

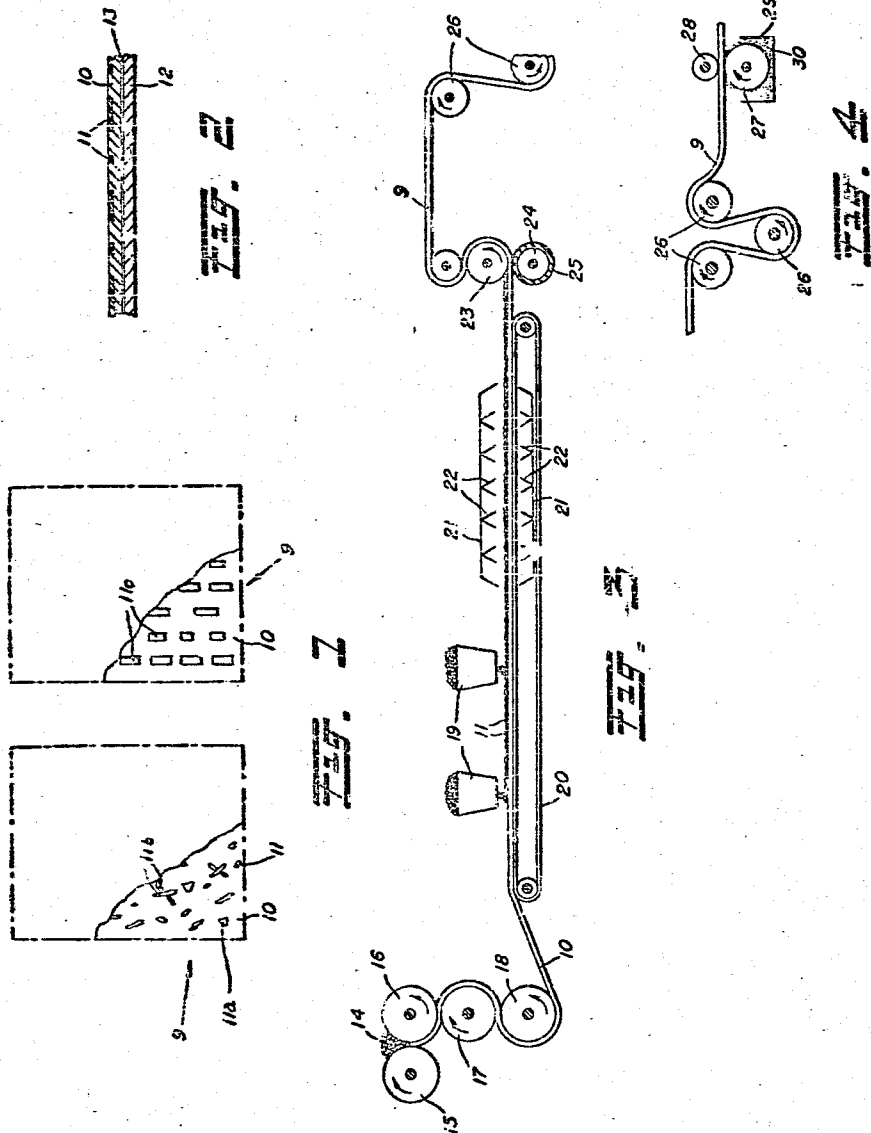
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METHOD OF MAKING A DECORATIVE SURFACE COVERING PRODUCT

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METHOD OF MAKING A DECORATIVE SURFACE COVERING PRODUCT

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This invention relates to composition sheets which are wear resistant and decorative and are adapted to be comprised in flexible, smooth surface coverings for floors, walls, articles of furniture and the like. It relates more particularly to such sheets which are composed of polyvinyl composition and which are composite in character and to the manufacture of such sheets.

This application is a continuation-in-part of my pending application Serial No. 508,449, filed May 16, 1955 and now abandoned.

Composition material has been used very extensively for the decorative and wear-resistant layer comprised in flexible, smooth surface coverings. Composition sheets usually are made adherent to a backing sheet such as bituminized felt or a fabric, but composition sheet material can be used by itself, e.g., in the form of tiles. Composition sheets for such purposes may be manufactured by sheeting out a substantially homogeneous mixture of binder material and filler to produce a sheet having substantially uniform color. Composition sheets having only a single color are most generally used in offices, stores, and other public buildings. However, for such purposes, as well as in the field of multiple or single dwellings, more decorative effects are frequently desired wherein more than one color is utilized.

In the production of decorative effects using more than one color, coverings of the linoleum type have been made by depositing or inlaying pieces of different color and complementary shape onto a common backing sheet. The decorative effects produced in this way are of the geometric type, e.g., a checkerboard arrangement of square pieces of contrasting color or polygonal pieces of one or more color that are inlaid in corresponding cutouts from a continuous sheet of contrasting color so as to form a predetermined pattern. The production of coverings of the inlaid linoleum type involves the employment of a backing sheet such as bituminized felt on which pieces may be inlaid and the operation is one requiring the use of large and expensive equipment for cutting out the pieces from a plurality of calendered sheets of linoleum composition or the like, carrying the backing sheet of bituminized felt on a moving support, depositing the desired cutout portions or pieces of the calendered sheets on the backing sheet at different points of travel of the backing sheet, rejecting and taking away the unwanted portions or pieces of the calendered sheets, and finally merging or fusing together the edges of the pieces that have been deposited on the backing sheet in interfitting inlaid relation. Because of the nature of the apparatus and method employed in making inlaid linoleum, the decorative effects produced are limited to designs of the geometric repeat type. Moreover, because any change-over from one design to another requires very substantial and costly changes in equipment, the number of designs that may, as a practical matter, be placed on the market by a particular concern is very limited. It is also a drawback to the inlaying method that a serious salvage problem is presented by reason of the unwanted portions of

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the calendered sheet material that do not enter into the particular design being produced. For example, it not infrequently is the case that less than 10% of a calendered sheet having a particular coloration is required for entering into the intended design, the remaining 90% of the calendered sheet being essentially scrap. In many instances, the salvage of this scrap is inconvenient to arrange and problems of storage are encountered not only as regards storage space and handling expense but also as regards the limits of time that the composition may be stored without becoming unworkable. Heretofore, it has been impossible to adapt the above-described process for preparing coverings of the vinyl type.

