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ROAD CONSTRUCTION MATERIALS

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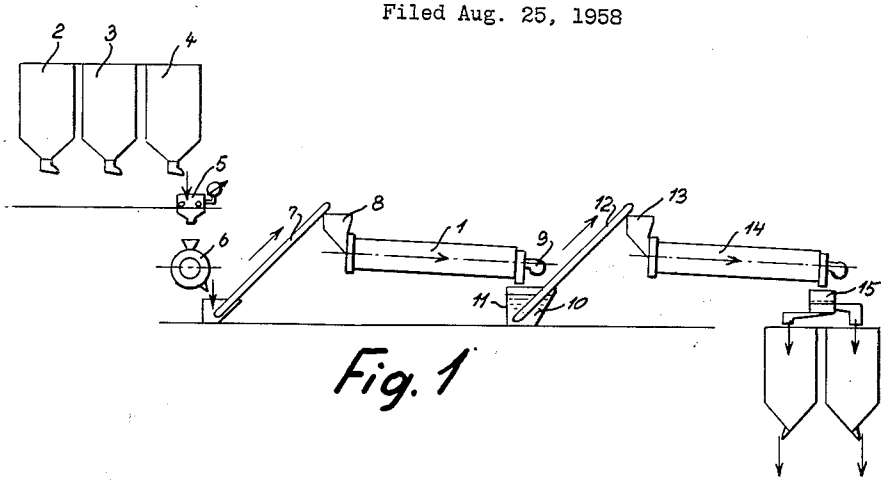


Fig. 1

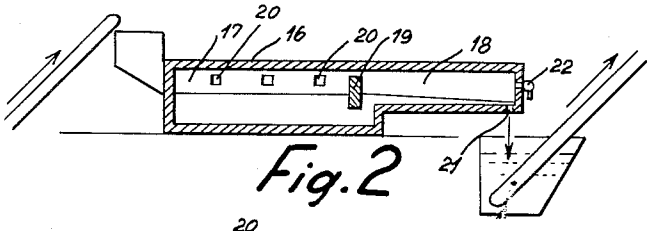


Fig. 2

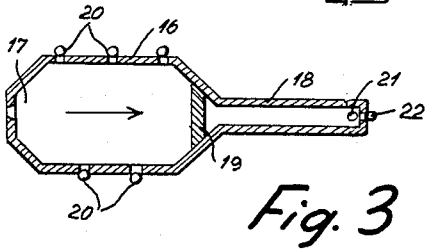


Fig. 3

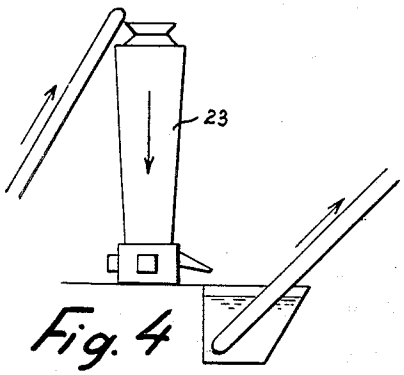


Fig. 4

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ROAD CONSTRUCTION MATERIALS

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This invention relates to road construction materials of the type comprising a so called aggregate, i.e. fragmentary or particulate matter, in the following referred to as grains, which is bound together by the cementing agent or adhesive in such materials as concrete, mortar, asphalt or coated macadam, in the following referred to as binder or matrix material. In such road construction materials, the brightness or light reflecting properties of the road surface can be varied by suitably selecting the aggregate material because the film of the matrix material formed on all sides of the grains of the aggregate material during the laying of a road surface coating of the type in question is gradually worn off at the road surface by the traffic so that the upper part of the grains are thereby exposed to view. The matrix material may on principle be any one of the road construction materials ordinarily used for the laying of road surface coatings or carpets. However, an improvement of the brightness or light reflecting properties of the road surface by means of the aggregate material is of particular interest when using matrix materials such as tar or bitumen, which have the disadvantage of rendering the road surface relatively dark, but are nevertheless used to a great extent on account of their excellent mechanical properties particularly as regards toughness and flexibility. For the principle of the present invention, however, it is immaterial whether such matrix materials or other matrix materials are used, such as thermo-plastic, thermo-hardening or chemically hardening resins.

It is in many cases desirable to have a relatively bright or light reflecting road construction material available, because this makes it easier to discern the road surface and particularly its borders when the road surface is illuminated by artificial light such as the headlights of an automobile or public lamps or road illuminating systems in the outskirts of cities.

