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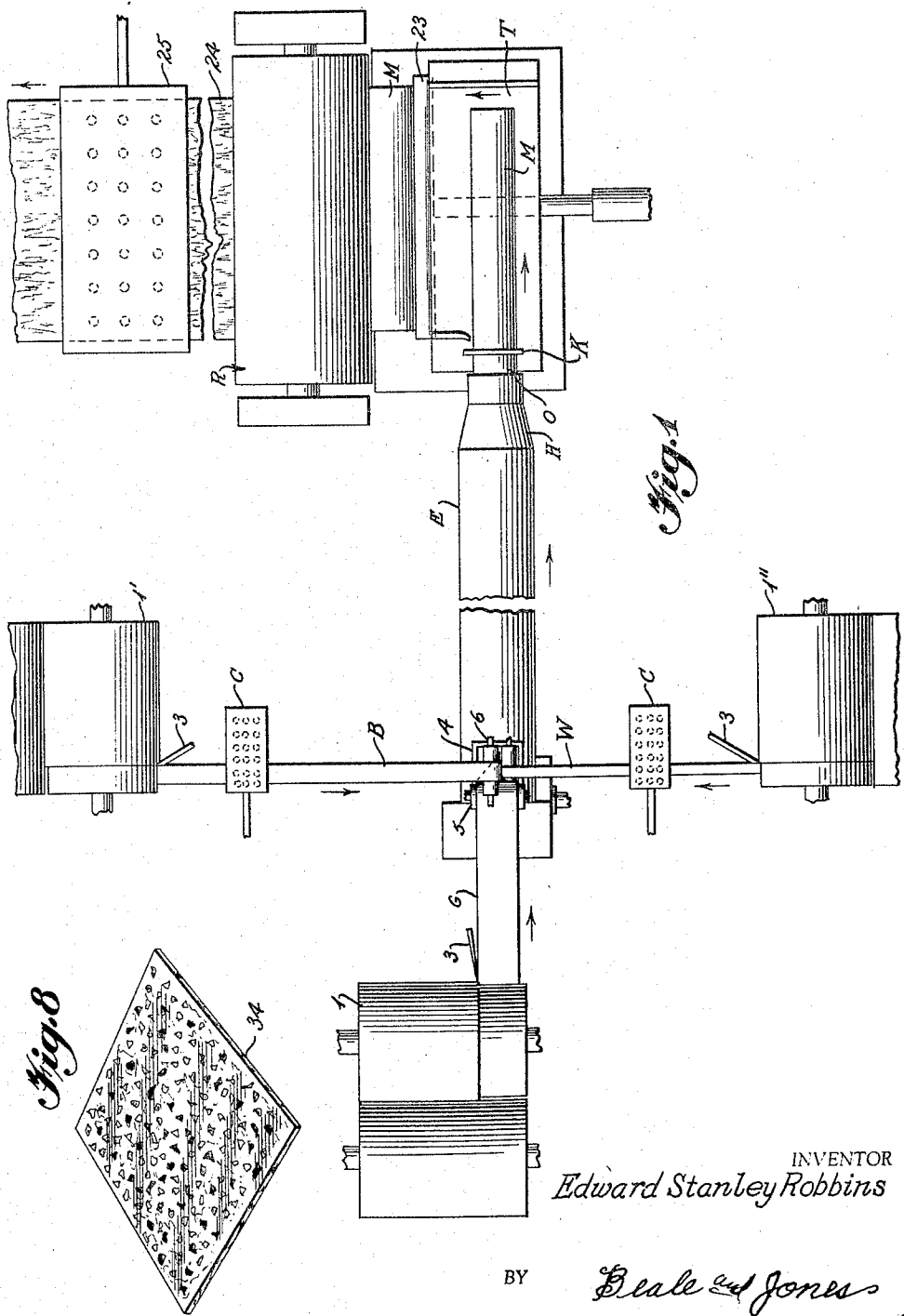
E. S. ROBBINS