More intricate decorative effects have been produced on covering materials by applying paint, lacquer, or the like to a suitable backing sheet such as bituminized felt by means of block printing or other analogous operations. Since coverings of this type have a wear layer whose thickness is provided merely by the paint or lacquer that has been applied as a coating, their wearing life is much less than that of inlaid linoleum wherein the wear-resistant layer is provided by calendering linoleum composition to whatever thickness may be desired, such thickness being many times the thickness of paint or lacquer applied as a coating.

As distinguished from applying differently colored pieces of calendered linoleum composition to a backing sheet or applying paints or lacquers of different color to a base sheet, calendered sheets of composition material such as linoleum composition have been produced which are of variegated appearance by mixing together pieces of the composition material having different color and, while the mixed pieces are of a plastic and moldable consistency, subjecting them to one or more calendering operations under conditions which are suitably controlled for producing the appearance desired. For example, linoleum composition may be formed prior to calendering into pieces about $\frac{3}{4}$ to 1 inch in length and having a transverse dimension of about $\frac{1}{4}$ inch. Pieces of different color that have been so formed are mixed together until the relative proportion of the pieces of different color is about the same in all portions of the mixture. The mixture is then fed into a calender and during passage through the calender the pieces largely retain their individual colors but are subjected to very substantial distortional commingling. This distortional commingling is evidenced in the product of the first calendering by the fact that the pieces have become stretched out into long streaks to provide a striated effect that is commonly referred to as jasper.

In addition to the jasper effect, a simulated marble effect may be produced by further distortional commingling of the pieces of different color. This usually is accomplished by cutting a previously formed jasper sheet into lengths, turning the lengths 90°, lapping the turned lengths and calendering the lapped lengths. The lapped jasper sheets are then cross calendered, that is, calendered in a direction 90° to the direction of the jasper streaks, and by so doing the jasper streaks are spread sidewardly with resultant production of an appearance resembling marble.

Variegated color effects likewise have been produced, particularly in connection with relatively heavy composition sheets, e.g., suitable for tiles, by initially forming by passage between rolls a sheet having substantially uniform color throughout and then prior to further formation of the finished sheet by passage between rolls adding pieces of contrasting color which may be of the character aforesaid and of essentially the same plastic consistency as that of the sheet to which they are added so that upon being subjected to calendering with the initially formed

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sheet, they become distortionally commingled therein while largely retaining their color, with resultant creation of a variegated appearance such as a jaspe or marbled appearance depending on the conditions to which the composition material is subjected during the calendering or other sheet-forming steps.

The variegated effect produced by carrying out operations of the type above referred to may be varied depending on such factors as the temperature of the rolls in relation to each other and the temperature of the composition material. If one of the rolls is caused to move relatively to the surface of the sheet being calendered, the dragging out of the colors in the direction of the calendering can be accentuated, and particularly if the roll in contact with one of the surfaces is operated so as to be at a temperature which increases the superficial plasticity of the composition in contact with the roll, a certain amount of surface smearing of the colors may be produced. However, in any case the variegated appearance is that resulting from random and very extensive distortionally commingling of portions of the finished sheet of composition material. Sheets having this type of decorative appearance are extensively used by causing them to adhere to a backing sheet such as bituminized felt to produce linoleum of the well-known jaspe or marbled types as well as in the production of asphalt tile. If desired in the case of linoleum, calendered sheet material of this type may be fed into an inlaying machine and pieces may be cut therefrom for providing certain of the pattern elements of inlaid linoleum. The heavier grades of such sheets likewise may be cut into tiles.

Polyvinyl composition has heretofore been employed for providing the wear-resistive layer or sheet comprised in flexible smooth surface coverings. Thus calendered polyvinyl composition sheets have been bonded to backing sheets such as bituminized felt. The decorative features of polyvinyl composition coverings have been somewhat more limited as compared with coverings comprising linoleum composition due primarily to the fact that the workability of polyvinyl composition depends upon its thermoplastic properties whereas linoleum composition can be worked at room temperature while the drying oil component of the binder is in an only partially oxidized and polymerized condition. Thus in the case of polyvinyl compositions relatively high temperatures are employed of the order of 250° F. to 350° F. during the operations of mixing and sheet formation. For this reason vinyl composition coverings have either been produced in plain colors or with variegated appearance such as jaspe or marbled appearance when a continuous process has been employed. This has been a serious limitation on the decorative and ornamental effects that are obtainable using this type of covering. Efforts directed to avoid this limitation usually involve a process wherein differently colored areas of granulated vinyl composition are physically placed on a backing or in a mold in a predetermined arrangement. Most frequently, this process is limited to providing thicker products, on the order of 1/8 inch, because of its slow operation and great expense. Polyvinyl sheets are frequently cut into tiles.

It is an object of this invention to provide a flexible smooth surface covering comprising a decorative sheet of composition material presenting surface areas of contrasting color, the sheet having extremely long-wearing characteristics comparable to coverings of the inlaid linoleum type while at the same time being capable of manufacture at much less cost both as regards processing and as regards the equipment used. A further object of this invention is to provide a composite composition sheet having unique structural characteristics whereby not only long wearing attributes are afforded but also unique, distinctive and attractive decorative effects. A further object of this invention is to provide the fore-

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going improvements in a composite sheet composed of polyvinyl composition.

Other objects of this invention relate to the provision of an improved method for making a composite sheet of vinyl composition having areas of contrasting color whereby sharply defined predetermined boundaries between the areas of different color are produced. Other objects of this invention are to provide a method of producing a composite sheet having the characteristics aforesaid that is economical and operable at a high production rate.

It is a feature of this invention that a decorative and wear-resistant sheet of polyvinyl composition is provided which is composite in that it comprises a matrix sheet and numerous pieces of contrasting color which are embedded within recesses in one of the surfaces of the matrix sheet in substantially spaced relation with respect to each other with the exposed surfaces of the pieces substantially flush with the surface of the matrix sheet. The embedded pieces may be of substantially uniform thickness substantially throughout and are fused to the matrix sheet at their interfaces therewith.

