Jan. 3, 1956 E. S. ROBBINS 2,729,770

ELECTRICALLY CONDUCTIVE PLASTIC PANELS

Filed April 13, 1954 2 Sheets-Sheet 1

Fig. 1

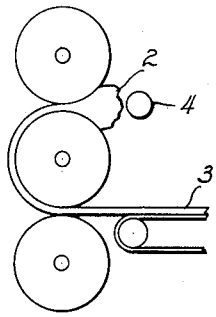

Fig. 2

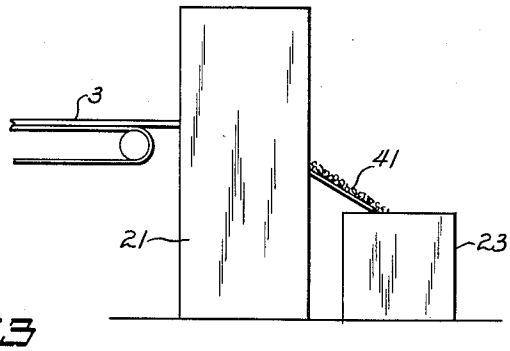

Fig. 3

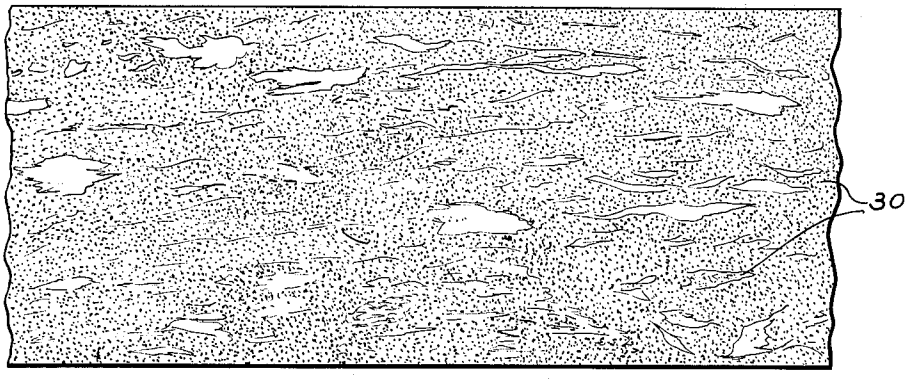

Fig. 6

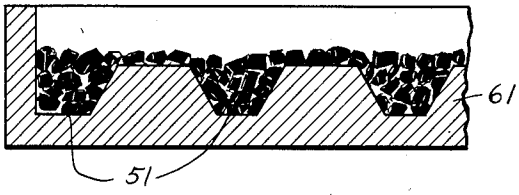

Fig. 4

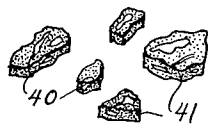

Fig. 5

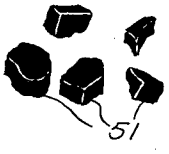

Fig. 7



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ELECTRICALLY CONDUCTIVE PLASTIC PANELS

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Fig. 8

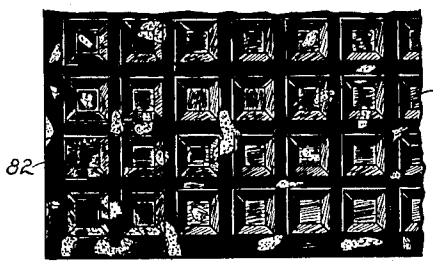
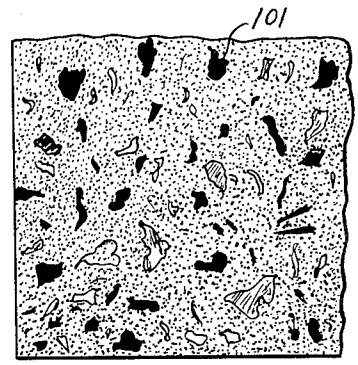


Fig. 9



Fig. 10



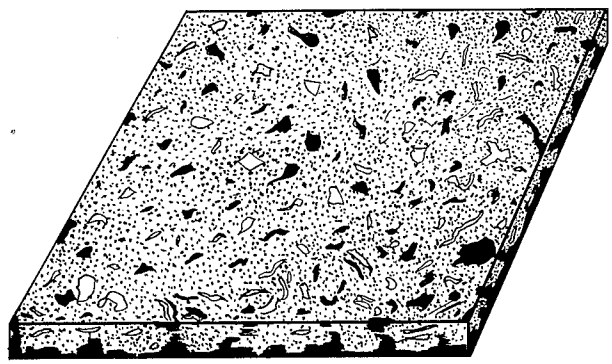


Fig. 11



Fig. 12

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2,729,770

ELECTRICALLY CONDUCTIVE PLASTIC PANELS

Edward Stanley Robbins, Killen, Ala.

Application April 13, 1954, Serial No. 422,797

11 Claims. (Cl. 317—2)

This invention relates to structural elements such as panels and tiles of synthetic plastic materials which are electrically conductive, for the dissipation of elecrtrostatic charges. The invention also relates to electrically conductive panels and tiles which are decorative and colorful in design.