2,914,807

EXTRUSION GRAINING PROCESS

Filed March 23, 1955

3 Sheets-Sheet 1



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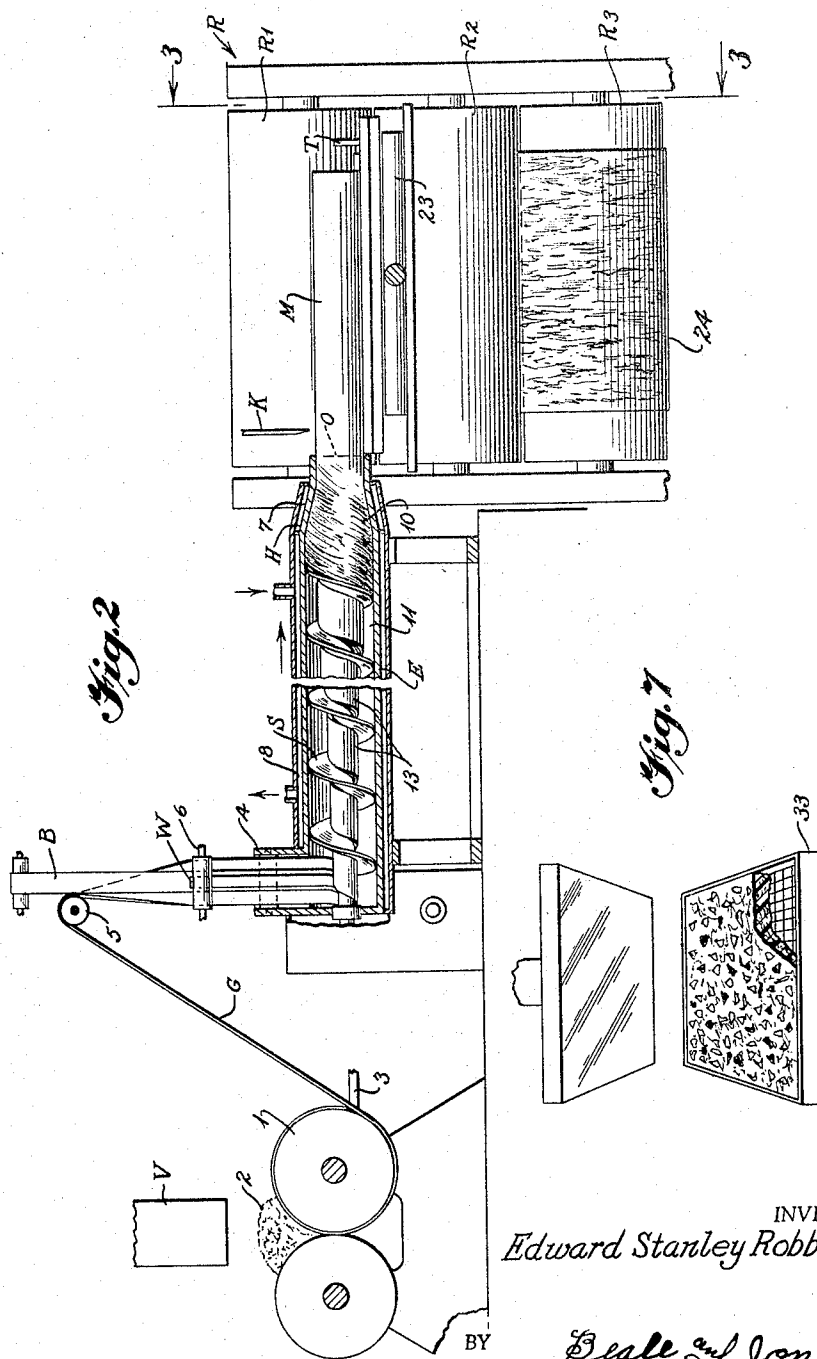
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3 Sheets-Sheet 2



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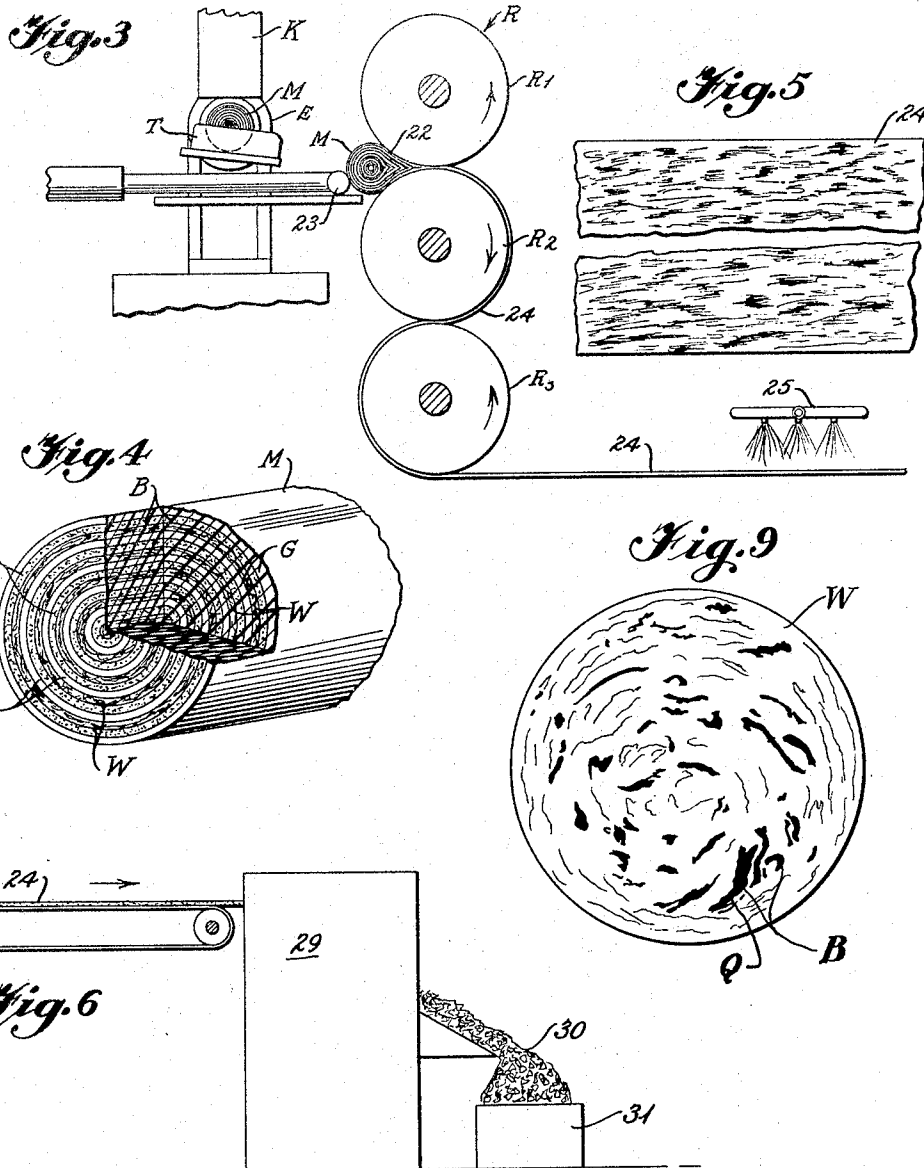
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3 Sheets-Sheet 3



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EXTRUSION GRAINING PROCESS

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Application March 23, 1955, Serial No. 496,119

7 Claims. (Cl. 18—48.8)

This invention relates to an improved process for the production of a marbled or grained plastic sheet. Plastic sheet material of this type has a background matrix of one color, in which one or more differently colored portions of the same material are distributed in a swirled, grained, or marbled pattern. This invention more particularly relates to a process for the manufacture of a grained plastic sheet in which the density of the color in the grained areas is substantially uniform throughout a given cross-section of the sheet.

