less than this minimum are used to coat the aggregate, non-uniform color values result in the product. This is particularly true in operations carried out on large commercial equipment. On the other hand, where an amount of binder and pigment employed for a given quantity and size of aggregate is employed in excess of this minimum, little, if any, difference in the color or uniformity of the product results.

In my process, where coarse aggregate is simultaneously color-coated with fine aggregate, I have found, surprisingly, that the amount of pigment and binder considered to be a minimum for the amount and type of finer aggregate employed, when the latter is color-coated alone, is in fact adequate for coating both the smaller aggregate and minor proportions of the large aggregate. No loss of color intensity is noticeable between the finer aggregate employed in my process and the same aggre-

gate when processed alone. The color intensity of the large aggregate is substantially equivalent to that of the finer aggregate. Further, substantially no evidence of scuffing or grinding caused by the action of the particles of the larger aggregate upon one another is seen. The particles of the large aggregate are uniformly coated over their entire surfaces.

My invention will now be specifically illustrated in detail with the aid of the following non-limitative examples.

Example I

	Pounds
Syenite fine aggregate (known in the art as #11 grade) having the following screen analysis:	2000
Screen size— (Weight percent retained)	
+8 mesh	0.0
+10 mesh	1.5
+14 mesh	35.0
+20 mesh	37.0
+28 mesh	22.0
+35 mesh	4.0
−35 mesh	0.5
Syenite coarse aggregate (1–2 inch) having the following screen analysis:	300
Screen size— (Weight percent retained)	
+1⅞ inch	20.0
+1¾ inch	28.0
+1¼ inch	42.0
−1¼ inch	10.0
Pigment:	
Burnt umber	12
Ochre	3
Red iron oxide	3
Binder composition:	
Kaolin	8
Sodium silicate ($Na_2O : 3.22SiO_2$)	40
Water	20

The #11 grade aggregate is fed from a storage bin by means of a vibrating feeder to a rotary tube pre-heater where the granules are heated to a temperature of about 200–250° F. The coarse aggregate is fed, without being preheated, onto a conveyor and with the #11 grade granules is fed into a metering hopper, the rate of flow into the hopper being carefully controlled at the ratio of 2000 parts by weight of the #11 grade aggregate to 300 parts of the coarse aggregate. From the hopper the mixed aggregate is fed into a tumbling barrel mixer. A previously prepared pigment and binder slurry consisting of the sodium silicate, water, kaolin and pigments is then added to the mixer. Room temperature air is circulated through the mixer during mixing operation until the total moisture content has been reduced sufficiently to make the mass of coated aggregate free-flowing. The entire mass of the coated aggregate is then transferred to a rotary kiln and fired at a temperature of about 1000° F. to insolubilize the binder. Dwell time in the kiln is preferably about 5–20 minutes.

The fired aggregate is then transferred while hot to a rotary tube type of cooler wherein the aggregate is sprayed with a cool dilute solution of ammonium chloride in water. The mass of cooled color-coated brown colored aggregate is then transferred to an agitated short trommel section fitted with a ball wire screen having ¾ inch openings. The coarse color-coated aggregate is thus separated from the fine aggregate.

All particles of the resulting product are uniformly coated. The intensity of the color of the coarse aggregate matches that of the resulting color-coated #11 roofing granules. The aging characteristics of the entire product are superior in all respects.

A total of 18 pounds of pigment and 48 pounds binder are employed to color-coat 2000 pounds of the fine aggregate and 300 pounds of the coarse aggregate. When 2000 pounds of the #11 grade granules, an amount equal to that of the present example, is coated by itself, an identical 18 pounds of pigment and 48 pounds of binder are required to provide a color-coating equal in intensity to that of the present example. Reduction of this amount of pigment and binder, as little as 5 percent, causes diminution of color intensity in the resulting granules.

Thus, by the processes hereof, the coarse aggregate is uniformly color-coated to a color intensity equal to that of the #11 grade granules without the necessity of any additional pigment and binder over that required to color-coat the same #11 grade granules alone. This surprising result becomes even more significant when it is recalled that neither uniform color-coating nor equivalent color intensity may be obtained when attempts are made to color the coarse aggregate by itself, no matter how much pigment and binder are employed.