The invention further relates to a decorative type of conductive plastic tile which meets the requirements of the National Fire Protection Association for safe practice for hospital operating rooms.

More specifically, the invention relates to a plastic panel or tile having a decorative surface pattern comprising a matrix of one color and irregularly shaped areas therein of contrasting colors, at least some of the areas having contrasting colors being electrically conductive, and being in electrically conductive contact with a common "ground," or conductive material of large area.

There have always been serious technical problems in making resilient tiles and panels in desirable patterns, and no pleasing pattern has ever been available in an electrically conductive tile. Electrically conductive panels which have been available in the past have usually been solid black, because of the presence of a large amount of conductive carbon. A "marbleizing" process has been in use in the part for the manufacture of conductive tile, but the black portion of the "marbleized" pattern has always predominated to an undesirable extent. The predominance of the black color has been caused in part by the necessity of obtaining the necessary conductivity. A further restriction on the marbleization pattern is imposed by the National Fire Protection Association. In addition to other standards, this association requires that no point on a non-conductive element in the surface of a plastic marbleized tile be more than one-quarter inch from a conductive element of the surface. This requirement restricts the distance between conductive or black marbleization areas to a maximum of one-half inch.

This requirement of the association, and other similar rules, are printed in a booklet entitled "Recommended Safe Practice for Hospital Operating Rooms." This booklet was published by the National Fire Protection Association in Boston in 1952. Copies are available from the Association at 60 Batterymarch Street, Boston 10, Massachusetts. The rules there set forth have been adopted by the American College of Surgeons, the American Hospital Association, the National Board of Fire Underwriters, and many other groups.

The foregoing considerations impose limitations on the patterns for conductive tile which are quite severe. In addition to the pattern limitations on marbleized conductive tile, there are other inherent production problems. When synthetic plastics of the type used in the resilient flooring industry are subjected to the calendering operation which produces marbleized sheets, internal stresses are developed in the sheets. These internal stresses may cause a marbleized panel to warp, craze, develop surface cracks, and show undesirable shrinkage characteristics. The process for the production of electrically conductive tiles and other panels described in this application includes, as a part thereof, a stress relieving process, which is more fully described in my copending application Serial No. 419,682, filed March 30, 1954, and entitled "Terrazzo Pattern Plastics Panels."

It is an object of the present invention to provide an electrically conductive panel of synthetic plastic material in which a plurality of desirable patterns and color arrangements may be employed.

A further object of the invention is to provide a process for making an electrically conductive panel of synthetic plastic material, which process will allow for the production of a plurality of colorful surfaced patterns on the panel.

Another object of the invention is to provide a process for making a decorative vinyl floor tile having electrically conductive characteristics, which process will produce a tile free of internal stress.

A still further object of the invention is to provide a decorative, electrically conductive vinyl floor tile which complies with the safety requirements of the National Fire Protection Association for hospital operating rooms.

Still another object of the invention is to provide a decorative plastic panel containing a sufficient amount of carbon for electrical conductivity, and in which panels there is a uniformly conductive underlayer of irregular thickness integrally united with an upper layer having a decorative pattern therein, and in which upper layer the conductive elements are in random distribution as a part of the decorative pattern.

These and other objects of the invention are obtained by a plurality of process steps. A unique feature of the process is the group of steps which relieve the resilient synthetic plastics employed of their internal stress. This series of steps relieves those internal stresses which are inherent in synthetic plastic sheets from the calendering operation, and allows the plastic to be used to produce molded products which are free from buckling, crazing, warping, surface cracking, irregularity caused by failure of the plastic particles to fuse together, and undesirable shrinkage characteristics.

A decorative terrazzo-type pattern may be imparted to a synthetic plastic panel by a series of steps which comprises: calendering a marbleized sheet of synthetic plastic; chopping the calendered marbelized sheet into relatively small, irrgularly shaped "granules"; heat-molding the granules under pressure into a panel of the desired shape, and cooling the panel in the mold under pressure. This series of steps produces a molded product free of internal stress, and may be readily adapted to the production of electrically conductive tiles and panels.

An electrically conductive synthetic plastic panel having a decorative terrazzo-type pattern, in which electrically conductive carbon is employed to impart electrical conductivity to the panel, may be made by forming a solid black first sheet of uniformly electrically conductive synthetic plastic which is heavily loaded with conductive carbon; chopping the solid black first sheet into granules; forming a second sheet of synthetic plastic having a marbleized pattern, in which the electrically conductive carbon is confined to certain marbleized areas; chopping said second sheet into granules; charging the bottom of a mold with black granules cut from the solid black sheet of uniformly conductive plastic; filling the remainder of the mold with granules of the second marbleized sheet; molding the granules under high pressure at a molding temperature to produce the desired electrically conductive panel, and cooling the panel in the mold under high pressure.

The invention may be best understood by reference to the drawings, in which like numerals refer to similar structural features.