This invention is particularly related to a process for producing uniformly grained plastic sheet material useful in the production of flooring products, such as asphalt composition, rubber, and vinyl plastic floor coverings and tiles.

There are a great many processes now in use for the production of grained plastic sheets. In one such process, two relatively large slabs of material of the color selected as the base color are employed, in combination with one or two relatively thin, small strips of a contrastingly colored, compatible material, to form a "sandwich." This "sandwich" is rolled, manually, into cylindrical form to form what is known in the art as a "jelly-roll." The "jelly-roll" may be passed through a calender roll one or more times, in order to achieve the desired marbleizing or graining effect. If desired, after one calendaring operation, the sheet may be rolled into cylindrical form again before re-rolling. The repeated calendaring operations tend to smear the colors into each other to provide the desired grained pattern.

In another method of making a grained sheet, chunks or granules of relatively cold colored material are calendered directly into a sheet having the desired base color. The calendaring operation produces a sheet in which the areas of contrasting color appear in the form of spots. The desired graining or marbleization effect may then be achieved by one or more additional calendaring operations, one of which may be at a 90° angle to the original calendaring. A very limited amount of graining may be imparted to the sheet by this process.

In still another process of the prior art, chunks of relatively cold material are placed in a batch of material having the desired base color, which is in a fluid condition. A very limited amount of mixing takes place, sufficient only to distribute the cold, solid material throughout the fluid mass, but insufficient to cause any blending of colors between the cold solids and the warm fluid. This mass of material, containing both fluid and solid components, is then forcibly extruded through a plurality of relatively small apertures into the form of wand- or

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rod-like multi-colored members. These multi-colored members are fed directly into a calender, which accumulates a mass of these rods in a random arrangement in the nip of the calender and expresses the rods into a sheet.

In this process, the rods are attempted to be maintained in such a manner that the length of the rods is substantially parallel to the axes of the calender rolls.

In each of these prior art processes, there is the serious drawback that the graining obtained is not uniform in nature. For example, in most floor tile installations today, there may be observed in the grained tile pattern rather wide spaces of the base color, and irregularly distributed concentrations of the mottled or grained contrasting color or colors, characterized by a relatively few, isolated areas of high-color density, and extremely few areas where a true veining or graining is visible.

The object of this invention is to provide a process for manufacturing a grained sheet in which the graining is substantially uniform in character.

A further object of this invention is to provide a grained sheet in which the contrasting color or colors of a grained or marbled sheet are distributed throughout the base color in substantially uniform density throughout the surface and entire thickness of the sheet.

A further object of the invention is to provide a process for manufacturing a substantially uniformly grained plastic sheet in which the color contrast between the base color and color or colors present in the graining is sharp and distinct.

Still another object of the invention is to provide a graining process for producing uniformly grained plastic sheets in which a minimum amount of hand-processing is necessary.

These and other objects of the invention, which will become obvious from the general and specific disclosure hereinafter set forth, are achieved by a process in which two or more strips having the desired colors and a predetermined temperature differential are wound into a helical form, which is then subjected to radial and axial pressure under controlled temperature conditions to form a solid cylindrical member. The solid cylindrical member is self-sustaining. The strips, in the process of consolidation, lose their structural identities but the material from each strip retains its color. The cylindrical member or rod, under some operating conditions, will appear in the form of a cylinder of the base stock, with chunks of the mottle material, of a contrasting color, distributed therein. Where the strips are placed in juxtaposition before being wound in helical form, and where the temperature differential between the strips is slight, the cylindrical member or rod will contain concentric rings of the mottle distributed among surrounding concentric rings of the base stock. The cylindrical member is cut into convenient lengths for handling and is immediately expressed between pressure-bearing members of a calender roll in a direction transverse to the longitudinal axis of the cut sections of the cylindrical member, to form a uniformly marbled sheet.

The uniformly marbled or grained sheet may be employed directly in the manufacture of plastic floor tiles, or may be subjected to further operations if desired. For example, the uniform marbleization or graining which characterizes the products of this process is ideal for forming floor tile having a terrazzo pattern of the type ob-

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tained from the process of my copending application, entitled "Resilient Rubber Floor Tile," Serial No. 424,003, filed April 19, 1954, now abandoned. In order to utilize the uniformly grained sheet in the manufacture of a floor tile having a terrazzo pattern, the uniformly grained or marbled sheet is comminuted into granules or giblets of irregular shape. The giblets are then molded at fusing temperature and pressure into a monolithic structure which is characterized by the desired terrazzo pattern.

These and other objects of the invention may be best understood by reference to the drawings, in which:

Fig. 1 is a plan view showing an arrangement of mill rolls, compressing apparatus, and calender rolls for use in the process;

Fig. 2 is a side elevation, in partial section, also showing the arrangement of mill rolls, compressor and calender rolls employed in the process;

Fig. 3 is a side elevation of the expressing apparatus (calender rolls) which forms the uniformly grained sheets;

Fig. 4 is a partial sectional view of a solid cylindrical member formed from the strips of contrasting colors;

Fig. 5 is a partial top view of a uniformly grained sheet as produced by the calendering apparatus of Fig. 3;

Fig. 6 is a diagrammatic representation of a chopping apparatus suitable for comminuting the grained sheet into granules of irregular size;

Fig. 7 is a perspective view of a mold suitable for the production of floor tiles from the granules;

Fig. 8 is a perspective view of a finished floor tile produced in the mold of Fig. 7;

Fig. 9 is a partial sectional view of another form of the solid cylindrical member formed from the strips of contrasting colors.