The 15 percent by weight of the coarse aggregate employed in the present example is by no means the maximum of the coarse aggregate which may be employed in my novel procedures. I may process up to about 50 percent of the coarse aggregate while still obtaining a highly satisfactory uniformly coated product. As high as about 20 percent or more may be employed without change in color characteristics. It may be necessary, however, to add small additional amounts of pigment and binder where the proportional amount of coarse aggregate is greatly increased in order that the color intensity matches that obtained by properly coating the finer aggregate alone. For example, where about equal amounts of coarse and fine aggregate are processed, an equivalent color intensity in the resulting granules is achieved where about 20–25 percent additional pigment and binder is added. Where more than about 50 percent by weight of coarse aggregate is added, the resulting coarse aggregate tends to show signs of being scuffed.

If pre-heated to a high temperature, the wet-coated coarse particles, particularly when they are quite large, have some slight tendency to dry out prematurely before they are fully coated. It is instead preferable to have the entire mass of coated particles dry out as nearly at the same time as possible in the interests of optimum coating uniformity. To that end it may be desirable to eliminate pre-heating entirely (as was the case in Example I); or the coarse aggregate may in some instances be pre-heated slightly, but to a temperature somewhat below that of the fine aggregate. However, a highly useful product is obtained whether the coarse aggregate is pre-heated or not.

In order to enjoy fully the achievements of the present invention the particle size of the coarse aggregate should exceed substantially that of the fine aggregate. For instance, in Example I the coarse aggregate ranged from about 1 to 2 inches in size. The largest particle of the fine aggregate did not exceed 8 mesh (0.093 inch). However, this differential does not demonstrate the minimum which may be used.

In practically defining what the permissive size differentials are between the coarse and fine aggregate, reference may not be made to exact particle size. Particles obtained in any sort of crushing and grinding operation are not identical in size or shape. Indeed, the range between the smallest and largest particles in any given quantity may be considerable. This is particularly so in the extremely fine particle range and is true also to a somewhat lesser extent in the case of larger particle sizes. I therefore prefer to refer to a representative average particle size of the quantity of fine aggregate in defining the minimum size differential which may be effectively used. I designate this representative average as the weight-median screen size. By weight-median screen size is meant the screen of theoretical size on which one-half the total weight of any given quantity of aggregate will be retained while one-half will pass through.

It has been found that in order to adequately derive the advantages of the present invention the minimum particle size of the quantity of coarse aggregate must exceed the weight-median screen size of the fine aggregate by at least about two-fold. In fact, I prefer to maintain a differential that is well in excess of two-fold.

The weight-median screen size of any given quantity of aggregate is easily determined by employing proce-

dures well known to the crushing and grinding art in particular and to the roofing granule industry in particular. A screen classification is first carried out according to known procedures. In general terms, screens of varying size, such as a series of "Tyler Screens," are arranged in superposition in order of diminishing screen size with the largest screen on top. The range of screens is selected such that the large screen will permit the coarsest particles of the sample to pass therethrough while the finest screen will permit only negligible quantities of fines to pass through it. A representative sample of the aggregate to be classified is then introduced to the top (largest) screen. The screen are agitated. The several particles proceed downwardly passing through screens until retained on a particular screen having openings too small to permit passage therethrough. The series of screens is then disassembled and the weight of particles on each is determined.

A plot is then prepared of the particle weight distribution versus screen size. One such plot customarily used finds the cumulative percent by weight of particles which would be retained on a given screen plotted as the ordinate against screen size plotted as the abscissa. These classifying procedures, as described thus far, are presently employed every day in industrial quality control experiments.

To determine the weight-median screen size of the sample from the plot is simple. It is that point on the plot representing the screen size where 50 percent of the sample would be retained.