Figure 1 is a schematic view of a bank of calender rolls which form the plastic into thin sheets.

Figure 2 is a schematic diagram of a chopping device for converting the pastic sheet into small "granules" of irregular shape.

Figure 3 is a perspective view of a marbleized sheet of synthetic plastic.

Figure 4 depicts, in an enlarged view, granules cut from a marbleized sheet.

Figure 5 is an enlarged view of granules cut from a solid black sheet.

Figure 6 is a sectional view of a mold for a floor tile, containing a quantity of black granules.

Figure 7 is a sectional view of the mold shown in Figure 6, containing a normal load of granules.

Figure 8 is a fragmentary bottom view of a floor tile formed in the mold shown in Figures 6 and 7.

Figure 9 is a sectional partial view of the tile shown in Figures 8 and 10.

Figure 10 is a top partial view of a floor tile formed in the mold shown in Figures 6 and 7.

Figure 11 is a perspective view of a flat tile made in accordance with the invention.

Figure 12 is a sectional view of a flat tile made in accordance with the invention.

The method for making an electrically conductive panel, according to this invention, necessitates the production of a plurality of calendered sheets of synthetic plastic material. One of these calendered sheets must be uniformly electrically conductive, and if conductive carbon is employed to provide electrical conductivity, this sheet will be solid black in color. The remaining plastic sheets which are to be employed in the process may be of any color or colors which will produce a desirable pattern. For simplicity of illustration and description of the invention, there will be described a process for the production of an electrically conductive panel in two colors only. The description will refer to the production of a green and black tile, from a black, electrically conductive, vinyl plastic batch of material, and from a decorative green, non-conductive vinyl plastic batch of material.

In order to produce an electrically conductive tile of satisfactory characteristics from two such plastic batches of material, a rather complex process is employed. As a first step in this process, each batch of plastic is formed into a sheet by passage of the batch through conventional calender rolls. Each sheet is then cut into large pieces or slabs of a size convenient for handling in factory operations. The green sheet is subjected to a further calendering operation of a more involved nature in order to distribute throughout the green plastic a small amount of the conductive black plastic. This further operation produces a marbleized sheet in which the green color predominates and appears to be, and actually is, a matrix in which the black, electrically conductive vinyl plastic is distributed. This process is a marbleization process and produces a calendered, marbleized sheet of black mottle in a green base. While most of the black, electrically conductive calendered vinyl sheet may be chopped into granules of small, irregular configuration, for direct use in molding operations, a portion must be retained in sheet form for blending with the green batch in the marbleization process.

Referring now in detail to Figure 1, the calender rolls work up a plastic mass **2** into a sheet **3** of any desired thickness. Since this same process is employed in calendering all sheets, the plastic mass **2** may be of any desired color. The process illustrated will be identical for all colors. The plastic mass **2** may be forced into the nip between the calender rolls by a ram **4** operated by a hydraulic mechanism (not shown). The calender rolls may be set to any desired sheet thickness, but for a sheet which is to be cut into small granules, a thickness of ⅛ inch to ¼-inch has been found to produce good results. The sheet **3** may be cut up into small granules **22** of

irregular shape in any suitable cutting device **21**. The granules **22** may then be stored for further use in any suitable container **23**. Although granules of irregular configuration have been found to give best results in molding operations, the granules may be of any desired shape, such as, for example, small cubes.

The solid black sheet of uniformly electrically conductive vinyl plastic may be taken directly from the calender rolls, and a great portion of it may be cut into small granules at once. A small portion of the sheet must be set aside for the marbleizing operations.

In order to make the marbleized sheet of green base vinyl plastic containing a small amount of electrically conductive black mottle, a plurality of manufacturing methods are available. In one method, a "sandwich" may be made up. In order to make the "sandwich," the calendered green plastic sheet is cut into slabs of convenient length. One such slab of convenient length is made the bottom layer of the "sandwich." Upon this bottom layer there may be placed narrow strips of solid black, uniformly electrically conductive vinyl plastic. These small strips are then covered with a second slab of green vinyl plastic. This makes the "sandwich." The "sandwich" is then manually or mechanically rolled into a cylindrical shape, which is similar in appearance to a jelly-roll. This "jelly-roll" is rolled in a mill roll to form a flat sheet, re-rolled, and passed through calender rolls, which form the mixture of black and green plastic into a marbleized sheet. In the perspective view of this sheet illustrated in Figure 3, the black, electrically conductive plastic appears against the green background in marbleized streaks **30**.

According to the process of the invention, the marbleized sheet is then chopped up into small granules of irregular shape. As may be observed from Fig. 4, the marbleized portions **40**, in which the electrically conductive composition is distributed, do not occupy a great proportion of the area of the granules' surface. While the total amount of electrically conductive carbon in the granules obtained from the marbleized sheet is relatively small, the granules **51** obtained from the uniformly electrically conductive solid black sheets are high in carbon content and are completely black, as illustrated in Fig. 5.