According to this invention, flat pieces are preformed from polyvinyl composition which is similar to that of the matrix sheet except for the contrasting color. The flat pieces may be produced in any suitable way as by cutting them from a calendered sheet or by transversely slicing an extruded body whose cross section has the desired shape. Preferably, the flat pieces are somewhat thinner than the matrix sheet and are caused to be pressed into the matrix sheet while the matrix sheet is at a temperature at which it is soft and readily deformable. The pressing is accomplished with virtually no distortionally commingling of the pieces with the matrix sheet and thereby they retain essentially their original predetermined shape and thickness. As a result, effects may be produced which in certain respects are similar to those obtained in the case of inlaid linoleum in that the original contours of the pieces remain essentially the same and likewise are sharply defined and in that the original surface pattern remains essentially the same during wearing away of exposed surface over very long periods of wear. On the other hand, effects may be produced which ornamentally are distinctly different from those that are ordinarily produced in making inlaid linoleum in that arrangements and shapes can be obtained which are beyond the capacity of machines for making inlaid linoleum. Thus pieces which have curved or other irregular outlines may be utilized as conveniently as the more regular and simpler pieces which are cut and placed in position in the manufacture of inlaid linoleum. Moreover, the pieces can be disposed in regularly recurring pattern repeat units or in scattered or random relation. In any such case both the manufacturing operation and the machinery for carrying it out are much less costly as compared with the manufacture of inlaid linoleum.

In the practice of this invention, the pressing in of the preformed flat pieces into the matrix sheet without substantial distortionally commingling is effected when the exposed surfaces of the pieces are at a substantially lower temperature than the temperature to which the matrix sheet is heated. For example, such temperature differential may be partially or entirely obtained by causing the pieces to be in contact with a surface that is maintained at a relatively low temperature. In addition, an initial temperature differential between the pieces and the matrix sheet may be employed. By use of a pressing part maintained at a lower temperature, difficulties due to sticking likewise are overcome. During the pressing step, the matrix sheet preferably is maintained in contact with a surface presented by a body of substantial thickness composed of a yieldable resilient material such as rubber or a synthetic rubber although the conventional steel or chrome plated rolls can be used. The pressing step between surfaces is of

such character that it can conveniently be carried out as a continuous operation using opposed rolls into which the matrix sheet having the pieces deposited thereon is fed after having been heated until the vinyl composition of which it is composed is rendered soft and deformable.

After the pressing step, the resulting composite sheet need only be cooled before use because during the pressing of the pieces into the matrix sheet the pieces become fused with the matrix sheet at their interfaces therewith. If the surface of the matrix sheet opposite to that into which the pieces are pressed becomes bulged to some extent in the locations where the pieces are pressed in, the composite sheet can be pressed in operative relation to a mechanism for planing off the bulges so that the composite sheet will be substantially of uniform thickness throughout.

Any of the polyvinyl compositions suitable for lamination with a backing sheet or for use in the form of tiles may be employed in the practice of this invention. Suitable polyvinyl compositions are disclosed in Patent No. 2,558,378. While, as stated in this patent, various polyvinyl compounds may be employed, that which is most generally employed is vinyl chloride-vinyl acetate copolymer containing from about 80% to about 98% by weight of vinyl chloride. The resinous polyvinyl compound is plasticized by any of a number of plasticizers such as tricresyl phosphate, dioctyl phthalate and chlorinated paraffin. The plasticized polyvinyl compound binder is mixed with suitable fillers and pigments which may constitute from about 20% to about 70% by weight of the composition, e.g., calcium carbonate, clay, silica flour, etc., as well as pigments which are selected depending on the color desired. Generally it is preferable to employ a substantial amount of a fibrous filler such as short asbestos fiber. Typical formulation comprises from about 20% to about 50% of polyvinyl resin, about 10% to about 30% of plasticizer and about 20% to about 70% of filler including pigments. Such and similar composition material is referred to herein and in the claims as polyvinyl composition, and may be utilized in the practice of this invention.

In the practice of this invention, the thermoplastic properties of polyvinyl composition which in certain respects present difficulties in the successful manufacture of flexible smooth surface coverings have been utilized to advantage and, in fact, this invention involves a novel utilization of the peculiar properties of polyvinyl compositions. Thus while polyvinyl composition generally is mixed and sheeted at temperatures in the range from about 250° F. to about 350° F., a sheet which has been formed as by calendaring may be heated to still higher temperatures ranging from about 350° F. to about 390° F. and while the composition at such temperatures becomes soft and readily deformable, it can be handled and even passed between rolls while retaining its desired sheet form and decoration. Moreover, at such elevated temperatures pieces of similar polyvinyl composition may be pressed into a matrix sheet that has thus been highly heated with little or no deformation of the preformed pieces. This is especially the case if the temperature of the pieces is held down at least at and adjacent the exposed surfaces thereof. When the matrix sheet is at such elevated temperatures, and even though the pieces are not substantially deformed, the pieces become fused to the matrix sheet so that there is no discontinuity of composition material in the finished composite sheet although the boundaries, as evidenced by the differences in color between the pieces and the matrix sheet, are very sharply defined. The result is that even though the matrix sheet is heated to very high temperatures at which it is soft and readily deformable, a composite sheet is provided whose upper surface containing the pressed-in sheet-form pieces is as uniform and regular as the original calendared sheet while containing the ornamental and decorative effect provided by the pressed-in pieces.

It is an advantage and unique attribute of this invention that the pressed-in flat pieces may be of any shape and may be of any size consistent with the capacity of the pieces to be pressed into the matrix sheet while the matrix sheet is heated to a temperature at which it is deformable and flowable when the pieces are pressed into the matrix sheet. In order to permit the pieces to be pressed into the matrix sheet in an operation which may be readily carried out commercially, it is usually desirable that the pieces not have an area greater than about $2\frac{1}{4}$ square inches. It has been found that pieces of this size and smaller are actually imbedded in the matrix sheet and result in only a minimum amount of lateral or longitudinal displacement of material of the matrix sheet. On the other hand, if the total surface area of the pieces exceeds about $2\frac{1}{4}$ square inches, the pieces are laminated to the matrix sheet and considerable displacement of material occurs. This seriously disturbs any pattern which may be present on the matrix sheet and tends to create areas of unevenness on the final composite sheet. When pieces having a surface area less than about $2\frac{1}{4}$ square inches are imbedded in accordance with the invention, there is little or no discernible lateral or longitudinal displacement of material of the matrix sheet. Apparently the composition is compacted or pressed to the back of the sheet. Even when using pieces measuring over about 1 square inch, care should be exercised to avoid close placement of the pieces to each other as the small amount of lateral and/or longitudinal displacement which does occur will result in slight surface unevenness of the final sheet. It is for this reason that the use of flat pieces having a surface area of 1 square inch or less is most preferred in the practice of the invention. In addition, pieces which have a greatest surface dimension which greatly exceeds any other dimension, such as length compared to width, are somewhat difficult to handle in processing particularly in connection with placement and control of decoration other than of the random type. The pieces may be made so as to have a relatively small area if desired, as for example if an effect of the type which is commonly referred to as a "salt and pepper" effect is desired. However, the pieces should be such that when deposited on the matrix sheet they will lie flatwise thereon so that after the pieces have been pressed into the matrix sheet, the surface of the pressed-in pieces will lie substantially flush with the surface of the matrix sheet and in the same plane so that the covering will present an over-all smooth surface. When reference is made to the area or dimension of the pieces, the reference is to the area or the linear dimensions of the exposed surface unless otherwise clearly defined.