Road construction materials have been proposed in which the aggregate consists of certain natural stone materials (blue flint) that have been burned, whereby the material assumes a brighter shade approximating white color. However, this aggregate material has the disadvantage of being relatively expensive. Moreover, there is no possibility of controlling the brightness, since the product has its own predetermined characteristics that cannot be varied at will. In the burning process, the natural stone material will be disintegrated to such an extent that it is not suitable for keeping up a satisfactory skid proofness of the road surface. Also, in the burning process cracks will be formed. Moreover, because of the smallness of the protruding grains, the road surface, when wet, will tend to become reflecting like a mirror, while coarser projections of the road surface would give this a rougher, less regularly reflecting surface. This drawback becomes even more pronounced when the road surface coating is gradually compressed by the traffic, because the cracks formed during the burning process are then further developed. The cracks developed in this manner will not be filled out by the matrix material, and consequently the road surface coating as a whole may become more or less porous so that water may penetrate to the base of the road and give rise to damages.

It is an object of the invention to provide an improved aggregate material not suffering from the described drawbacks. To this end, according to the invention, an aggregate material is provided, which consists of devitrified glass.

As is well known, glass as ordinarily defined is an amorphous product produced by the melting together of minerals containing silica and certain metal oxides, among which reference may particularly be made to CaO, MgO, K_2O and Na_2O. In the making of this amorphous product care is taken to avoid or minimize the tendency toward crystallization or devitrification during the cooling of the material. For this reason the components of the melting bath are selected so that the tendency toward crystallization will be as low as possible.

The present invention on the other hand is based on the recognition that the crystallization of glass materials results in properties which are very much preferable to those of amorphous glass materials for the purposes of road construction, and consequently the raw materials are selected in such a manner as to promote the tendency toward crystallization. Generally speaking, therefore, compositions of raw materials suitable for the purposes of the present invention will be such having a very high content of SiO_2 and CaO, these two components preferably totalling more than 90%, and a very low content of K_2O and Na_2O. In this connection it should be observed that as is well known CaO may in part be replaced by MgO. The compositions will also include suitable ingredients acting as fluxing agents, i.e. to reduce the melting point and/or to reduce the viscosity. Small proportions of K_2O and Na_2O may serve this purpose and also a small proportion of Al_2O_3 may have a similar effect.

Experiments have shown that grains of devitrified glass have many advantages for use as an aggregate for road construction materials. Among these advantages the following may be mentioned:

Owing to the crystal form, devitrified glass has a suitable color shade (generally whitish) to make the whole surface bright when illuminated by headlights or the like at night.

It is hard and wear resistant, but not brittle.

It is non-hygroscopic and resistant to moisture, oil and all chemical influences to which it may be subjected during use.

As contrasted to glass it is non-polishable so that notwithstanding the wear to which it is subjected by the traffic, it always retains a sufficient roughness to give the road surface suitable anti-skidding properties.

It has good light reflecting properties without a glaring effect such as is characteristic of amorphous glass particularly when the latter is polished by the traffic.

All these advantages are obtained by the simple and inexpensive process of devitrification so that the material will be cheap enough for use as an aggregate. It is also to be noted that simple and inexpensive constituents may be used for the glass bath from which the material is produced, because extreme purity is not essential.

The invention also relates to particularly advantageous methods of producing the aggregate material in question.

The invention will in the following be described in further detail with reference to the accompanying drawings, in which

FIG. 1 diagrammatically shows an example of a plant for producing grains of devitrified glass,

FIG. 2 a vertical section through a glass tank that may alternatively be used for the melting of the raw materials,

FIG. 3 a horizontal section through same, and

FIG. 4 in diagrammatical side elevation a blast furnace that may likewise be used for the melting of the raw materials.

Consideration will first be given to the raw materials

that may be used for making up the molten bath, from which the aggregate material is produced.

A first example of the raw materials is as follows:

	Parts by weight
Dune sand	75
Chalk or lime	45
Dolomite	15

When these raw materials are molten, carbon dioxide and other gases and vapors will escape to leave 100 parts by weight of molten product, which may be treated in one of the ways specified below to obtain devitrification.