In order to form an electrically conductive floor tile according to the method of the invention, a novel molding procedure is followed. The lower part of a tile mold **61** is charged with a sufficient amount of uniformly conductive granules **51** to substantially cover the lower surface. The mold depicted in Figure 6 has, for purposes of illustration, a surface adapted to produce a waffle-like pattern on the under surface of the tile. The mold is then completely filled with marbleized granules **41**. The mold cover is applied, and the granules are fused together under heat and pressure.

The finished product is a tile having an under surface in which the uniformly conductive granules predominate, and the under surface is therefore substantially black. However, as illustrated in Figure 8, in some portions of the under surface **80**, particularly in the indented portions **81**, small areas of green plastic **82** are visible. Although these areas may have been covered with black granules when the mold was filled with granules, it is believed that during the molding process there is some migration of the granules. This migration is believed to be partly responsible, at least, for the effectiveness of this tile in dissipating electrostatic charges, since the conductivity of the tile appears to be attributable, in large measure, to the presence of "chimneys" or "eruptions" **92**, of black, conductive material which extend to the upper surface of the tile. Since the presence of these "chimneys" throughout the tile and the prevalence of black areas **101** on the tile surface are out of proportion to the distribution of granules in the mold, some factor such as migration may have been responsible for the final distribution. It has been found that a random arrange-

ment of granules in the mold, with the solid black granules covering the bottom, and granules containing black in marbleized streaks filling the remainder of the mold, provides a sufficient number of conductive paths **92** for the dissipation of electrostatic charges.

The process described above and the mold shown in Figure 6 have illustrated the production of a particular type of tile. This tile is horizontally compressible and may be laid without adhesive. Tiles of this general structure are disclosed and claimed in my copending application, Serial No. 305,625, filed August 21, 1952. Tiles of this structure may be laid directly over sheets of metal foil or wire mesh on a floor. The metal foil or wire mesh may be grounded, if desired, but it alone usually provides a sufficiently large field to eliminate the danger of static sparks.

It should be understood, however, that the molding process described is equally applicable to other types of resilient tiles. For example, in Figures 11 and 12 there are illustrated flat, electrically conductive, plastic panels. Panels of this type are adapted for use as adhesively secured tiles. Conductivity from the upper surface to the lower surface is obtained through the elongated passages, "chimneys" or "eruptions" **121** containing conductive carbon black. The adhesive may also be conductive, according to conventional practice with currently available conductive tile which is completely black in appearance.

Any suitable synthetic plastic compositions for forming resilient floor tile may be employed in manufacturing the panels of this invention. A satisfactory vinyl resin composition for the green batch is given below:

Green vinyl batch

	Pounds	Percentage by weight
VYNW [1] (Polyvinyl Chloride resin)	159.75	31.3
Lead Carbonate (Heat Stabilizer)	22.50	4.4
Light Stabilizer (Stabelan XL)	7.50	1.5
Paracoumarone-Indene Resin (Softener and Plasticizer)	21.00	4.1
Clay Filler and Hardening Pigment	233.41	45.7
Green Color Pigment	10.34	2.0
Dioctylphthalate	56.25	11.0
Total	510.75	100.00

[1] VYNW resin is between 93 and 95% polyvinyl chloride having an average molecular weight of about 24,000; the remainder is polyvinyl acetate.

This composition can be made into a perfectly satisfactory floor tile. In order to render this general type of composition electrically conductive, conductive carbon black may be added. The addition of the conductive carbon upsets the balance of the formulation somewhat, and must be compensated. A suitable adjustment of the formulation may be made by decreasing the amount of filler and increasing the amount of plasticizer. A satisfactory conductive vinyl batch, containing balanced proportions of ingredients, and compatible with the previously mentioned green batch, is as follows:

Electrically conductive vinyl batch

	Pounds	Percentage by weight
VYNW [1] (Polyvinyl Chloride resin)	260	27.4
Lead Carbonate	27.5	2.9
Stabelan XL	9.0	.9
Atomite (Calcium Carbonate Filler)	288.0	30.4
Stearic acid	3.0	0.3
Dioctylphthalate	185.0	19.5
Conductive Black	177.0	18.6
Total	949.5	100.00

[1] VYNW resin is between 93 and 95% polyvinyl chloride having an average molecular weight of about 24,000; the remainder is polyvinyl acetate.

It will be understood that many modifications in these basic formulae are possible and will be readily evident to those skilled in the art. Many other types of vinyl resins may be substituted for the VYNW Vinylite resin specified above, with equally successful results, provided suitable fillers, plasticizers, and stabilizers are employed. This description of an electrically conductive vinyl tile is for purposes of illustrating the invention, and it should be understood that other resin compositions may be substituted for those disclosed. For example, many other commercially available, highly polymerized polyvinyl chloride resins may be substituted for the VYNW resin mentioned above. Among such resins which are satisfactory are those sold commercially under the names Geon 101, Marvanol 20, 21, 22, and Geon 101 E. P. and 103 E. P. Each of the foregoing is a polyvinyl chloride resin of the type suitable for use in the flooring industry. Similarly, other resins may be substituted for the polyvinyl chloride resins, provided that suitable processing treatments are applied.