The thickness of the matrix sheet and the thickness of the pieces depends upon the desired thickness of the composite sheet for use in the commercial product for which the composite sheet is intended. For example, in the production of a laminated covering comprising a decorative and wear-resistant layer which is bonded to a backing sheet such as bituminized felt, the decorative and wear-resistant layer when made according to this invention may typically be about 0.025 inch in thickness. Usually it is desirable that this layer not be below about 0.020 inch in thickness. On the other hand, heavier grades of such coverings may be produced if desired. If the composite sheet is to be used in the manufacture of tiles without a backing composed of nonvinyl material, the sheet that is produced is usually about 0.030 inch or greater in thickness.

The pieces which are pressed into the matrix sheet preferably are substantially thinner than the matrix sheet. For example, the pieces may desirably be about one-third the thickness of the matrix sheet. If the pieces are thinner, then, the serviceability of the covering is not as good. If the pieces are thicker than about one-half the thickness of the matrix sheet, then greater difficulty is en-

countered in pressing them into the matrix sheet without the production of an undesirably large amount of bulging at the opposite surface of the matrix sheet. However, pieces have been successfully pressed into the matrix sheet which are nearly the same thickness as the matrix sheet and which have been over 75% of the thickness of the matrix sheet. As is apparent it is usually necessary to reduce the gauge of the matrix sheet while pressing in the pieces to produce a smooth, glossy surface on the sheet. By way of more specific example, when the composite sheet is to be about 0.025 inch in thickness, the pieces may be about 0.015 inch in thickness and the matrix sheet prior to pressing about 0.035 inch in thickness.

Further objects, features and advantages of this invention will be apparent from the following description of the accompanying drawings which are illustrative of the practice of this invention and wherein:

Fig. 1 is a plan view on a reduced scale of a flexible smooth surface covering which illustrates certain of the effects that may be produced according to certain embodiments of this invention;

Fig. 2 is a fragmentary cross section of a flexible smooth surface covering comprising a composite sheet embodying this invention, the section being on an enlarged scale for increased clarity in the showing;

Fig. 3 is a diagrammatic side elevation which is illustrative of one type of apparatus which may be used in the practice of this invention; and

Fig. 4 is a diagrammatic side elevation of a continuation of the apparatus shown in Fig. 3 which may be optionally used in the practice of this invention.

Fig. 1 illustrates the fact that the sheet-form pressed-in pieces may be of virtually any shape such as rectangles, diamonds, crescents, elongated strips which may be either straight or curved, etc. The shapes of the pieces which may be readily used according to this invention provide much greater flexibility as regards the shapes of decorative design elements than is in any way practical in the case of inlaid linoleum, whose manufacture requires very complicated and expensive machinery for cutting out pieces from certain calendered sheets and fitting in pieces from other calendered sheets as to make up a mosaic. As shown in Fig. 1, the pieces are disposed in substantially spaced relation. By the term "substantially spaced relation" as used herein and in the claims, it is intended that the pieces are spaced so that a substantial portion of the matrix sheet is exposed. Ordinarily the major portion of the surface of the composite sheet is that of the matrix sheet. In Fig. 1 the exposed area of the matrix sheet is indicated by the reference character 10 and the reference character 11 is applied to the various pieces. The composite sheet as a whole is indicated by the reference character 9. The spaced relationship of the pieces is not, however, to be regarded as precluding the possibility of two or more of the pieces contacting each other as illustrated, for example, by the pieces 11a. Likewise, two or more pieces may overlap each other as illustrated by the pieces 11b. Such contact or overlapping of pieces is likely to occur when the pieces are distributed in the random fashion illustrated in the left-hand portion of Fig. 1. Very pleasing decorative effects can be produced by such random distribution of the pieces. On the other hand, if desired, the pieces can be disposed in definite design repeat units as illustrated in the right-hand portion of Fig. 1 wherein the pieces 11c are arranged in this way.

In Fig. 2, as in Fig. 1, the matrix sheet is indicated by the reference character 10 and the sheet-form pressed-in pieces are indicated by the reference character 11. The composition sheet consisting of the matrix sheet 10 and the pieces 11 is shown for purposes of illustration in bonded relation to a backing sheet 16 which may, for example, be bituminized felt. A layer of bonding material may be used and is indicated by the reference char-

acter 13 and may comprise one or more layers adapted to provide the necessary bond and, when desired, a seal to prevent migration of the binder in the backing sheet 12 into the composite sheet consisting of the matrix sheet 10 and the pieces 11. It is to be noted in connection with Fig. 2 that the exposed surfaces of the pieces 11 are substantially flush with the surface of the matrix sheet 10. Moreover, the pieces 11 are substantially the same thickness substantially throughout. This results from the fact that the pieces 11 before being pressed into the matrix sheet 10 are sheet-form in that they have the shape of a piece cut from a larger sheet or produced by cutting a thin layer of uniform thickness from an extruded body. When the pieces 11 are pressed into the matrix sheet 10, they remain substantially unchanged and the interface between the pieces and the matrix sheet is sharply defined. This sharp definition is evident at the surface of the composite sheet and likewise is apparent if the sheet is cut transversely so as to show a section such as that illustrated in Fig. 2.