Referring now to the drawings in detail, wherein like numerals refer to similar structural features, the invention may be illustrated by a description of a process in which three differently colored strips are formed into a uniformly grained sheet. The entire operation is preferably carried on in continuous fashion, and therefore the process has been depicted in the drawings as a continuous process. Each strip may be formed from a differently colored batch of material, by any conventional forming method, such as extrusion or calendering. In Fig. 1, for simplicity and clarity of illustration, each strip is shown as being formed on a set of mill rolls. For purposes of illustration, it may be considered that the grained sheet is being formed with a gray background in which there is distributed a black and white graining.

Thus, in Fig. 1, the relatively large gray strip G may be continuously removed from a mill roll 1 by means of an adjustable doctor knife 3, which regulates the width of the strip. The mill rolls may operate directly under the vent V of a Banbury mixer (Fig. 2) and the raw material 2 may comprise virgin material as well as scrap, where the scrap is reworkable.

The gray strip G is juxtaposed with a black strip B and a white strip W, both of which may be similarly formed on mill rolls 1' and 1'', although extruders could also be employed. The sources of the differently colored strips are preferably placed approximately an equal distance from the head 4 of the extruding apparatus E, so that the temperature loss of each strip up to the input 4 of the extruder E is approximately equal under ordinary circumstances.

The extrusion operation normally will smear each strip into the other strips, where the strips are at the same temperature or where the temperature differential is small. An important feature of this invention is, therefore, the provision of a cooling means, preferably in the form of a water bath, or baths, C, for each of the strips of mottle stock, namely, the black strip B and the white strip W. Each of the mottled strips is preferably cooled to a temperature which is about 20° F. to about 300° F. lower

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than the forming temperature for each strip. Generally speaking, it may be said that the temperature differential need only be sufficient to prevent blending of the colors during the compressing or extruding operation. A mottle strip temperature of about 140° F., going into the extruder, is preferred.

The three strips may then be juxtaposed by rollers 6 which align the strips so as to be in a plane parallel to the central axis of the winding screw. The gray strip G is twisted into a plane parallel to the central axis of the winding screw during the juxtaposition by the combined action of a preliminary twist roller 5 and the pair of aligning rollers 6. It will be understood that other roller arrangements may be necessary where the feed strips approach the head 4 of the compressor from different angles, where juxtaposition of the strips is desired. The juxtaposed strips are then continuously wound by the screw S within the compressor or extruder E into a helical form. The head H on the extruder is of a smaller diameter than the largest diameter of the screw S. There is thus created a back pressure which acts upon the helical wound strips in both an axial and a radial direction, compressing the strips into a solid cylindrical member.

The product obtained by this process is a continuous cylinder M comprising a gray body having distributed therein minor amounts of the two mottle strips of black and white material. The mottled strips may be distributed against the predominant background color in a variety of ways. Where the temperature differential is slight, on the order of 20° F. to 50° F., there is a tendency for the mottle colors to assume the form of concentric rings, as illustrated in Fig. 4. Where the temperature differential is relatively great, on the order of 175° F. to 250° F., the mottle colors tend to be distributed as arcuate or slightly arcuate slugs, with varying degrees of elongation or attenuation, as shown in Fig. 9. In almost all cases, there are indications in the solid cylindrical member of some smearing in the compressor E, in the form of delicate lines of the mottle colors in arcuate arrangement against the predominating base stock color. In the case where three strips are employed, as shown, a cross section of the cylinder M contains primarily the concentric ring arrangement of white and black narrow rings against a gray background which also appears to be in ring form, as illustrated in Fig. 4. If the strips are not fed into the extruder in juxtaposition, or if the temperature differential between the strips is over about 50° F., there is a tendency for the mottle to be distributed as "chunks" as illustrated in Fig. 9, rather than as rings, with all intermediate types of distribution being possible.

As the solid, cylindrical member M is continuously formed by the compressive action of the extruder, it is continuously cut by a knife, a taut wire, or by any suitable cutting apparatus K, and is continuously rolled by means of calender rolls R operating on the cut sections of the cylindrical member M in a direction transverse to the longitudinal axis of the cylindrical member. The mottle, whether in the form of arcuately-shaped chunks or annular rings, is thus compressed to form a graining pattern which is substantially uniform in the distribution of colors on the surface of the sheet and throughout the body of the sheet. If desired, the uniformly grained sheet 24 may be subjected to a cooling treatment in a progressively colder water bath 25 in order to reduce it to room temperature gradually.

The uniformly grained sheet may be employed directly for the formation of articles such as floor tiles, or it may be subjected to still further operations. For example, the uniformly grained sheet may be comminuted into small granules or giblets 30 of irregular shape, which may be molded into resilient floor tiles 34 having a terrazzo-like pattern, or into articles of any desired configuration.

This process is generally applicable to all types of compositions of the type commonly employed in the

flooring industry. Thus, the invention has particular utility with respect to vinyl resin tile mixes, rubber tile mixes, and asphalt tile mixes. The invention may also be successfully employed in connection with cellulosic plastics such as cellulose acetate; cellulose butyrate, and other cellulose esters, such as the mixed esters; cellulose ethers; and to other similar plastic compositions which may be employed to form resilient floor coverings.

In order to further illustrate the invention, there will be described specific examples of the process as employed in connection with several different types of materials.