For vinyl compositions of the type mentioned above, the calender rolls may be operated at about 290° F., although lower or higher temperatures may be employed if desired. After calendering, the green, non-conductive sheets are allowed to cool, and then are chopped into granules, as previously described. As previously mentioned, a marbleized sheet is formed by calendering together portions of both conductive (black) and non-conductive (green) plastic. The marbleized areas **30** contain conductive carbon and are electrically conductive. As will be noted from the formulation for the electrically conductive vinyl batch above, about 18.6% by weight of the resin composition is conductive carbon. The precise amount of conductive carbon employed may be varied somewhat, but it has been found that the lower limit for effective results in obtaining a conductive panel or tile, in a vinyl or other synthetic resin composition, is about 15%. When less carbon than this amount is employed, the resistance of the mass mounts rapidly, and the plastic takes on undesirable insulating characteristics.

The upper limit to the amount of carbon which may be employed has been found to be about 20%. This figure must be determined empirically, and the maximum, as would be expected, has been found to depend upon several conditions. Where the object of the panel is to eliminate static electricity, as in a resilient floor, it is nevertheless desirable that the panel have some resistance, in order to eliminate shock hazard. Thus, the National Fire Protection Association requires that:

"2. The resistance of the conductive floor shall be less than 1,000,000 ohms as measured between two electrodes placed three feet apart at any points on the floor.

"3. For additional protection against electric shock, the resistance of the floor shall be more than 25,000 ohms, as measured between a ground connection and an electrode placed at any point on the floor, and also as measured between two electrodes placed 3 feet apart at any points on the floor."

The method of making this test is, as follows:

Method of test

"1. The floor shall be clean and dry and the room shall be free of explosive gas mixtures. Each electrode shall weigh 5 pounds and shall have a dry, flat, circular contact area 2½ inches in diameter which shall comprise a surface of aluminum or tin foil 0.0005 to 0.001 inch thick backed by a layer of rubber ¼ inch thick and measuring 50 plus or minus 10 hardness as determined with a Shore Type A durometer. (American Society for Testing Materials Tentative Method of Test for Indentation of Rubber by Means of a Durometer, ASTM Designation D676–49T, obtainable from ASTM, 1916 Race St., Philadelphia 3, Pa.)

"2. A suitably calibrated ohmmeter with a nominal open circuit output voltage of 500 volts D. C. and a

short-circuit current of 2.5 to 10 milliamperes shall be used. Measurements shall be made at five or more locations in each room and the results averaged. For compliance with section 6–2 (*a*) 2, the average shall be within the limits specified and no value shall be greater than 5 megohms. For compliance with section 6–2 (*a*) 3, where resistance to ground is measured, two measurements shall be made at each location, with the test leads interchanged at the instrument between measurements, with the average to be taken as the resistance to ground at that location. For compliance, no location shall have average resistance of less than 10,000 ohms and the average for all locations shall be greater than 25,000 ohms. All readings shall be taken with the electrode or electrodes more than three feet from any ground connection or grounded object resting on the floor." [1]

The above requirements set forth a lower limit for electrical conductivity and an upper limit as well. The requirement for the lower limit is an obvious one, since this requirement assures that static charges will be conducted away and dissipated. The requirement for an upper limit is also set in these requirements, and for equally necessary reasons. If the floor were constructed of a good electrically conductive material, such as aluminum or iron, there would be a great hazard of electrical shocks from the electric equipment within such a room. The conductive tile of the present invention fulfills these conductivity requirements in a very satisfactory manner, in that it is a sufficiently good conductor to dissipate static electrical charges, but is not a sufficiently good conductor to present a shock hazard.

In following the test procedures described above for floor tile, it has been found that tiles made of the specific compositions set forth above, when made according to the process described in connection with Figures 1 through 9, and laid as a flooring unit in accordance with procedures more fully described in my copending application Serial No. 305,625, filed August 21, 1952, by slight horizontal compression of each tile, and without any adhesive, over a sheet of aluminum foil, or wire mesh, have an average resistance of 100,000 ohms. This is well within the limits specified in the requirements for safe practice of the National Fire Protection Association. This resistance figure is not materially affected by changes in humidity or temperature, and the tile is therefore a highly desirable flooring product, for use in operating rooms, laboratories, and in other places where static charges of electricity are a hazard.

The present invention has achieved a result which is indeed unique. The present invention provides a method for making electrically conductive tiles for the dissipation of static electricity in many decorative patterns and colors. The present invention also provides a conductive flooring which is not subject to warping, crazing, and shrinkage, since the unique manufacturing process employed produces a plastic panel which is free from internal stress. The invention also provides a very flexible molding process for making conductive panels. For example, other substances may be substituted for conductive carbon as the electrically conductive component of the conductive plastic composition. If these substances are either more or less conductive than is the carbon black, suitable adjustments may be made in the percentage of conductive material which is processed to form the marbleized sheet.