In Fig. 3 there is illustrated one type of apparatus which may be used in the practice of this invention. Any suitable source of a sheet of polyvinyl composition may be employed. In Fig. 3 a calender is shown of the type which is adapted to produce a calendered sheet from an unformed mass of vinyl composition. The unformed vinyl composition is indicated at 14 and may be vinyl composition which is of substantially uniform color throughout as, for example, a composition that results from mixing the ingredients of a polyvinyl composition in a Banbury mixer. The matrix sheet 10 is produced from the mass 14 by passage between the rolls 15 and 16, between the rolls 16 and 17 and between the rolls 17 and 18. If it is desired that the matrix sheet 10 have a mottled appearance, then the mass 14, which is initially formed by passage between the rolls 15 and 16, may be a mixture of pieces of vinyl composition of different color of the type hereinabove referred to. If a marbled base sheet is desired, then previously formed and lapped jasper sheets may be cross calendered as by passage through a 3-roll calender arranged in the manner indicated by the rolls 16, 17 and 18. Any other type of calender or sheet-forming apparatus may be employed for initial formation of the matrix sheet. Because of the nature of the polyvinyl composition, the matrix sheet as initially formed is at an elevated temperature which may be from about 250° F. to about 350° F. Since the step wherein the pieces are pressed into the matrix sheet is carried out when the matrix sheet is in a highly heated and softened condition, it is preferable to proceed with the incorporation of the pieces into the matrix sheet immediately after the matrix sheet has been formed at elevated temperature. As illustrated in Fig. 3, the matrix sheet 10 immediately after having been formed has the pieces 11 deposited thereon from the feeding devices 19. This is conveniently done while the sheet 10 is being carried on the continuous conveyor belt 20 such as a steel mesh conveyor. The feeding devices 19 have been indicated schematically both because such suitable feeding devices are well known and because the particular feeding device employed may take a number of different forms depending upon the decorative effect desired. For example, the devices 19 may consist of a belt type feeder adapted to distribute the pieces in random fashion at a controlled rate in relation to the rate of movement of the matrix sheet 10. Alternatively, a feeding device of the sifting type may be employed for effecting random distribution of the pieces. If a predetermined pattern is desired, then the feeding devices 19 may be such as to deposit the pieces at predetermined locations on the matrix sheet as the matrix sheet 10 is moved in operative relation therewith. For example, a feeding device may be used of the known type in which a vacuum is used for picking up pieces on the surface of a rotating cylinder, the pieces thereafter being released for

deposit on the moving matrix sheet 10 at desired locations. While two feeding devices 19 have been shown, this has been done merely for the purpose of illustrating that either a single feeding device or a plurality of feeding devices may be employed depending upon the nature of the pieces to be deposited on the matrix sheet and the decorative effect that is to be produced.

While the matrix sheet 10 is preferably heated to a temperature of the order of about 250° F. to about 350° F. when the pieces 11 are deposited thereon, the pieces 11 preferably are deposited while at ordinary room temperature.

After the pieces 11 have been deposited on the matrix sheet 10, the matrix sheet with the pieces deposited thereon is passed through the heating unit 21, which may be of any suitable type adapted to raise the temperature of the matrix sheet to the temperature desired for the pressing step. For example, if the matrix sheet already is heated to about 250° F., the heating unit 21 can readily raise the temperature of the base sheet to the desired temperature in only about 15 to 30 seconds. For this purpose the heating unit may be about 10 feet in length for a travel rate in the neighborhood of 40 feet per minute. Any suitable heating elements may be used and conventional infra-red heating elements 22 are very satisfactory. It is desirable to dispose the heating elements 22 underneath the matrix sheet 10 as well as above the matrix sheet 10, for the matter of primary concern is that of raising the temperature of the matrix sheet and it is preferable to do so while minimizing the heating of the pieces deposited thereon. It is usually desirable in order to obtain the desired plasticity and flowability of the matrix sheet by heating it to a temperature of about 330° F. to 390° F., namely, to the highest temperature that the matrix sheet will withstand without excessive decomposition and without such extreme softening of the polyvinyl composition as to render further handling of the matrix sheet impossible or impractical. The precise temperature to which the matrix sheet is heated will depend somewhat upon the composition of the matrix sheet. Thus increase in the amount of plasticizer enables the matrix sheet to be softened at a lower temperature than specified above. If the polyvinyl resin which is used has a lower softening point, this also results in lowering the temperature to which the matrix sheet may be heated. The proportion of the filler is also significant for increase in filler component tends to increase the temperature to which the polyvinyl composition should be heated in order to obtain good results.

The foregoing factors which affect the temperature at which the matrix sheet becomes softened also affect the temperature at which the pieces become softened. Since it is desirable in the practice of this invention that the pieces retain as much as possible their original form, this objective may be realized to somewhat better advantage by causing the pieces to be composed of polyvinyl composition having a substantially higher softening point than that of the matrix sheet, e.g., by the employment of less plasticizer in the formulation of the pieces.

While the heating of the matrix sheet has been shown in Fig. 3 as being effected after the pieces have been deposited on the matrix sheet, the sequence may be varied. For example, the matrix sheet may be passed through a heating oven prior to the deposit of the pieces thereon. By partially heating the matrix sheet before the pieces are deposited on the matrix sheet, the extent to which the pieces are heated in a subsequent heating step may be minimized in relation to the final temperature to which the matrix sheet is heated prior to the pressing step.

The pressing step is carried out by passing the heated matrix sheet 10 with the pieces 11 deposited thereon between the pressing rolls 23 and 24. Suitable means (not shown) may be provided for maintaining the de-

sired spacing between the rolls 23 and 24 and for maintaining the desired pressure to be applied. Such means are conventional and for this reason have not been shown in Fig. 3. The roll 23 presents a smooth, rigid surface suitable for imparting the desired finish to the composite sheet. Thus the roll may have a chromium finish or it may be a polished steel roll. Rolls of this type impart a high polish. If a surface finish of some other type such as a matte finish is desired, then the surface of the roll 23 may be appropriate for the production of such a finish.