In tests carried out with raw materials of the composition specified, the following analysis of the final product has been found:

	Percent
SiO_2	65
CaO	25
MgO	3
Al_2O_3	5
Fe_2O_3	1
K_2O or Na_2O	1

SiO_2 is derived from the sand, CaO from the chalk or lime and from the dolomite, MgO from the dolomite, Al_2O_3 from the sand, which contains a small proportion of feldspar. Fe_2O_3 is an impurity which is hard to avoid and is not fatal as long as the proportion is low, but higher proportions of Fe_2O_3 are very objectionable because they result in miscoloring. K_2O and Na_2O are derived from the feldspar in the sand and are not undesirable in small quantities. Somewhat larger quantities might be used, but this would necessitate the use of more expensive raw materials and does not result in any advantages for the purpose here in question.

As another example of the raw materials the following may be mentioned:

	Parts by weight
Pure quartz sand	65
Lime	50
Feldspar	15

In tests with this composition of raw materials the following analysis has been found:

	Percent
SiO_2	69
CaO	25
Al_2O_3	3
K_2O+Na_2O	2
Impurities, mainly iron compounds	1

It will be understood that similar products may be made from other raw materials which may be chosen from the point of view of availability and price. The analysis will determine the amounts of the various ingredients to be used according to principles well known in the glass industry.

It is characteristic of the products in question that they contain a very high percentage of CaO, which as will be seen forms the predominant constituent besides SiO_2. As has already been mentioned, however, part of the CaO may also be replaced by MgO and also other metals such as beryllium or strontium or lead in the form of red lead (Pb_3O_4) may be substituted in part for CaO, if this is found preferable. It should be understood, however, that the other ingredients present are not entirely unimportant, but should preferably comprise such ingredients as have the effect of reducing the melting point. The MgO of the dolomite of the first example has this effect to some extent and also the small quantities of K_2O and Na_2O present in both examples act as fluxing agents without destroying the crystallizing properties. The small proportion of Al_2O_3 has a somewhat similar effect. Other fluxing agents such as fluorspar and calcium phosphate could also be used. Fluorspar, however, is relatively expensive and may lead to inconveniences in poisoning the atmosphere. Calcium phosphate is relatively expensive as a raw material at most locations, but where e.g. phosphate rock is available at low price, this can be used with advantage.

The experiences obtained from a long series of experiments indicate that a preferable composition of raw materials for the melting process will be such as to keep the following limits for the analysis of the product:

SiO_2	Above 60%.
CaO+MgO	Above 20%, preferably above 25%.
Al_2O_3	Below 5%.
K_2O+Na_2O	Below 5%, preferably below 1%.
Fe_2O_3	Below 1%.
S	Below ½–1%.
C	Traces.

As regards sulphur it is observed that this has the disadvantage of giving rise to dark-coloring of the product and should therefore be avoided as far as possible, but small percentages such as ½–1% will not be fatal. C in the form of organic matter is very objectionable in likewise miscoloring the product and therefore only traces of C would be permissible.

Various examples will now be given of the manner, in which glass forming raw materials of the general character referred to may be treated to form grains of devitrified glass.

Example 1

Raw materials, e.g. of the specific composition first referred to, are mixed and heated in an inclined rotary oven **1** as illustrated in FIGURE 1. The oven may be of the type used in the cement industry, and as an example, which is by no means limitative, it may have an inner diameter of 2.4 m. and a length of 30 m. and may be disposed at an inclination of 4%. The speed of rotation may be ½–1 revolution per minute. The supply of raw materials is diagrammatically represented by three hoppers **2**, **3** and **4**, a movable weighing apparatus **5**, a mixing drum **6**, a conveyor **7** and a funnel **8**. As will be seen, the raw materials are continuously introduced at the upper end of the oven. The heating is performed in counter current by means of an oil burner **9** at the lower end of the oven. It is observed that thorough mixing of the raw materials is by no means essential seeing that a mixing will take place during the first part of the travel of the raw materials through the oven. Preferably, the raw materials are in powder form and may be supplied either dry or in the form of a sludge. In the latter case drying of the materials will take place during the first part of the travel through the oven.

During the travel, the raw materials are gradually heated, and when their temperature reaches the softening point the particles will coalesce to form a dam from which the materials gradually melt completely and flow in molten condition through the last part of the oven.

As an example, the temperature of the oven may be kept at about 1400° C. at the lower end and about 500° C. at the upper end. The supply of raw materials may amount to 135 metrical tons per 24 hours and the output of molten material pouring out from the lower end of the oven will then be about 100 metrical tons per 24 hours. In the example corresponding to the figures specified the time of travel from one end of the oven to the other will be about 3 hours.