Where electrically conductive carbon is employed as the additive to impart electrical conductivity to the plastic batch, about 15% to 20% carbon content by weight may be employed. The requirements of the National Fire Protection Association for conductivity have been met by making the marbleized sheet with a content of about 4.2% conductive plastic as compared to the entire weight of the marbleized sheet. Of this 4.2% of conductive plastic, only 15 to 20% represents electrically conductive carbon. This relatively small percentage of conductive material imparts sufficient conductivity to the entire tile or panel, when produced by the techniques herein disclosed, to dissipate static electricity before any substantial charge can accumulate.

Tile made in ccordance with the above disclosure has been found satisfactory and has been approved by the Underwriters' Laboratories, Incorporated.

The novel products produced according to this invention are not only desirably decorative in appearance, they possess an exceptionally long life. One disadvantage of electro-conductive flooring materials hitherto available has been their relatively short life. It has been found that flooring material containing substantial amounts of carbon black, as it has been available in the past, has deteriorated with age. After a few months' service, there has always been a noticeable increase in the electrical resistance of this type of flooring. After one year of service, the deterioration has usually been such that replacement is necessary. The decorative panels and floor tiles produced according to the present invention suffer from no such defects. The smooth upper surface which may be produced by the molding process of the invention is free from warping, crazing, and cracking, because the process produces plastic products which are free from internal stress. This smooth surface of the electro-conductive plastic panels keeps dirt, oxygen, actinic light, and other deleterious agents from contact with the conductive carbon. Experimental tests with this type of tile have shown that the electrical conductivity remains constant over a period of many years.

The surface pattern of this type of tile or panel appears to consist of a matrix or base color in which there are a great many smaller areas of a contrasting color. These smaller ares vary in size from spots to delicate striations. While the specific example described bove disclosed a process for manufacturing a green and black tile, it is perfectly possible to use three or more colors to obtain any desired effect. However, the most attractive patterns are usually obtained when one base color is allowed to predominate and give the appearance of a matrix in which minor amounts of other colors appear. The effect obtained by the decorative patterns is similar to that of random crystals of ice on a window pane. The pattern is irregular and random, so that when a plurality of the panels or tiles are placed side by side to form a large unit, the pattern itself does not indicate any line of juncture between adjacent pnels or tiles. In addition, as the surface of the tile is abraded through constant usage, the pattern will not show the wear since it extends substantially throughout the entire wearing depth of the tile.

The process described above, in which uniformly conductive granules are placed in the bottom of the mold, and marbleized granules containing only about 4.2% of conductive plastic fill the remainder of the mold, produces a panel which is much more conductive in its lower regions than in its upper regions. The conductivity of the surface of the tile must be carefully regulated in order to produce a tile which will satisfactorily dissipate electrostatic charges without creating any electrical hazard. The high degree of electrical conductivity of the under surface of the panel or tile insures good electrical contact with the subjacent material. This subjacent material may be electrically conductive material or may be a sheet of metal foil, depending upon the particular type of tile and its method of installation. The presence of this highly conductive region at the under extremity of the tile or panel has been found to be necessary to insure that overall electrical conductivity requirements are met.

In general, about 40% by weight of the granules which are used to fill the mold should be the solid black, uniformly electrically conductive plastic granules which form

[1] Safe Practice for Hospital Operating Rooms, June 1952, National Fire Protection Association, Boston, Mass., pages 18 and 19.

the conductive under-surface of the panel or tile. While the 40% figure has been found to give excellent results, a range of from about 25% to about 60% will also give good results. Where a smaller amount of electrically conductive granules than 25% is employed, it has been found that the electrical contact with the subjacent material is not completely satisfactory. Where a percentage higher than 60% of the electrically conductive granules is employed, it has been found that there is an unsatisfactory amount of migration of the black granules to the upper surface of the tile or panel during the molding process. This migration has two serious disadvantages. The presence of the solid black particles in the upper surface of the tile disrupts the pattern and tends to spoil the decorative effect. More seriously, the presence of a large number of migrated black granules increases the electrical conductivity to a dangerously high figure.

In manufacturing panels and tiles of this type, it is therefore necessary to consider a great many variables. Thus, the proportion of electrically conductive granules which are placed in the bottom of the mold is a very important factor in obtaining good conductivity and a decorative surface pattern. Similarly, the amount of conductive carbon black employed in the production of the electrically conductive plastic batch is quite important. If an amount of carbon less than 15% by weight of the batch is employed, the electrical resistance of the batch will be too high. If an amount in excess of 20% is employed, the electrical conductivity will tend to be too high, and the plastic batch will lose some of its desirable physical characteristics. Also, in making the marbleized sheet from a base sheet and a small amount of electrically conductive plastic, the total amount of electrically conductive plastic employed must be carefully regulated. A surprisingly small amount of electrically conductive plastic will suffice to impart electrical conductivity to the panels, since there is migration during the molding process of solid black granules from the bottom of the mold into higher regions of the mold.