The roll 24, as indicated in Fig. 3, is provided with a surface layer 25 of yieldable resilient material. For example, the layer 25 on the surface of the roll 24 may be about 1 inch in thickness and since this roll comes in repeated contact with the highly heated matrix sheet, the material of which the surface layer 25 is composed desirably is one which will withstand use at relatively high temperatures. A synthetic rubber material such as chlorobutadiene polymer or butadiene-styrene copolymer is suitable for the purpose. However, since the gradual deterioration is minimized by maintaining the temperature of the layer 25 somewhat under 300° F., the roll 24 preferably has associated with it means for circulating a cooling fluid therethrough. Rolls provided with means for circulating a cooling fluid therethrough are conventional in the art and for this reason such cooling means has not been shown in the drawing in the interest of clarity and simplicity. A similar comment is also applicable in the case of the roll 23 which is operated at a considerably lower temperature than the roll 24. It is to be understood, however, that the cooling of the roll 24 is effected only in the interest of avoiding excessively rapid deterioration of the resilient surfacing layer 25 for it is preferable to run the roll 24 at as high a temperature as possible so as to keep the matrix sheet in a soft and deformable condition. A temperature range of about 150° F. to 250° F. has been found particularly effective.

It is necessary to keep the surface of the roll 23 substantially below that of the matrix sheet 10 and it has been found to be desirable to maintain the surface temperature of the roll 23 at a temperature differential of at least about 50° F. and preferably at least 75° F. By maintaining such temperature differential at the surface of the roll 23 any tendency of the composite sheet to stick to the roll 23 is avoided and any tendency to smear in the regions of the demarcation between the pieces and the matrix sheet is reduced to a minimum. Moreover, by maintaining the surface of the pieces which come in contact with the roll 23 at a relatively low temperature, the amount of deformation of the pieces from their originally preformed shape during the pressing step is minimized. The temperature and amount of the cooling fluid passed through the roll 23 is controlled so as to maintain the desired surface temperature at the surface of the roll 23. If necessary, water or brine at a temperature substantially below room temperature may be employed.

When the heat plasticized matrix sheet with the pieces placed thereon is passed between the rolls 23 and 24, the surface-forming roll 23 is preferably arranged with reference to the feed of the matrix sheet so that it comes in initial contact with the exposed surfaces of the pieces, the roll 23 not coming in contact with the matrix sheet until the pieces have been pressed into the matrix sheet until their exposed surfaces are flush with the surface of the matrix sheet. This is desirable both from the point of view of keeping the pieces cool so as to retain their preformed shape and from the point of view of avoiding the cooling of the matrix sheet until the pieces have been pressed therein. The resilient layer 25 enables the matrix sheet and the pieces to be taken into the nip between the rolls 23 and 24 without building up a bank wherein the

softened polyvinyl composition becomes bunched or worked and results in more uniform pressure application.

Merely by way of illustration, the roll 23 may be from about 18 to 24 inches in diameter and the roll 24 may be from about 12 to 18 inches in diameter. The length of the rolls may be varied depending upon the width of the composite sheet to be produced. Both rolls are driven at a rate adapted to receive the heated matrix sheet from the calendaring and heating steps. Any suitable means (not shown) may be employed for driving the rolls 23 and 24 and synchronizing their rate of rotation with the other apparatus parts.

While the operation preferably is carried out so that the pieces 11 are at a substantially lower temperature than the temperature of the matrix sheet, when the matrix sheet is caused to pass between the rolls 23 and 24, the pieces 11 where they come in contact with the matrix sheet are raised to such temperature that fusion occurs so that there is no physical discontinuity in the finished composite sheet but only a discontinuity as regards color between the matrix sheet and the pieces. The pressure exerted between the rolls 23 and 24 is preferably just sufficient to result in embedding the pieces 11 until their exposed surfaces are substantially flush with the surface of the matrix sheet. A pressure of from about 200 to about 400 pounds per linear inch is ordinarily sufficient. Ordinarily pressure is applied by urging the roll 24 upwardly by some suitable means (not shown) such as a pneumatic or spring means.

After the composite sheet has passed the zone of initial pressure contact, it is preferably carried on the surface of the roll 24 for a substantial distance so that it may be cooled to a temperature at which it may more readily be separated from the surface of this roll. For example, the composite sheet may be cooled while on the surface of the roll 23 to a temperature of about 150° F. to 175° F. and thereafter the composite sheet may be passed over cooling drums 26 on which it may be cooled to ordinary room temperature. It is preferable, however, to strip the composite sheet off of the surface of the roll while it is still hot to produce a glossy and polished surface.

The use of the process typified by the use of rolls 23 and 24 is greatly advantageous in the practice of the invention. In one operation the surfaces of the decorative pieces are cooled by the action of the metal roll contacting them prior to its contacting the matrix sheet; the overall sheet is rendered smooth by the pressing of the decorative pieces in the matrix sheet without any substantial lateral or longitudinal displacement of material of the matrix sheet; the decorative pieces are immediately fused into the matrix sheet due to the heat contained therein yet there is little, if any, distortion of the decorative pieces or the decoration of the matrix sheet; the composite sheet is further cooled and "set" in its final form; the resilient bottom roll prevents a build up of material in the nip of the roll which would destroy the decoration of the matrix sheet; and, in addition, the bottom roll minimizes the removal of heat from the matrix sheet thus permitting the colder top roll to operate as described.

If desired, the composite sheet after having passed between the rolls 23 and 24 may be subjected to one or more additional pressing steps carried out similarly and prior to substantial cooling of the composite sheet. However, if one or more additional pressing steps are utilized, the composite sheet may be subjected to reheating prior to any one or more of such repeated pressing steps.

After the composite sheet 9 has become cooled by passage over the cooling rolls 26, the sheet is ready to be comprised in a commercial product. Thus the composite sheet may be bonded with a backing sheet such as felt or a second vinyl sheet to provide a covering of the type shown in Fig. 2. On the other hand, sheets of heavier

gauge may be cut to form tile adapted for use without any backing.

Depending upon the operating conditions during the pressing step, including the temperature and composition of the matrix sheet and the area and thickness of the sheet-form pressed-in pieces, the matrix sheet may to some extent become bulged outwardly in back in those locations where the pieces are pressed into the matrix sheet. When the finished composite sheet is caused to be laminated with a bituminous backing sheet that has been heated to a temperature at which it is substantially softened when the lamination is caused to occur utilizing substantial pressure, such bulges as may occur in the back of the matrix sheet may become absorbed by and counter sunk in the backing sheet so that notwithstanding the bulges the finished laminated covering is of uniform gauge throughout. If, however, the bulges are regarded as excessive for such use or if it is desired that the composite sheet be of uniform gauge so that it may be used for the manufacture of tiles, for example, the bulges may be removed by planing them off as, for example, by a mechanism such as that indicated diagrammatically in Fig. 4.