Example I

A suitable formulation of vinyl plastic is as follows:

	Pounds	Percentage
VYNW (Polyvinyl chloride resin) (VYNW resin is between 93 and 95% polyvinyl chloride having an average molecular weight of about 24,000, the remainder is polyvinyl acetate)-----	159.75	31.3
Lead Carbonate (Heat stabilizer)-----	22.50	4.4
Heat Stabilizer (Stabelan XL)-----	7.50	1.5
Paracoumarone-Indene Resin (Softener and Plasticizer)-----	21.00	4.1
Clay Filler and Pigment-----	243.75	47.7
Dioctylphthalate-----	56.25	11.0
Total-----	510.75	100.00

It is to be understood that the particular formulation disclosed above is given by way of illustration, and that many other compositions based upon other thermoplastic resins are known in the art, and may be substituted therefor. The essential ingredient in the formulation is a resin or plastic binder, such as the commercially available VYNW vinyl resin mentioned above. Other commercially available vinyl resins which are quite suitable are sold commercially under the trade names of Geon 101, Geon 101 E.P. and 103 E.P., and Marvanol 20, 21, and 22. Each of the foregoing is a highly polymerized polyvinyl chloride resin of a type in common use in the resilient flooring industry. The large clay content is typical of floor tile formulations. The various stabilizers and plasticizers mentioned are conventional in the art.

This formulation may be made up in a Banbury mixer and may be continually dropped into the nip of a pair of mill rolls 1, where it is gradually worked into a sheet of a thickness convenient for handling. If desired, the batch of plastic may be worked through two mills connected in series, in order to bring the sheet to a desired thickness. However, for simplicity of description and illustration, only a single mill is shown in the drawings. With this particular vinyl formulation, the mill rolls are desirably operated at a temperature within the range of 275° F. to 325° F.

A desirable pattern for the grained sheet may be formed by setting the rolls for the gray batch so as to form a sheet of gray plastic G about ¼ inch thick. This may be continuously taken from the mill roll 1 by a doctor knife 3 operating in conjunction with a power-driven roller 5. The black strip is similarly formed and may be approximately 1½ inches wide by ⅛ inch in thickness. The white strip may be ⅜ inch in thickness and 1 inch wide. These dimensions will produce a desirable pattern, but it is to be understood that the particular dimensions are given by way of illustration, and that any desired dimensions may be selected with the view to producing a particular color density in the pattern. The process is operated as a continuous process, and the transit time between the mill rolls and the input to the compressor E is very small, usually on the order of ten to fifteen seconds. The normal temperature loss in transit is therefore negligible from a practical standpoint.

In order to prevent smearing and blending of the colors during the winding and compressing operation, the black strip B and the white strip W are each cooled

in transit between their respective mill rolls and the input 4 to the compressor or extruder E. This is preferably accomplished by a cooling bath or series of baths C, in which progressively colder streams of cooling water are played upon the moving plastic strip. Sufficient heat exchange should take place to reduce the temperature of the black strip B and the white strip W about 150° to 175° F., to about 140° F. or thereabouts. This temperature represents a preferred temperature at which the smearing and blending between the differently colored plastic masses in the extruder E is at a minimum. However, a temperature differential between the black strip B, the white strip W, and the larger gray strip G which is as low as 20° F. may be effective for batches containing a small amount of plasticizer. While a 20° differential is satisfactory for the batch suggested above, it has been found that with such a small temperature differential, there may be some blending of the colors to a degree which detracts from the beauty of the final product. With temperature differentials of less than 20° F., the white strip tends to blend into the gray strip to produce a gray which is milky in appearance in the areas which would normally contain a white graining. Similarly, the black is so diluted by the gray that the pattern is quite unsatisfactory at such a small temperature differential. While the preferred range is 150° F. to 175° F. an extreme differential as great as 300° F. has been found to produce satisfactory graining. There appears to be no practical lower limit to the temperature to which the mottle strip(s) may be reduced, from the standpoint of satisfactory production. In practice, a temperature differential over 300° F. would seldom be obtained or be necessary for good operation.

The three colored strips may be brought into juxtaposed relation as they enter the extruder E by a pair of rollers 6 which also orient the strips so that their surfaces lie in planes parallel to the central axis of the screw S. The three strips, in superposed relation, are then wound around the screw S and are carried forward by its rotation to be compacted into the mass of plastic 10 which is backed up within the barrel 11 of the extruder E. The exact amount of material 11 which is backed up within the barrel of the extruder will depend upon several conditions, such as, the rate of rotation of the screw; the rate of feed into the compressor; the degree of plasticity of the original batches of plastic material; the temperature of the plastic material, the barrel 11 and the extrusion head H; and, the ratio between the size of the barrel 11 and the aperture O in the extrusion head H. Many of these variables must be carefully controlled in order to avoid smearing and blending of the colors while the strips are being compacted into the solid cylindrical member M. For example, the temperature of the barrel 11 may be regulated by passing water through a water jacket 8 which surrounds the barrel. The jacket temperature should be maintained at about 290° F. for optimum results, with the vinyl formulation disclosed above. This is somewhat below the fusing temperature of the formulation, which is in the range of 320° F. to 350° F., depending upon the pressure. In order to maintain the temperature at 290° F., it is usually necessary to pass a small amount of cooling water through the water jacket 8 in order to remove heat generated during the compression of the plastic mass 11 by the screw S. The temperature of the extrusion head H is desirably regulated by a separate water jacket 7. Since the danger of smearing and blending in the extrusion head H is relatively small because of the short transit time through the extrusion head, this portion of the apparatus may be allowed to become slightly warmer than the barrel 11. Usually, no cooling water need be used in the head. The cooling jacket of the extrusion head H may be maintained at about 300° F., usually without the use of cooling water. The screw itself is usually provided with a heat exchanger, and with this vinyl

formulation, the use of some cooling water has proved helpful.

The nature of the winding and compressive action taking place within the extruder E is not entirely clear. For purposes of illustrating the invention only, the size of the windings 13 around the screw S has been portrayed as continuously increasing, until a solid mass 10 is built up against the head H, completely filling the head H and barrel 11 of the extruder E. This is merely one theoretical possibility, however, and is offered by applicant as a possible explanation of the action of the compressor. Such theoretical speculation is of secondary importance, since the process is a demonstrated success and is in commercial operation. In the usual operation of the apparatus, an intermediate status between "starvation" and "flooding" is sought. A "starved" screw will churn and smear the mottle into the base stock to an excessive and undesirable degree. A "flooded" screw will choke up and will stop feeding. Operation at an intermediate point is obtained by control over the rate of feed and the rate of rotation of the screw.