Although the results permitted by the novel processes of the present invention are particularly significant in very large aggregate, such as that having a size of 1 to 2 inches or larger, they extend also to that aggregate which is in the coarser range of that presently employed in the roofing granule industry. In fact, coarse aggregate in the neighborhood of at least about ¼ inch in screen size is beneficially affected to a considerable extent by the simultaneous coating procedures hereof. This is true even though such aggregate may be color-coated alone with some degree of success. The degree, however, is limited. The amount of scuffing that takes place due to the action of particles this size upon one another when processed alone, renders the coating inferior with respect to both uniformity and color intensity upon comparison to the uniformly coated product hereof. Also, these granules are produced at substantially lower cost when color-coated according to the present invention. The following example illustrates the color-coating of particles in this size range.

Example II

	Pounds
Dacite porphyry aggregate having the following screen analysis:	2300
Screen size—	Weight percent retained
+0.5 inch	0.0
+0.371 inch	1.2
+3 mesh	5.1
+4 mesh (0.263 inch)	4.4
+6 mesh (0.131 inch)	2.0
+8 mesh	0.4
+10 mesh	1.3
+14 mesh	30.4
+20 mesh	32.2
+28 mesh	19.1
+35 mesh	3.5
−35 mesh	0.4
Pigment: Red iron oxide	16
Binder composition:	
Kaolin	8
Sodium silicate ($Na_2O : 3.22SiO_2$)	35
Water	16

Bright red color-coated aggregate was prepared in the following manner: The mass of aggregate was pre-heated to a temperature of about 200° F. and added to a rotary mixer. It will be noted that the mass includes about seven percent of particles having a screen size in excess of about ¼ inch, the weight-median screen size of the remainder being about 0.046. The mass of aggregate

was then mixed in the mixer with the coating composition, which consisted of the pigment, binder composition and water.

Pre-drying, firing and cooling of the mass was carried out in the manner described in Example I. The resulting cooled color-coated aggregate was then separated into two fractions by transferring the mass onto an agitated short trommel section having a 10 mesh screen.

The coarser fraction, of a size range known in the roofing granule industry as #46 grade, had the following screen analysis:

Screen size:	Weight percent retained
+.5 inch	0.0
+.371 inch	9.0
+3 mesh	39.0
+4 mesh	34.0
+6 mesh	15.0
−6+10 mesh	3.0

The resulting #11 grade finer fraction had a screen analysis of:

Screen size:	Weight percent retained
+10 mesh	1.5
+14 mesh	35.0
+20 mesh	37.0
+28 mesh	22.0
+35 mesh	4.0
−35 mesh	0.5

The particles of the two fractions were all uniformly color-coated. Color intensity was identical. The #11 grade fraction provided excellent granules for use in asphalt shingles while the coarser #46 grade fraction provided aggregate of superior qualities for use in decorating built-up roof surfaces.

The quantity of pigment and binder employed to color-coat the entire mass of aggregate was 59 pounds. The minimum amount of pigment and binder, consistent with proper coating, to color-coat 2000 pounds of #11 grade granules to the same color intensity is an identical 59 pounds.

The finer fraction, namely, the color-coated #11 grade granules, weighed slightly more than 2000 pounds. Hence, slightly over 300 pounds of the coarser (#46 grade) fraction were obtained. The required amount of pigment necessary to coat an equivalent 300 pounds of the #46 grade granules alone, in order to approach the color-intensity exhibited by the product of the present example, is about 15 pounds. Moreover, scuff-marks may be seen on the surfaces of the larger particles. Thus, even where particles having a size in the order of at least about one-fourth inch are processed according to my invention, not only do sizable economic savings occur but also significant advantages in the product are realized.

As in Example I, up to about equal portions of the coarse aggregate of the present example (greater in size than ¼ inch) may be employed with the fine aggregate without adversely affecting the uniformity of the color-coating of the coarse aggregate. However, where such high proportions of coarse aggregate are processed it may be necessary to slightly increase the pigment and binder in order to achieve equivalent color intensity.

It is not necessary that the mass of combined coarse and fine color-coated aggregate be separated into fractions which exclusively contain only the coarse in one and the fine aggregate in the other. Nor need the separation be confined to two fractions; for it may be desirable to simultaneously process a mass of aggregate which will provide more than two useful fractions of the desired particle size and range.

