Our invention relates to luminescent dials and the like, and to methods of producing the same.

In the production of dials for aeronautical instruments and the like, it is essential that the various characters appearing on the dials, including sub-dividing lines, number and the like, be instantly legible both in daylight and under ultra violet light. A high degree of legibility is desired, and this is particularly important and its attainment becomes a problem when the dials are viewed under ultra violet light. It is essential further that dials and the like be made by a method which will permit both the production of relatively fine lines and obtaining a relatively large capacity output. Heretofore, so far as we are aware, it has been impossible to secure the high degree of legibility desired, particularly in ultra violet light, while at the same time employing a method which permits the use of relatively high speed production methods by substantially unskilled labor. One method of producing a highly luminous product involves a hand painting operation over a previously applied printed outline, this being one type of operation heretofore sometimes employed for the production of luminous clock faces and the like. This method has not been fully satisfactory, particularly from a production standpoint. Another method is to incorporate luminescent material in a printing ink and print the dial faces from a prepared plate. By this method, and modifications thereof, large volume production can be obtained, but legibility under ultra violet light is markedly reduced.

In accordance with our method, we select the material from which the dial is to be produced and finish it, preferably to have a dark, optionally liquid-like product. To this surface, we apply a base material comprising a luminescent material in a binder, by a screening method which will be described. The proportion of luminescent pigment to binder is relatively very high, but we nevertheless produce a character on the dial which is clear cut, comprises a stand-out reproduction of the dial intended to be reproduced and which will not readily be dislodged from the surface to which it is applied. The method can be carried out rapidly and by its use the objects of our invention are obtained. In order that those skilled in the art may understand the manner of practicing our invention, we shall first give a specific example thereof and subsequently point out certain ways in which the details given in the specific example can be modified.

In accordance with a preferred embodiment, we first prepare a base comprising an alkyd resin, 50%, China-wood oil, 25%, cobalt naphthenate, 0.05%, manganese naphthenate, 0.03%, and balance xylene. The ingredients identified are mixed together to obtain a homogeneous liquid-like product and into 25% of this base material we incorporate 73% of a -200 mesh luminescent zinc-cadmium sulphide pigment and 2% of zinc stearate. After being mixed together, this product is milled in a printing ink roller mill until a good consistency is obtained and a substantially homogeneous product produced. Two to three passes through the mill as a rule produces a satisfactory product. This product comprises a luminescent silk screen base or silk screen ink, either terminology being acceptable to identify the product.

This luminescent silk screen base is applied to a filled dull-black vinylite resin dial surface by a screening operation. The screen is finished in a usual way to close certain meshes of the screen, leaving open the mesh in the area in which it is desired to print. A silk screen comprising so-called Swiss silk and having 160 meshes to the inch gives very good results. This silk screen has a relatively large open mesh area as compared to the area of the strands, the relation being approximately three to one. In the silk screening operation a portion of the silk screen base is applied to the surface of the screen at one end thereof, and with the dial under the silk screen and supported in proper position by a suitable jig, a squeegee-like tool is used to move the silk screen base material across the surface of the screen and force some of this base material through the meshes of the screen. The squeegee is then moved in the opposite direction in accordance with a usual method employed in so-called silk screening operations. The silk screen is then raised, and the dial removed and allowed to stand until dry, after which it is ready for use. If desired a solution of a resin may be sprayed over the silk screened surface of the dial to act as a further protection to the applied characters. In the event the silk screen base should dry out to any extent while it is being used, a relatively small amount of a thinner, for example, about 5% of a high boiling point naphtha may be added. The dial produced by this method is readily visible in the daylight and has a high degree of legibility at night.
when the surface thereof is subjected to the action of ultra-violet light.

Certain characteristics of our operation will be apparent from the above example and will be brought out in further description of the method. It will be noted, however, that we employ a relatively high proportion of luminescent pigment compared to binder. The xylene or other thinner employed evaporates and the proportion of pigment to base in the final product is higher than the proportions employed at the start.