The extruder E may be a conventional plastics extruder. The ratio between the interior diameter of the barrel 11 and the interior diameter of the extrusion aperture O is relatively important. A ratio as large as two to one has been found satisfactory, although the preferred relative sizes of the internal diameters is 10 inches for the barrel 11 and 8¼ inches for the aperture O. If a ratio greater than two to one is employed, considerable smearing between the color results. Where the difference between the diameters is not sufficient, the extruder will not produce a continuous cylindrical member which can be handled readily, but the cylinder will frequently break up into small segments before it can be cut into the proper size for further processing, because of insufficient cohesion.

The screw S serves to wind the strips into a spiral or helix, and to compact them into a continuous solid cylindrical member which is readily extruded through the aperture O. This solid cylindrical member M has unusual physical characteristics. When a low temperature differential is maintained between the mottle and base stock, the cylindrical member has a great many annular rings, each ring being continuous around its periphery and discrete from adjacent rings. Each ring is also substantially continuous in the longitudinal direction. The thickness of these annular rings with respect to each other will depend upon the size of the strips which are fed into the extruder E. The important feature of this type of color distribution is that the solid cylindrical member may be cut up into sections and continuously progressively expressed through a calender roll R, where the axis of the rolls is parallel to the axis of the cut section of the cylindrical member, in such a way that a substantially uniformly grained sheet is produced by the calendering. At greater temperature differentials between the mottle strip or strips and the base stock, the mottle flows less easily. Consequently, the greater the temperature differential, the greater the tendency for the mottle to remain in its original form, as a strip. The extruder reacts to this tendency by shredding or tearing the mottle into chunks, in which form it is distributed in the base stock. Depending on localized temperature conditions and the pressure exerted by the extruder screw, the "chunks" may occur in arcuate or semi-circular form. For fixed operating conditions, a substantially uniform distribution is obtained of the mottle in the base stock. The result is a substantially uniform graining pattern in the calendered sheet obtained from calendering the cylindrical member. When the strips are in juxtaposition when they are fed into the extruder, any tendency to form concentric rings is enhanced. Conversely, when the strips are allowed to enter the extruder in a free or random arrangement, there is a tend-

ency to form a "chunk" type of distribution of the mottle in the warmer base stock material.

As the solid cylindrical member is discharged from the aperture of the extruder E, the exterior surface temperature of the cylindrical member is approximately 280° F. to 290° F. This high temperature is a result of the compressive action exerted by the screw S, which produces pressures which may be as high as 1000 p.s.i. within the extrusion head H. The cylindrical member is preferably cut up into sections which are approximately 37½ to 40 inches long by a suitable cutting apparatus K. This length has been found to be very convenient for handling and for calendering operations.

While the exterior temperature of the solid cylindrical member is approximately 280° F. to 290° F., this is actually only the temperature of the exterior layer of gray plastic. Generally, the strip which is outermost from the axis of the screw S will form the surface layer on the solid cylindrical member M as the plastic mass passes through the extrusion head H and the aperture O. The predominant or base stock color is usually, but not necessarily, kept in this position, since it is desired to maintain the mottle colors at a low temperature in order to avoid smearing and blending during the compressing and calendering operations. Thus, the portions of colored plastic immediately beneath the exterior layer will desirably retain the low temperature to which they were cooled in the cooling baths C. However, unless the cylindrical member M is calendered promptly, there will be a heat exchange between the cool white and black annular rings and the warmer gray annular rings in the interior of the cylindrical member, which may result in an undesirable blending of the colors. The base stock in the interior of the cylindrical member as it is extruded is about 305° F. to 315° F. The mottle in the interior of the member approaches this temperature quite rapidly. Thus, the time lag between extrusion through the aperture O and delivery of the cut section to the calender rolls is preferably in the neighborhood of ten to fifteen seconds, to minimize the effect of any heat exchange.

The cut section 21 of the solid cylindrical member M moves along a sloped table T and is forced into the nip 22 of a bank of calender rolls C by a hydraulic reciprocable ram 23 which is under the control of the operator of the bank of calender rolls R. The top calender roll R may be operated at a temperature of about 280° F. to 300° F. The second or next lower calender roll R2 is preferably maintained at a slightly higher temperature, for example, 290° F. to 305° F., in order that it will take the calendered sheet in preference to the top roll. The lowermost roller R3 may be employed as an idler roll to reverse the direction of the travel of the sheet, or to provide a final control over the thickness of the grained sheet 24. Heat control over the lowermost roller R3 is usually not necessary. Where the grained plastic sheet is to be employed for the manufacture of tile ⅛ inch thick, the calender rolls may be adjusted to produce a grained sheet having a thickness of approximately 0.130 inch to allow for polishing and abrading. If desired, the grained sheet may be subjected to a cooling bath provided by conventional cooling apparatus 25.