As shown in Fig. 4, the composite sheet 9 may be taken from the cooling drums 26 so that the undersurface of the composite sheet will be passed in operative relation to an abrading means such as the roll 27 which has an abrading composition, as, for example, sandpaper, on the surface thereof. In order that the sheet 9 may be held in proper relationship to the surface of the abrading roll 27, the roll 28 may be employed as an ordinary steel roll. By rotating the roll 27 so that its peripheral abrasive-presenting surface is moved relatively to the undersurface of the composite sheet 9, any bulges are effectively planed off and removed, with the resultant production of a composite sheet that is of uniform gauge throughout. Any material 30 that is thus planed off may be collected by suitable means such as that indicated diagrammatically by the reference character 29 and, if desired may be incorporated with the composition material that is used either in the initial production of the matrix sheet or in the production of some or all of the flat pressed-in pieces.

The following example is given for the purpose of illustration:

Example

A vinyl composition matrix sheet six feet wide and 0.035" thick was produced having the following composition:

	Parts by weight
Co-polymer of vinyl chloride and vinyl acetate	316
Diocetyl phthalate	126
Asbestos fiber	140
Wood flour	30
Dry ground limestone	100
Silica flour	215
Stearic acid	2
Basic lead silicate	6
Titanium dioxide	50
Chrome green	15

Small decorative elements having dimensions $\frac{3}{16}$ inch x $\frac{3}{16}$ inch x $\frac{3}{16}$ inch were cut from a vinyl sheet of similar composition having a contrasting coloration. The matrix sheet at a temperature of about 100° F. was passed under a feeding mechanism which deposited decorative elements on the surface of the sheet in spaced relationship so that they covered approximately 15% of the surface of the sheet. The matrix sheet carrying the decorative elements was then passed through a bank of infra red heating lamps which raised the temperature of the sheet to 350° F. The heated matrix sheet was then fed at a rate of twenty-five feet per minute between two steel rolls having diameters of 24 inches. The top roll contacting the decorative element and the surface of the matrix sheet had a polished chrome surface and was heated to 275° F. The roll contacting the back of the matrix sheet

was maintained at a temperature about 195° F. The rolls were adjusted so that the sheet, upon passing from the rolls, had a thickness of about 0.025 inch. The sheet thus produced was allowed to travel with its surface in adherent contact with the surface of the chrome roll for approximately one-half revolution at which point it was stripped from the roll. The sheet was then passed over cooling rolls to reduce its temperature to about 100° F. and laminated to a bitumen impregnated felt having an adhesive coating. The product was then wound onto a collecting roll. The decorative sheet produced had a smooth, glossy surface with the design elements, having their original rectangular shape, firmly embedded in the surface of the sheet to a depth of about two-thirds the thickness of the sheet.

While certain equipment has been illustrated in the drawings and described hereinabove which may be employed in the practice of this invention, it is to be understood that this has been done in order to illustrate the practice of this invention so that an understanding thereof may be facilitated and that other types of equipment may be employed for providing a heated matrix sheet of polyvinyl composition having numerous sheet-form pressed-in pieces distributed thereof in substantially spaced relation and for pressing the pieces into the heat plasticized matrix sheet in the manner and for the purposes hereinabove described.

What is claimed is:

1. A method of making a decorative and wear-resistant flexible surface covering for floors, walls and the like, which comprises disposing in substantially spaced relation on the surface of a preformed sheet of thermoplastic polyvinyl composition numerous preformed flat pieces of polyvinyl composition of contrasting color, heating said sheet to a temperature at which said surface is readily deformable and pressing said pieces flatwise into said heated sheet while said surface is deformable with a smooth surface maintained at a temperature substantially below the temperature of said heated sheet until the exposed surfaces of said pieces are flush with the surface of said sheet thereby fusing said pieces to said sheet at their interfaces therewith without substantially distorting the shape of said pieces.

2. A method of making a decorative and wear-resistant flexible smooth surface covering for floors, walls and the like, which comprises disposing in substantially spaced relation on the surface of a preformed matrix sheet of polyvinyl composition numerous flat pieces of polyvinyl composition whose coloration contrasts with that of said matrix sheet and which are substantially thinner than said matrix sheet and have an area of less than about 2 3/4 square inches in surface area, heating the sheet to a temperature at which said surface of said preformed matrix sheet is deformable and pressing said pieces flatwise into said heated sheet while said surface is deformable with a smooth surface maintained at a temperature substantially below the temperature of said heated sheet until the exposed surfaces thereof are flush with the surface of said matrix sheet thereby fusing said pieces to said sheet without substantially distorting the shape of said pieces to form a smooth and uniform sheet, said pieces during said pressing step being at least at the exposed surfaces thereof at a substantially lower temperature and of harder consistency than said matrix sheet.

3. A method of making a decorative and wear-resistant flexible smooth surface covering for floor, walls and the like, which comprises disposing in substantially spaced relation on the surface of a preformed sheet of polyvinyl composition numerous flat pieces of sheet material composed of similar polyvinyl composition having coloration contrasting with that of said sheet, heating said sheet and flat pieces to a temperature at which said surface of said preformed sheet is deformable between about 350° F. and about 390° F., pressing said pieces into said sheet while said surface is deformable with a smooth hard sur-

face maintained at a temperature substantially below the temperature of said heated sheet until the exposed surfaces thereof are flush with the surface of said sheet thereby forming a smooth, uniform sheet and cooling the resulting sheet.

4. A method of making a decorative and wear-resistant flexible smooth surface covering which comprises disposing in substantially spaced relation on the surface of a preformed sheet of polyvinyl composition numerous preformed flat pieces of polyvinyl composition whose coloration contrasts with that of said sheet, heating said sheet to a temperature at which said surface of said preformed sheet is deformable, passing said sheet while said surface is deformable between a first roll presenting a hard, rigid surface maintained at a temperature substantially lower than that of said heated sheet and a second roll comprised at least at and adjacent the surface thereof of yieldable resilient material, said first roll contacting said pieces and pressing them into said sheet while said sheet is supported by said second roll until the exposed surfaces of said pieces are substantially flush with the surface of said sheet thereby forming a smooth and uniform sheet without distorting the shape of said pieces.