The stream of glass pouring out at the lower end of the oven flows directly into a water bath **10** in a vessel **11**, to which fresh water is supplied as required by means not shown. When suddenly cooled in the manner described, the material is immediately solidified and granulated and then falls on to an inclined conveyor **12** which carries the material out of the water bath. The granulation has been substantially completed upon cooling of the material from 1400° C. to about 600–900° C. Since this cooling takes place very rapidly there is no need for keeping

the material in the water very long. The time of stay in the water may, e.g., be about ½ minute. When the material leaves the water it may still be relatively hot, e.g. up to 500–600° C.

The material leaving the conveyor **12** may if desired be kept in stock for later reheating. However, in the example shown, this material is directly transferred by means of the conveyor **12** and a funnel **13** to a second rotary oven **14**. This oven may be identical with the oven **1**, only the temperature is kept lower so that the temperature of the material does not exceed about 950° C. In this reheating stage, a devitrification takes place, i.e. crystals are formed in the grains. The crystallization commences only in the neighborhood of 950° C. so the heating taking place during the preceding part of the travel has no effect on the crystallization of the product but will to some extent remove inner stresses resulting from the granulation. It has been found that only a very short time is necessary for crystallization at the maximum temperature. Laboratory tests in which individual grains have been heated in an electric furnace have shown that the crystallization is completed in about 10 minutes at 950° C.

If the temperature exceeds 950° C. in the example here under consideration, there will be a too strong tendency to coalescing. At 950° C. there is no coalescing, but the crystallization proceeds quickly. It is characteristic that the crystallization can take place without complete melting and without coalescing which is not possible with ordinary glass material.

The crystallization tendency has been promoted by the composition of raw materials selected. It has been found that the sudden cooling of the molten material in a water bath also promotes the crystallization tendency. Moreover, crystallization is promoted, if the material is not completely vitrified in the oven, but a certain amount of not completely molten seeds or nuclei of the material are left in the molten mass. In the rotary oven there will be a natural tendency to the occurrence of such nuclei in the molten material because there is no physical separation between the solid raw materials and the molten material so that some particles may travel a little faster along the length of the oven than others and will therefore not be completely molten or vitrified.

The product leaving the second rotary oven **14** at the lower end thereof is the final product of the invention, i.e. a material consisting of grains of devitrified glass. In physical tests it has been found that the grain size of a product produced in the manner described will predominantly be in the range from 0–12 mm. screen size. In the drawing, a screening arrangement **15** is shown, by means of which the product can be separated into two different grades, e.g. 0–3 and 3–12 mm., but of course a finer grading is also possible.

To illustrate the relative heat treatment in the two stages of the process it may be mentioned that in practical operation the oil consumption in the first oven under the conditions specified was found to be 16 metrical tons per 24 hours against 4 metrical tons per 24 hours in the second oven. If ovens of greater length are used, the oil consumption may be reduced.

Example 2

Instead of the inclined rotary oven **1** a batch rotary drum oven may be used, in which a batch of raw materials is molten whereafter the whole of the batch is discharged in molten condition. The remaining steps of the process may be carried out in the same manner as in Example 1. Since the molten material will be discharged intermittently, the granulated material may be carried to an intermediate hopper of sufficient capacity to permit continuous supply of the material from this hopper to the second heating stage.

Example 3

The melting of the raw materials may alternatively be effected in a glass tank **16** of more or less conventional design. The glass tank illustrated in FIGURES 2 and 3 comprises a melting compartment **17** and an elongated discharge passage **18**, between which a bridge **19** is inserted in a position such that material is only permitted to pass from the melting compartment **17** to the discharge passage **18** below the bridge **19**. Since the non-molten materials will float on top of the molten bath, the bridge will thus prevent non-molten materials from passing into the discharge passage. Oil burners **20** serve to keep the melting compartment at the required temperature, e.g. 1400° C. like in the previous example. At the far end of the discharge passage a discharge opening **21** is provided. If raw materials are continuously supplied to the melting compartment at the left hand end thereof, a continuous stream of molten material will flow out of the discharge opening. The molten material leaving the glass tank may be treated in the same manner as described in the first example.