The grained sheet 24 may be employed directly for the manufacture of marbleized floor tiles by simply cutting it to size, polishing one surface and abrading the under-surface for the reception of adhesive. Alternatively, the grained or marbleized sheet may be employed to manufacture floor tiles which do not require adhesive, having the structure described in my copending patent application, Serial No. 305,625, filed August 21, 1952, now U.S. Patent No. 2,737,693. This further treatment includes comminuting the marbleized sheet 24 in a conventional chopping apparatus 29 into small granules or giblets 30 of irregular shape. These giblets may be stored

in any suitable container 31 until a quantity suitable for use has been accumulated. The giblets are then placed in a mold 33 (Figure 7) and are subjected to fusing temperature and pressure, the temperature desirably being in the range of 320° F. to 350° F., at a pressure of approximately 1000 pounds per square inch. These fusing conditions may be maintained for a period of approximately 15 to 20 minutes depending upon the size of the tile being produced in the mold. The conditions just described are suitable for the production of a tile having a thickness of approximately 1/4 inch and a size of nine inches by nine inches. The fusing step should be followed by a cooling in the mold under pressure until the temperature is below 160° F., approximately. The cooling should be a gradual process in order to avoid undue internal stress in the plastic. While this cooling step is essential for vinyl plastics, it is not necessary for rubber and for certain other of the resilient plastics used in the flooring industry. This series of steps has been found to relieve internal stresses caused by the calendaring operation, and is described in my copending application entitled "Terrazzo Pattern Plastic Panels," Serial No. 419,682, filed March 30, 1954, now abandoned. The finished product 34 (Figure 8) is a monolithic tile having a stress-relieved character, and having a terrazzo-like surface pattern.

The terrazzo-like surface pattern of the finished tile 34 is an extremely desirable one because the pattern alone gives no indication of the lines of juncture between adjacent tiles. It has been found that the regularity of this terrazzo pattern is considerably enhanced when the graining of the sheet from which the granules or giblets 31 are formed is substantially uniform in density of color distribution.

The process just described is particularly desirable for manufacturing processes where thermoplastic compositions are employed, since where the uniformly grained sheet 24 has satisfactory physical characteristics, it may be employed directly in the manufacture of floor tiles or similar products by simply cutting the grained sheet into the desired size. Where the grained sheet 24 is lacking in some desired physical characteristic, as, for example, where an aperture appears in the sheet due to faulty calendaring, that section of the grained sheet may be comminuted into giblets 30 for molding into products such as the terrazzo pattern tile 34.

Example II

The general process may also be employed to produce rubber sheets having uniform graining. The only changes which are necessary are temperature and pressure changes in the process to accommodate the somewhat different physical characteristics of rubber batches which are satisfactory for resilient flooring materials.

For example, where rubber is employed in this process, the mill rolls may be operated at 200° F. to 240° F., approximately 225° F. being the normal operating temperature. The base strip is taken directly from the mill rolls, whereas the mottled strips are passed through cooling troughs C to reduce the temperature at least 20° F. With rubber, the preferred temperature differential is in the range of 125° F. to 150° F. As the strips are wound into a spiral within the tuber or extruder E, the cooling jacket 8 around the barrel 11 is maintained at a temperature within the range of 175° F. to 250° F. The extruder head H may be maintained within the same approximate temperature range.

As was the case with the process where vinyl was used, the grained sheet 24 has an unusually uniform density of color distribution throughout the entire thickness of the sheet as well as on the surface. The sheet may be used directly, or may be comminuted for molding purposes. Where the grained sheet is used directly, it is preferably vulcanized in a mold before the sheet is cut to final size, and then may be polished on one side and

abraded on the other side. Where the grained sheet is comminuted into small giblets of irregular shape, the rubber sheet must be first cooled to cutting temperature, which is below about 115° F., and preferably below 40° F., as described in my copending patent application entitled "Resilient Rubber Floor Tile," Serial No. 424,003, filed April 19, 1954, now abandoned. The giblets are then preferably immediately placed in a mold and vulcanized in the mold at about 1500 pounds per square inch for a time equivalent to about six minutes for each 1/8 inch of thickness of the rubber. By this process, it is possible to produce tiles having the structure described in my copending application, Serial No. 305,625, filed August 21, 1952, now U.S. Patent No. 2,737,693, and having on the surface thereof a desirably regular terrazzo-like pattern which tends to conceal the line of juncture between adjacent tiles.

Example III

White base stock and black mottle vinyl strips of a composition similar to that described in Example I were formed on mill rolls at about 310° F. The base stock strip, which was 8" x 0.250", was transferred continuously directly into the extruder before any substantial temperature drop took place. The mottle strip was 0.150" x 3/4", was cooled in a water bath in transit to the extruder, to a temperature of about 140° F., and was fed into the extruder at the same linear speed as the base stock. The strips were allowed to transfer into the extruder without any guidance or restraint, so that a random distribution or arrangement occurred.

The extruder was the same as employed in Example I. The head of the extruder was allowed to run hot, without the use of any cooling water. The same head size of 8 1/4" was employed. The extruder body was also allowed to run hot, but cooling water was employed in the screw to minimize smearing and churning in the interior.

The cylindrical member obtained from the extruder was cut into 37 1/2" lengths and was immediately calendared, one length at a time, into a sheet having substantially uniform graining. The cross-section of the cylindrical member exposed by the cutting revealed that the black mottle B was distributed in the white base stock W in chunks C. In some cases, the chunks were elongated and arcuate, as indicated in Figure 9.

The cylindrical member was immediately calendared into a marbleized sheet, which was characterized by the same uniformity of graining which was obtained in the previous examples.

Similarly, the process above described may be employed in connection with asphalt tile mixes to produce uniformly grained sheets of asphalt composition. Where asphalt compositions are employed in this process, the added advantage is secured of orienting the asbestos fiber fillers in a desirable direction by the combination of compression in the extrusion apparatus and calendaring.

While the cylindrical member M is particularly useful in this process as an intermediate in the production of uniformly grained sheets, it is also independently a desirable product in itself. If the cut sections are allowed to cool or are chilled, the member solidifies and may be cut into relatively thin slices having a unique pattern of differently colored plastic pieces united into a whole. These slices may be cured and polished to form decorative plastic plates and plaques. They may also be trimmed into smaller segments for particular purposes.