In place of the resin referred to heretofore for use in the base vehicle, we may employ other binders, such as other resins, natural or synthetic, including, for example, nitrocellulose, cellulose acetate, vinyl resin, methyl methacrylate resins, phenolic resins and the like. The binder employed should be one which is solid to plastic at ordinary temperatures, is transparent to ultra-violet light and compatible with the other constituents employed. In place of China-wood oil, we may employ other drying oils, or we may employ solely a base, the solid binder materials of which comprise entirely resinous material; in general, however, we prefer to employ a base material which dries in part by oxidation and in part by evaporation.

In place of xylene as a thinner, we may employ other relatively high boiling point solvents compatible with the other materials present. By the expression high boiling point solvents we include, generally speaking, organic liquids boiling above 150 degrees C. but it will be understood that the boiling point of the solvent is only one factor, and the suitability of a solvent is determined to some extent by characteristics of the solvent and constituents of the base vehicle other than those referred to. Examples of solvent substances which can be employed in place of xylene are high boiling point naphthas, mineral spirits, Shell Petroleum Company high boiling point thinners No. 35-11°, “TS 11°,” “TS 58,” cellosolve acetate, butyl cellosolve, amyl acetate, carbitol, carbitol acetate, and other relatively high molecular weight alcohols, esters, ethers, hydrocarbons and the like. There is an advantage, of course, in using a thinner which is inexpensive and one which will not leave a residue.

In place of cobalt naphthenate or manganese naphthenate, other so-called driers may be employed. The zinc stearate which is employed in the final silk screen base is used as a so-called “sharpening.” By using this material, we are able to apply a relatively heavy deposit of the silk screen base on the surface of the dial, and it will not deform during drying but will remain sharp, and continue to “stand out” in substantially the form it assumed when first applied. As sharpeners, we may employ other insoluble soaps such as zinc palmitate, aluminum stearate and the like. These sharpeners are preferably added in the form of a very fine powder, at least —200 mesh.

Our method involves the use of a relatively large proportion of pigment and this, in turn, is facilitated by the proper selection of a screen. While we may employ various types of screens made of various materials, we have found that very good results are obtained by using so-called Swiss silk. We employ a material having at least 100 meshes to the inch but, in general, not more than approximately 180 meshes to the inch, although as the number of meshes to the inch increases, the strand material should be of smaller diameter, that is to say, the ratio of screen area to strand area must be maintained at least within certain workable limits. When this ratio is as high as 5 to 1, as we have found to be possible when the screen is made of certain types of materials, the number of meshes to the inch can be increased and a sharp line and adequately heavy deposit obtained. We may also use a metal screen having these characteristics but, in general, all things considered, we prefer to employ a silk screen. We have found that the ratio of openings to solid portion should be at least of the order of 5 to 3 if adequate results are to be obtained.

Hereinafore we have referred to the use of 75% of solid materials (pigment plus sharpener) and 25% of the base vehicle. Since approximately 25% of the base vehicle is removed by evaporation, however, the relationship of these materials in the final product is changed. We may have present in the final product as much as 85 parts by weight of the pigment to 15 parts by weight of the binder (after drying by evaporation), while we obtain fair results when other features of our invention are followed, if, in final product, the pigment comprises 70 parts and the binder 30 parts. In general, we prefer to balance the ingredients so that the pigment comprises approximately 80 parts and the binder 20 parts of the final product. All proportions referred to hereinafore are by weight unless the context clearly shows otherwise.

Our method produces a highly luminous dial and one which is adequately rugged under all usual conditions encountered during the normal life span of the instrument of which the dial forms a part. The limitations in the scope of the invention are set out in the claim.

What we claim as new and desire to protect by Letters Patent of the United States:

The method of producing a luminescent dial, which comprises producing a screening base comprising an organic binder, including a resin and a drying oil, a solvent for such binder, a luminescent pigment, and a relatively small proportion of an insoluble soap as a sharpener, the proportion of pigment to binder being of the order of seventy to thirty, preparing a pattern on a screen having about 160 meshes per inch and a size of strand such that the ratio of the total area of the openings to the total area of strand surface is at least five to three, and applying said screening base to the dial surface through the pattern of said screen.

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