It is to be observed that while in the arrangement of FIGURE 1 the molten material will leave the rotary oven **1** at its maximum temperature, the arrangement of FIGURES 2 and 3 may be such that the molten material will leave the glass tank at a somewhat lower temperature, say about 12–1300° C. This is possible because the temperature of the discharge passage may be selected more or less independently of that of the melting compartment. A certain cooling of the material in the discharge passage is therefore possible. In the example illustrated, an oil burner **22** is arranged at the end of the discharge passage, it being assumed that some heating is necessary in order to compensate for heat losses. However, this oil burner may be omitted, if the losses of heat are not higher than desirable, and it is even possible to blow in cooling air instead, if this is found necessary to reduce the discharge temperature to the desired value. The advantage of discharging the material at a somewhat lower temperature is that it has been found that owing to the higher viscosity at a reduced temperature the material will tend to granulate into larger grains, i.e. in such a manner that the percentage of finer grains will be smaller, which is sometimes desirable.

Example 4

As illustrated in FIGURE 4, the melting step may also be performed in a blast furnace **23**, in which the minerals and fuel are piled up and fresh materials are supplied from the top while the molten glass is discharged from the bottom. Instead of solid fuel, gas may be used for the burning process and will then be supplied at the bottom of the furnace or alternatively an oil burner may be used, the flame of which is directed from outside the furnace towards the lower part of the charge from where the flame will then spread upwards through the charge. In the case of a blast furnace, the minerals must be used in fragments of a suitable size, e.g. approximately egg size, and if the raw materials are in powder form they should therefore be pressed into briquettes. If solid fuel is used, this may also be in the form of fragments of similar size or it may be made into briquettes together with the minerals. The molten material discharged from the lower end of the furnace may be treated in the same manner as in Example 1.

As regards the melting process it is to be observed that in all of the examples described it is preferable that this should take place in a practically neutral atmosphere, because it is found that in a reducing atmosphere miscoloring of the product is very likely to occur. If for some reason it is found preferable to perform the melting process in a reducing atmosphere, the disadvantageous effect of this treatment may be compensated for by sub-

sequently subjecting the molten glass to oxydation, e.g. by blowing oxygen or air through the molten material.

Example 5

A molten material produced according to any of the beforegoing examples is molded into blocks e.g. in sand dies, and these blocks are cooled slowly so that the temperature of the blocks will pass slowly through the crystallization range. When the temperature has fallen to 8–900° C., the slow cooling conditions need not be maintained any longer, since the crystallization has then been completed. The cooling down to this temperature should take from 1 to 24 hours. If the blocks are very large, no special measures need be taken for insulating them to keep cooling slow. If desired, the die may be covered with sand or other insulating material or it may be passed through a heat preserving oven.

After the blocks have been cooled down to at least the temperature mentioned, they are mechanically crushed. In order to obtain economical crushing, the bodies to be crushed should not be too large, preferably not more than 20–25 cm. However, the blocks may if desired be molded in larger sizes e.g. up to 1 m.^{3} because blocks of this size will generally develop crevices so that they may easily be split up into bodies of a size suitable for mechanical crushing.

It has been found that the specific composition of raw materials referred to in the second example is particularly advantageous for the process of the present Example 5.

Some remarks will now be given on the character of the product and the manner in which this is incorporated in a road construction material.

As previously mentioned, the grain size of the product will usually be in the range 0–12 mm. screen size. This product may be graded into different ranges according to requirements. Usually the finer grade from 0–3 mm. will be separated from the remainder to be used for special purposes where a high skid-proofness is not a principal requirement. Grain sizes from 3–12 mm. have been found to be suitable for ordinary road surfaces. Best results are obtained with grain sizes from 3–6 mm. for road carpets and 5–7 mm. for mastic and compressed asphalt. Grains within these ranges are large enough to break the water film on a wet road so that the road surface does not reflect the light like a mirror, and besides these grain sizes offer an excellent friction for the wheels of vehicles.

The grains may be produced completely compact or with minute cavities as desired. In the latter case it is desirable that the acvities should not form continuous pores, but should be discrete so that the material does not assume a porous character. A product practically without cavities in the bodies of the grains has been obtained from a glass tank, while on the other hand it has been found that the product molten in a rotary oven will usually have a certain amount of cavities. A product of the last named character may also be obtained from a glass tank. The material without cavities has a greater strength, but a certain amount of cavities is advantageous in various respects. The cavities will make the product less polishable by the traffic and besides will increase the adhesion between the grains and the binder, because the latter will be able to penetrate to some extent into the cavities present in the surface of the grains. It has been found that a total volume of the cavities amounting to 5–15% and a maximum diameter of the cavities of about 0.5 mm. or even lower such as about 0.2 mm. will be preferable. This amount of cavities will reduce the specific gravity of the grains to 2.2–2.3 as against a specific graviyt of 2.5–2.6 of the compact product.