It should be understood that the specific embodiments of the invention described above should be construed for purposes of understanding the invention and not for limiting the invention. Thus, while it has been assumed throughout that the individual strips of differently colored plastics could be most conveniently taken from mill rolls, the strips can also be taken directly from small extruders, which have the advantage of producing a sub-

stantially uniformly sized strip which tends to enhance the uniformity of the grained sheet still further. Furthermore, while the screw S of the extrusion apparatus E has been illustrated as having a uniform thread, many other types of threads may be employed with equally satisfactory results. The exact structure of the compressing and extruding apparatus is not critical, provided that a suitable compressive action can be obtained. Many other possible variations in the apparatus described and in the process within the scope of the invention will occur to those skilled in the art.

The present application is a continuation-in-part of my earlier filed application, Serial No. 434,268, filed June 3, 1954, now abandoned.

I claim:

1. The process of continuously consolidating a plurality of separate differently colored ribbon-like strips of plastic material of different sizes into a self-sustaining rod in which the plastic material in each strip substantially retains its original color and loses its original physical shape, comprising providing a plurality of separate and discrete, differently colored ribbon-like strips of plastic material of different sizes at a temperature below the fusion temperature but within the plastic range for the material, providing a temperature differential between the strips of different color sufficient to prevent blending of the colors in subsequent operations, juxtaposing the strips as a multi-colored loose assemblage, and continuously and progressively passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere and under sufficient axial and radial pressure to cause consolidation of the assemblage into a self-sustaining rod.

2. The process of continuously consolidating a plurality of separate differently colored ribbon-like strips of plastic material of different sizes into a self-sustaining rod in which the plastic material in each strip substantially retains its original color and loses its original physical shape, comprising providing a plurality of separate and discrete, differently colored ribbon-like strips of plastic material of different sizes at a temperature below the fusion temperature but within the workable plastic range for the material, providing a temperature differential between the strips of different color sufficient to prevent blending of the colors in subsequent operations, juxtaposing the strips in random arrangement as a multi-colored, loose assemblage, and continuously and progressively passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere and under sufficient axial and radial pressure to cause consolidation of the assemblage into a self-sustaining rod in which the portions of different color appear predominantly in the form of elongated chunks of material attenuated in a substantially circular direction.

3. The process of continuously consolidating a plurality of separate, differentially colored ribbon-like strips of plastic material of different sizes into a self-sustaining rod in which the plastic material in each strip substantially retains its original color and loses its original physical shape, comprising providing a plurality of separate and discrete differently colored ribbon-like strips of plastic material of different sizes at a temperature below the fusion temperature but within the workable plastic range for the material, providing a temperature differential between the strips of different color sufficient to prevent blending of the colors in subsequent operations, continuously passing a plurality of said strips in free juxtaposition into a screw-type extruder, therein winding the strips into a spiral and continuously and progressively applying axial and radial pressure to said spiral at a temperature at which said strips will cohere to consolidate the strips in said spiral into a self-sustaining solid cylindrical rod in which the portions of different color appear predominantly in the form of elongated arcuate segments.

4. The process of continuously consolidating a plurality of separate, differently colored ribbon-like strips of different sizes and of a vinyl plastic material rich in polyvinyl chloride into a self-sustaining rod in which the vinyl plastic in each strip substantially retains its original color and loses its original physical shape, comprising providing at least a first strip and a second strip of different colors of a vinyl plastic composition rich in polyvinyl chloride at a temperature in the range of about 275° F. to about 325° F., the first strip being sufficiently larger than the second to provide a predominant base color, cooling said second strip at least 20° F. below the temperature of said first strip, juxtaposing said strips in a loose assemblage, and continuously and progressively passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere and under sufficient axial and radial pressure to consolidate said assemblage to form a self-sustaining rod.

5. A process of continuously consolidating a plurality of separate, differently colored rubber ribbon-like strips of different sizes into a self-sustaining rod in which the rubber in each strip substantially retains its original color and loses its original physical shape, comprising providing at least a first rubber strip and a second rubber strip of different colors at a temperature in the range of about 175° F. to about 250° F., the first strip being sufficiently larger than the second to provide a predominant base color, cooling said second strip at least 20° F. below the temperature of said first strip, forming a loose assemblage of said strips, and continuously and progressively passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere with under axial and radial pressure to form a self-sustaining rod.

6. The process of continuously forming a marbled sheet of plastic material having substantially uniform marbleization comprising providing a plurality of separate, discrete differently colored ribbon-like strips of different sizes of plastic material at a temperature below the fusion temperature but within the plastic workable range for the material, providing a temperature differential between the strips of different colors sufficient to prevent blending of the colors in subsequent operations, juxtaposing the strips as a multicolored loose assemblage, continuously and progressively passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere and under sufficient axial and radial pressure to cause consolidation of the assemblage into a self-sustaining rod in which the plastic material in each strip has substantially retained its original color although it has lost its original physical shape, and immediately progressively expressing said rod between pressure-bearing members in a direction transverse to the longitudinal axis of said rod to form a uniformly marbled sheet, said rod having a diameter such that substantially only a single rod can be expressed between said pressure-bearing members at any one time.

7. The process of continuously forming a uniformly marbled sheet comprising providing at least a first strip and a separate second strip of a vinyl plastic rich in polyvinyl chloride of different colors at a temperature in the range of about 275° F. to about 325° F., the first strip being sufficiently larger than the second to provide a predominant base color, cooling said second strip at least 20° F. below the temperature of said first strip, juxtaposing the strips as a loose assemblage passing said assemblage through a substantially cylindrical zone of restricted volume at a temperature at which said strips will cohere and under sufficient axial and radial pressure to form a self-sustaining rod in which the vinyl plastic in each strip has substantially retained its original color although it has lost its original physical shape, and immediately progressively expressing said rod between pres-

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sure-bearing members in a direction transverse to the longitudinal axis of said rod to form a uniformly marbled sheet, said rod having a diameter such that substantially only a single rod can be expressed between said pressure-bearing members at any one time.

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