The simultaneous processing of the present invention is employed with equally successful results in the color-coating of coarse aggregate of sizes even greater than that shown in the first example. For instance, aggregate

having a size up to about 4 inches has been uniformly color-coated by employing procedures hereof.

The fine aggregate may be of any size, providing the screen size of the weight-median thereof is exceeded by at least twofold by the screen size of all the coarse aggregate. It may exceed ¼ inch. However, it must be borne in mind that in each instance the resulting color-coated coarse aggregate is equivalent in coating uniformity and color intensity to that of the fine aggregate. Thus where a quite large colored aggregate is desired which is substantially free from scuff marks, the particles of finer aggregate employed should have screen sizes less than about one-fourth inch. On the other extreme, that is, where extremely fine aggregate is to be employed, it may be necessary to adjust the viscosity of the coated slurry to insure that the fine particles do not adhere to the surface of the coarse aggregate.

Not only has the present invention provided means for uniformly economically color-coating large aggregate in the production equipment conventionally employed in the roofing granule industry, but it has provided in addition, insofar as I am aware, aggregate of a screen size greater than about one-fourth inch which is uniformly coated over the particle surface with insolubilized inorganic pigment and binder compositions.

Having now described my invention, it being understood however that I do not intend to be limited by the specific embodiments shown, what I claim is as follows:

1. In the process of producing artificially colored aggregate including uniformly color-coated coarse aggregate, the steps comprising: mixing a mass of aggregate including a first quantity of coarse aggregate the particles of which have a screen size of from about ¼ inch to about 4 inches, and at least an equal amount by weight of a second quantity of finer aggregate the particles of which have a screen size less than that of said first quantity, with an amount of binder and coloring material at least sufficient to provide uniform color-coating of said second quantity alone, the screen size of all the particles of said first quantity exceeding by at least twofold the weight-median screen size of said second quantity; drying and firing the mass; and separating the mass into a plurality of fractions one of which includes the color-coated particles of said first quantity.

2. In the proceess of producing artificially colored aggregate including uniformly color-coated coarse aggregate, the steps comprising: mixing a mass of aggregate including a first quantity of coarse aggregate the particles of which have a screen size of from about ¼ inch to about 4 inches, and at least an equal amount by weight of a second quantity of finer aggregate the particles of which have a screen size less than that of said first quantity, with an amount of binder and coloring material at least sufficient to provide uniform color-coating of said second quantity alone, the screen size of all the particles of said first quantity exceeding by at least twofold the weight-median screen size of said second quantity; drying and firing the mass; and separating the mass by screening into one fraction containing the color-coated particles of said first quantity and a second fraction containing the color-coated particles of said second quantity.

3. In the process of producing artificially colored aggregate including uniformly color-coated coarse aggregate, the steps comprising: mixing a mass of aggregate including a first quantity of coarse aggregate the particles of which have a screen size of from about ¼ inch to about 4 inches, and at least an equal amount by weight of a second quantity of finer aggregate, the particles of which have a screen size less than that of said first quantity, with an amount of binder and coloring material at least sufficient to provide uniform color-coating of said second quantity alone, the screen size of all the particles of said first quantity exceeding by at least twofold the weight-median screen size of said second quantity; drying and firing the mass; and separating the mass by a screen into a plurality of fractions one of which includes the color-coated particles of said first quantity and a portion of the color-coated particles of said second quantity.

4. In the process of producing artificially colored aggregate including uniformly color-coated coarse aggregate, the steps comprising: mixing a mass of aggregate including a first quantity of coarse aggregate the particles of which have a screen size of from about 1 inch to about 2 inches, and at least an equal amount by weight of a second quantity of finer aggregate the particles of which have a screen size less than about ¼ inch, with an amount of binder and coloring material at least sufficient to provide uniform color-coating of said second quantity alone; drying and firing the mass; and separating the mass into a plurality of fractions one of which includes the color-coated particles of said first quantity.

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