Cavities may be produced in various manners. In the rotary oven they will be formed very easily presumably because air is continuously introduced into the molten material owing to the rotation of the oven, or this rotation prevents the occluded gases from escaping. Only the larger bubbles will escape, while the smaller bubbles are retained. In a glass tank special measures may be taken for promoting the formation of bubbles, if these do not naturally occur to the desired extent. E.g. air may be blown into the molten material or may be introduced into the latter by means of a rotating drum partly immersed into the molten bath. Gas developing raw materials may also be used and the melting process may be discontinued at a so early stage as regards temperature and time that the gases are not permitted to escape.

As an alternative or supplement to the irregularity of the surface obtainable by the formation of cavities a certain roughness of the surface may also be obtained by the presence of non-vitrified or incompletely vitrified particles in the grains. This may be obtained by adding mineral particles to the molten material immediately before the discharge thereof. Such particles, which may e.g. consist of sand or crushed rock, will be embedded in the material of the finished grains, and may be more or less fused together with the latter without however being completely vitrified. The presence of such particles will contribute towards making the grains less polishable and increasing the adhesion between the grains and the binder.

The addition of particles immediately before the discharge of the molten material may also be used as a means for increasing the crystallization tendency. E g. very fine quartz dust is a suitable ingredient for this purpose. This step is particularly recommendable for use in the process of Example 5.

The aggregate according to the invention may be worked into road construction materials in similar manner as aggregate from other sources. It has been found that suitable light reflecting properties can be obtained also if the new aggregate material is mixed with usual aggregate materials. One example of a road construction material, in which the aggregate according to the invention is incorporated, is a material for making road carpets having the following composition:

30% devitrified glass grains of 3–6 mm. screen size,
58% other stone material having grain sizes of 0–6 mm. screen size, at least 5½% thereof falling within the range below 0.074 mm. (filler),
5½% filler,
6½% asphalt.

This road carpet material may be laid in an amount of about 40 kgs./m.^{2}.

As another example, the aggregate according to the invention may be used for road surfaces consisting of mastic and compressed asphalt where the grains are scattered upon the surface of the asphalt and are then rolled into the latter, the excess of aggregate being subsequently swept off for renewed use. In this case the asphalt layer may have a thickness of about 5 cm. and the amount of devitrified glass grains may be about 5 kgs./m.^{2} together with another 5 kgs./m.^{2} of other stone material. In this case grain sizes within the range 5–7 mm. are preferably used.

The aggregate material according to the invention may also be used for other building materials wherever the special character of the grains of devitrified glass is found advantageous.

This application is a continuation-in-part of applicant's earlier application, Serial No. 536,744, filed September 26, 1955, now abandoned.

I claim:

1. A non-brittle, wear-resistant aggregate for road construction material consisting essentially of grains of devitrified glass the analysis of which shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said SiO_2 and CaO equalling at least about 90 percent, said aggregate being adapted to impart a light-reflective, glare-free surface to roads containing the same.

2. A non-brittle, wear-resistant aggregate as claimed

in claim 1 wherein the bodies of said grains of devitrified glass have a multitude of discrete cavities.

3. A non-brittle, wear-resistant aggregate as claimed in claim 1 wherein the particle size of said grains of devitrified glass is between 3 and 12 mm. screen size.

4. A non-brittle, wear-resistant aggregate as claimed in claim 1 wherein the particle size of said grains of devitrified glass is predominantly in the range of from 3 to 12 mm. screen size, said grains having a multitude of discrete cavities in the bodies thereof, the total volume of said cavities amounting to less than 15 percent of the total volume of the grains, said cavities having predominantly diametrical sizes below 0.5 mm.

5. A non-brittle, wear-resistant aggregate as claimed in claim 1 wherein said grains of devitrified glass have incompletely vitrified mineral particles embedded therein.