5. A method according to claim 4 wherein said sheet is heated to a temperature in the range from about 350° F. to about 390° F. immediately prior to passage between said rolls, said preformed flat pieces are less than about one square inch in area, and the surface temperature of said first roll is not greater than about 130° F.

6. A method of making a decorative and wear-resistant flexible smooth surface covering for floors, walls and the like which comprises disposing in substantially spaced relation on the surface of a preformed matrix sheet of polyvinyl composition numerous preformed flat pieces of polyvinyl composition of contrasting color, heating said matrix sheet to a temperature at which said surface is deformable, pressing said matrix sheet with said pieces disposed thereon while said surface is deformable between a surface presented by yieldable resilient material in contact with said matrix sheet and a surface presented by hard, rigid material that is maintained at a temperature lower than that of said matrix sheet until the surfaces of said pieces are flush with the surface of said matrix sheet with resultant formation of bulges from the surface of said matrix sheet opposite to that into which said pieces are pressed in the places where said pieces occur, and thereafter planing off said bulges to provide a composite sheet of substantially uniform thickness throughout having a smooth upper surface.

7. A method according to claim 6 wherein said pieces are substantially thinner than said matrix sheet and are less than about one square inch in area, said matrix sheet is heated to a temperature between about 350° F. and 390° F. immediately prior to said pressing and said pressing of said matrix sheet with said pieces is effected between a roll contacting said matrix sheet that presents a body of elastomer on the surface thereof and a hard, rigid, smooth surface metal roll that contacts said pieces and that is maintained at a temperature not above about 130° F., and said matrix sheet is cooled after said pressing step and prior to said planing off of said bulges.

8. A method of making a flexible smooth surface covering for floors, walls and the like, which comprises disposing on the surface of a smooth calendered polyvinyl composition sheet a plurality of flat pieces of polyvinyl composition having a higher softening temperature than the sheet, heating the sheet and flat pieces to a temperature at which said surface is deformable and pressing the pieces into said deformable surface with a smooth hard surface maintained at a temperature substantially below the temperature of said heated sheet until the exposed surfaces of the pieces are flush with the surface of the sheet thereby fusing the pieces to the sheet at their interfaces therewith without substantially distorting the shape of said pieces.

9. A method of making a flexible smooth surface covering for floors, walls and the like which comprises preheating a smooth calendered sheet of polyvinyl composition to a temperature between about 250° F. and about 350° F., disposing on the upper surface of the preheated sheet a plurality of flat pieces of polyvinyl composition having colors that contrast with the color of the sheet, heating the sheet with the pieces disposed thereon to a temperature at which said upper surface is deformable between about 350° F. and about 390° F. and pressing the pieces into the heated sheet while said surface is deformable by passing between a hard surface roll maintained at a temperature substantially lower than that of the sheet and a second roll until the exposed surfaces of the pieces are flush with the surface of the sheet thereby fusing the pieces to the sheet at their interfaces therewith and forming a sheet having a smooth and uniform surface, the rolls being disposed so that the hard surface roll contacts the pieces during the pressing.

10. A method of making a flexible smooth surface covering for floors, walls and the like which comprises forming a smooth sheet of polyvinyl composition comprising about 20 to 50 percent polyvinyl resin, about 10 to 30 percent plasticizer and about 20 to 70 percent pigments and fillers, disposing on the upper surface of the sheet a plurality of flat pieces of similar polyvinyl composition in colors which contrast with the color of the sheet and being less than about two and a quarter square inches in area and at least one third the thickness of the sheet, heating the sheet to a temperature at which said upper surface is deformable, passing the heated sheet while said surface is deformable between two calender rolls, one calender roll having a hard surface maintained at a temperature substantially lower than the temperature of the sheet which contacts the pieces, thereby pressing and fusing the pieces so that the exposed surfaces thereof are substantially flush with the surface of the sheet and fused to the sheet at their interfaces therewith and laminating the sheet thus formed to a felt backing material.

11. A method of making a decorative and wear-resistant flexible surface covering for floors, walls and the like, which comprises disposing in substantially spaced relation on the surface of a preformed sheet of thermoplastic polyvinyl chloride composition numerous preformed flat pieces of polyvinyl chloride composition of contrasting color, heating said sheet to a temperature at which said surface is readily deformable and pressing said pieces flatwise into said heated sheet while said surface is deformable with a smooth surface maintained at a temperature substantially below the temperature of said

heated sheet until the exposed surfaces of said pieces are flush with the surface of said sheet thereby fusing said pieces to said sheet at their interfaces therewith without substantially distorting the shape of said pieces.

12. A method of making a decorative and wear-resistant flexible smooth surface covering for floors, walls and the like, which comprises disposing in substantially spaced relation on the surface of a preformed sheet of polyvinyl chloride composition numerous flat pieces of sheet material composed of similar polyvinyl chloride composition having coloration contrasting with that of said sheet, heating said sheet and flat pieces to a temperature at which said surface of said preformed sheet is deformable between about 350° F. and about 390° F., pressing said pieces into said sheet while said surface is deformable with a smooth hard surface maintained at a temperature substantially below the temperature of said heated sheet until the exposed surfaces thereof are flush with the surface of said sheet thereby forming a smooth, uniform sheet and cooling the resulting sheet.

13. A method of making a flexible smooth surface covering for floors, walls and the like which comprises disposing on the surface of a smooth sheet of polyvinyl composition a plurality of flat pieces substantially thinner than the sheet of similar polyvinyl composition having colors that contrast with the color of the sheet and having a thickness exceeding one-third the thickness of the sheet, heating the sheet to a temperature at which said surface is deformable, the temperature being less than about 390° F., passing the heated sheet while said surface is deformable between a hard surface roll maintained at a temperature substantially lower than that of the sheet and a second roll thereby pressing the pieces until the exposed surfaces thereof are substantially flush with the surface of said sheet without substantially distorting the shape of said pieces the rolls being disposed in such a way that the hard surface roll contacts the pieces before the sheet is passed between the two rolls.

14. The method of claim 13 wherein the thickness of the pieces is between one-third and one-half the thickness of the sheet, the sheet is heated to a temperature between about 350° F. and about 390° F. and the hard surface roll is maintained at a temperature less than about 130° F.

References Cited in the file of this patent

UNITED STATES PATENTS

1,939,045	Fredriksen	Dec. 12, 1933
2,091,361	Heppes	Aug. 31, 1937