A content of 3% to 6% by weight of the conductive plastic, marbleized in the base material of colored plastic, will produce a surprisingly high conductivity in the tile. This is partly attributable, of course, to the migration of black granules from the bottom of the mold, during the molding process.

The stress-relieving process is more fully described in my copending patent application, Ser. No. 419,682, filed March 30, 1954.

I claim:

1. The method of making a decorative, monolithic, resilient plastic panel characterized by a controlled, limited electrical conductivity adapted to dissipate static electrical charges while resisting the flow of dynamic electricity, comprising: forming a first resilient plastic mass; forming a second resilient plastic mass of a plastic composition compatible with the composition of said first plastic mass, said second plastic mass having uniformly distributed therein a material imparting limited electrical conductivity thereto; combining a portion of said second plastic mass with said first plastic mass to form a marbleized plastic mass having the limited electrically conductive plastic confined to the marbleized portions of said marbleized plastic mass; comminuting said marbleized mass into small granules of irregular shape adapted for molding; comminuting the remainder of said second plastic mass to form small granules of irregular shape adapted for molding, of uniformly electrically conductive plastic; distributing said granules in a mold so that one layer of the said granules in the mold is substantially completely comprised of uniformly electrically conductive granules, with the remainder of said mold being filled with granules from said marbleized plastic mass; molding said granules under fusing pressure and temperature, and cooling the fused plastic in the mold under pressure to form a monolithic, resilient panel.

2. The method of making a decorative, monolithic, resilient plastic panel characterized by a controlled, limited electrical conductivity adapted to dissipate static electrical charges while resisting the flow of dynamic electricity, comprising: calendering a first resilient plastic sheet; calendering a second resilient plastic sheet of a plastic composition compatible with the composition of said first sheet, said second sheet having uniformly distributed therein a material imparting limited, uniform electrical conductivity to said second plastic sheet; combining a portion of said second sheet with said first sheet on a calender to form a marbleized plastic sheet having the limited electrically conductive plastic confined to the marbleized portions of said sheet; comminuting said marbleized sheet into small granules of irregular shape adapted for molding; comminuting the remainder of said second sheet to form small granules of irregular shape adapted for molding of uniformly electrically conductive plastic; distributing said granules in a mold so that at least one layer of the said granules in the mold is substantially completely comprised of uniformly electrically conductive granules, with the remainder of the said mold being filled with granules from said marbleized sheet; molding said granules under fusing pressure and temperature and cooling the fused plastic in the mold under pressure to form a monolithic, resilient panel.

3. The method of making a decorative, monolithic, resilient plastic panel characterized by a controlled, limited electrical conductivity adapted to dissipate static charges while resisting the flow of dynamic electricity, comprising: forming a first resilient plastic sheet, said plastic containing a major proportion of highly polymerized polyvinyl chloride; forming a second resilient sheet of a plastic composition compatible with the plastic composition of said first sheet, said second sheet having uniformly distributed therein electrically conductive carbon imparting limited electrical conductivity to said second plastic sheet; combining about 3% to about 6% by weight of said second electrically conductive sheet with said first sheet to form a marbleized plastic mass having the limited electrically conductive plastic confined to the marbleized portions of said mass; comminuting said marbleized mass into small granules of irregular shape adapted for molding; comminuting the remainder of said second sheet to form small granules of irregular shape adapted for molding, of uniformly electrically conductive plastic, distributing said granules in a mold so that at least one layer of the said granules in the mold is substantially completely comprised of uniformly electrically conductive granules, with the remainder of said mold being filled with granules from said marbleized mass; molding said granules under fusing pressure and temperature and cooling the fused plastic in the mold under pressure to form said monolithic, resilient panel.

4. The method of making a stress-relieved decorative, monolithic, resilient plastic panel characterized by a controlled, limited electrical conductivity between the upper and undersurfaces thereof, said conductivity being adapted to dissipate static electrical charges while resisting the flow of dynamic electricity, comprising: forming a first sheet of a resilient vinyl plastic; forming a second sheet of a compatible, resilient vinyl composition having uniformly distributed therein a material imparting limited electrical conductivity to said second plastic sheet, combining a minor proportion of said second sheet with said first sheet to form a marbleized plastic mass having the limited electrically conductive plastic confined to the marbleized portions of said mass; comminuting said marbleized mass into small granules of irregular shape adapted for molding; comminuting the remainder of said second sheet to form small granules of irregular shape adapted for molding, of uniformly electrically conductive vinyl plastic; distributing said granules in a mold so that a layer comprising about 20% to about 60% by weight of said granules in the mold are of said uniformly electrically

conductive granules, with the remainder of said granules in the mold being from said marbleized mass; molding said granules under fusing pressure and temperature, and cooling the fused plastic in the mold under pressure to form said monolithic, resilient panel.