6. A non-brittle, wear-resistant aggregate for road construction material consisting essentially of grains of devitrified glass the analysis of which shows a content of more than 60 percent and up to 69 percent SiO_2, more than 20 percent and up to 25 percent CaO, less than 10 percent of metal oxide fluxing agent selected from the group consisting of Al_2O_3, K_2O, Na_2O and mixtures thereof, the amount of Al_2O_3 and the combined amount of Na_2O and K_2O present, respectively, being less than 5 percent, said aggregate being adapted to impart a light-reflective, glare-free surface to roads containing the same.

7. A process of producing an aggregate for road construction materials comprising the steps of heating glass-forming raw materials the analysis of which in the finished product shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said SiO_2 and CaO equalling at least about 90 percent, to form a molten mass of glass, forming said molten glass into grains and devitrifying said grains.

8. A process of producing an aggregate for road construction materials as claimed in claim 7, wherein said glass-forming raw materials are characterized by a tendency to promote crystallization in a substantially neutral atmosphere.

9. A process of producing an aggregate for road construction materials as claimed in claim 7, wherein mineral particles are added to said molten mass of glass at a time and under conditions such that said added mineral particles will be incompletely vitrified.

10. A process of producing an aggregate for road construction materials as claimed in claim 7, wherein said glass-forming raw materials are characterized by a tendency to promote crystallization at temperatures and under conditions such as to obtain an incompletely vitrified molten mass of glass.

11. A process of producing an aggregate for road construction materials comprising the steps of heating glass-forming raw materials the analysis of which in the finished product shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said SiO_2 and CaO equalling at least about 90 percent, to form a molten mass of glass, causing said molten material to flow into a water bath thereby to become granulated, removing the grains thus formed from said water bath and reheating these grains to devitrification temperature.

12. A process of producing an aggregate for road construction materials as claimed in claim 11, wherein said glass-forming raw materials are supplied to the upper end of an inclined rotary oven kept at temperatures sufficient to melt said raw materials during their passage through said oven, causing the molten material thus formed to flow off from the lower end of said rotary oven into a cooling water bath, thereby to become granulated.

13. A process of producing an aggregate for road construction materials as claimed in claim 11, wherein said molten material is caused to flow through a water bath on to a conveyor partly immersed into said water bath carrying the grains thus formed out of said water bath by means of said conveyor.

14. A process of producing an aggregate for road construction materials comprising the steps of heating glass-forming raw materials the analysis of which in the finished product shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said Sio_2 and CaO equalling at least about 90 percent, to form a molten mass of glass, molding said molten material into blocks, cooling said blocks sufficiently slowly to allow the glass to devitrify and subsequently mechanically crushing said blocks.

15. A process of producing an aggregate for road construction materials comprising the steps of heating glass-forming raw materials the analysis of which in the finished product shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said SiO_2 and CaO equalling at least about 90 percent, to form a molten mass of glass, at about 1400° C., subjecting said molten material to rapid cooling, thereby to become granulated, and reheating the grains thus formed to devitrification temperature at about 950° C.

16. A road construction material comprising a binder and an aggregate comprising non-brittle, wear-resistant grains of divitrified glass the analysis of which shows a content of more than 60 percent SiO_2 and more than 20 percent CaO, the total of said SiO_2 and CaO equalling at least about 90 percent, said construction material producing a road characterized by a light-reflective, glare-free surface.

17. A road construction material as claimed in claim 16, wherein the bodies of said grains of devitrified glass have a multitude of discrete cavities.

18. A road construction material as claimed in claim 16, wherein the particle size of said grains of devitrified glass is between 3 and 12 mm. screen size.

19. A road construction material as claimed in claim 16, wherein the particle size of said grains of devitrified glass is predominantly in the range of from 3 to 12 mm. screen size, said grains having a multitude of discrete cavities in the bodies thereof, the total volume of said cavities amounting to less than 15% of the total volume of the grains, said cavities having predominantly diametrical sizes below 0.5 mm.

20. A road construction material as claimed in claim 16, wherein said grains of devitrified glass have incompletely vitrified mineral particles embedded therein.

References Cited in the file of this patent

UNITED STATES PATENTS

225,991	Lee	Mar. 30, 1880
1,143,885	Brookfield	June 22, 1915
1,842,772	Von Veress	Jan. 26, 1932
2,635,054	Doyle et al.	Apr. 14, 1953
2,889,952	Claypoole	June 9, 1959
2,920,971	Stookey	Jan. 12, 1960

OTHER REFERENCES

Morey: The Properties of Glass, 2nd ed., Reinhold Publishing Corp., New York, 1954, page 19.