5. The method of making a decorative, monolithic, resilient plastic floor tile characterized by a controlled, limited electrical conductivity between the upper and undersurfaces thereof, said conductivity being adapted to dissipate static electrical charges while resisting the flow of dynamic electricity, comprising: forming a first sheet of a plastic containing a large proportion of a highly polymerized polyvinyl chloride resin; providing a second sheet of a plastic composition compatible with the composition of said first sheet, said second sheet having uniformly distributed therein a material imparting limited electrical conductivity to said second sheet; combining relatively minor amount of said second sheet with said first sheet to form a marbleized plastic mass having the limited electrically conductive plastic confined to the marbleized portions thereof; comminuting said marbleized mass into small granules of irregular shape adapted for molding; comminuting the remainder of said second sheet to form small granules, of irregular shape adapted for molding, of uniformly electrically conductive plastic material; distributing said granules in the mold so that the undersurface of said tile is formed from a layer of uniformly electrically conductive granules comprising between about 20% and about 60% by weight of the total charge of granules in said mold, the remainder of said mold being filled with granules from said marbleized plastic mass; molding said granules at approximately 1000 pounds per square inch and at a temperature in the range of between about 300° F. and about 350° F., and cooling the fused plastic in the mold under pressure to form said monolithic, resilient plastic tile.

6. The method of making a multi-colored, decorative, monolithic, resilient plastic panel characterized by a controlled, limited electrical conductivity between the upper and undersurfaces thereof, said conductivity being adapted to dissipate static electrical charges while resisting the flow of dynamic electricity, comprising: forming a first resilient plastic sheet having a particular color; forming a second resilient plastic sheet of a plastic composition compatible with the composition of said first sheet, said second sheet having a color different than the color of said first sheet, said second sheet having uniformly distributed therein a material imparting limited electrical conductivity to said second sheet; combining a minor portion of said second sheet with said first sheet to form a marbleized plastic mass having the limited electrically conductive plastic confined to the marbleized portions of said mass; comminuting said marbleized mass into small granules of irregular shape adapted for molding, said granules having therein the different colors of the marbleized plastic mass; comminuting the remainder of said second sheet to form small granules, of irregular shape adapted for molding, of uniformly electrically conductive plastic; distributing said granules in the mold so that at least one layer of the said granules in the mold is substantially completely comprised of uniformly electrically conductive granules, with the remainder of said mold being filled with granules from said marbleized mass; molding said granules under fusing pressure and temperature, and cooling the fused plastic in the mold under pressure to form said decorative, monolithic, resilient plastic panel.

7. A singular, integral, semi-conductive floor covering characterized by a controlled, limited electrical conductivity between the upper wearing surface and the supporting undersurface thereof; said floor covering being semi-conductive and operative for dissipating static electricity, said covering comprising two distinctive floor covering materials which are intermixed and of different electrical characteristics of conductivity, the first material being electrically resistive, the second material being electrically conductive; the electrically resistive material forming the major proportion of the upper portion of the floor covering, including its upper wearing surface, and being irregularly disposed through the floor covering in amounts lessening toward the lower surface, the electrically conductive material forming the major proportion of the lower portion of the floor covering, including its supporting undersurface, and being irregularly disposed throughout said floor covering in lessening amounts toward the upper surface, said conductive material forming irregular channels extending from the lower portion of the floor covering to the upper wearing surface thereof, whereby a plurality of electrically conductive paths are provided between the upper wearing surface and the electrically conductive supporting undersurface of said floor covering; said materials being fused into an integral, monolithic, unitary floor covering.

8. The singular, integral, semi-conductive floor covering of claim 7 in which said electrically conductive material comprises between about 20% and 60% by weight of the entire floor covering, said electrically conductive material consisting essentially of a highly polymerized polyvinyl chloride rendered electrically conductive by the incorporation therein of between about 15% and 20% by weight of carbon black.

9. A floor structure covered with floor tiles, said floor structure being characterized by a controlled, limited electrical conductivity, and being operative for dissipating static electricity, comprising: a subfloor; grounded electrically conductive means disposed on said subfloor; and a tile floor covering comprising a plurality of singular, integral, monolithic semi-conductive tiles superposed in abutting relation on said grounded conducting means, each tile comprising two distinctive floor covering materials which are intermixed and of different electrical characteristics of conductivity, the first material being electrically resistive, and the second material being electrically conductive, the electrically resistive material forming the major proportion of the upper portion of the tile, including its upper wearing surface, and being irregularly disposed throughout the tile in lessening amounts toward the lower surface thereof, the electrically conductive material forming the major proportion of the lower portion of the tile, including its lower supporting surface, and being irregularly disposed throughout said tile in lessening amounts toward the upper surface thereof, said conductive material forming irregular channels extending from the lower portion of the tile to the upper wearing surface thereof, whereby a plurality of electrically conductive paths are provided between the upper wearing surface and the electrically conductive lower supporting surface of each tile; said materials being fused together into an integral monolithic, unitary tile structure.

10. The floor structure of claim 9 in which the grounded electrically conductive means comprises a flat, metallic conductor disposed on said subfloor.

11. The floor structure of claim 9 in which said grounded electrically conductive means comprises an electrically conductive adhesive disposed on said subfloor and securing said tiles in position.

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