

UNITED STATES PATENT OFFICE

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METHOD OF MAKING MIRRORS

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This invention relates to an improved method of making silvered glass mirrors having as its principal object the use of separately atomized silver and reducing solutions adapted to be sprayed onto the glass and which react with sufficient rapidity and degree to insure the deposit of a silver film of a density and homogeneity adequate for mirror purposes.

Heretofore and prior to this invention it has been the common practice in the making of mirrors to apply a silvering solution to one surface of a glass while maintaining said surface in a perfectly horizontal plane, the metallic silver being permitted to deposit out of the solution and upon the glass surface. While various expedients have been resorted to in order to insure maintenance to the glass surface in properly leveled condition, this leveling operation nevertheless entails considerable difficulties and the expenditure of much valuable time. Also, in order to insure uniform spreading of the solution over the leveled surface of the glass, such surface must be maintained constantly wetted with the result that the water so present upon the glass surface often interferes with the proper uniform deposition of the silver out of the silvering solution.

In addition, improper leveling of the surface to be silvered results not only in considerable variations in the thickness of the deposited metallic silver film in different areas thereof, the silver film being quite heavy or dense over one area and considerably lighter or thin over another area of the silvered surface, but also in inadequately coated edges.

Moreover, in the conventional methods of silvering mirrors wherein the silvering solution is necessarily poured over the surface to be silvered, it is an exceedingly difficult task to prevent or detect the deposit of non-reflecting decomposition products of the silvering solution along with the reflecting metallic silver. Should these decomposition products be removed during the final rinsing and drying operation, objectionable pinholes are produced, while should such products perchance remain bound in the silver film, they nevertheless result in translucent spots clearly visible to the eye when the finished mirror is held up to the light.

The present invention has as its object the elimination of the aforementioned objections to and difficulties encountered in the old method of silvering mirrors by the use of separately atomized silver and reducing solutions which may be sprayed onto the glass or other surface even while the latter is maintained in a plane inclined at a

substantial angle with respect to the horizontal and which react with sufficient rapidity and degree to insure the deposit of a silver film of a density and homogeneity adequate for mirror purposes.

A further and important object of the present invention is to provide silvering solutions of such formulae that, without the necessity of employing any accelerating agents, they are suitable for use in atomized state to form practically instantaneously silver reflecting films of adequate density and homogeneity.

It is well known that when accelerating agents, such as sodium or potassium hydroxide, are mixed with the usual silver ammonio nitrate solution to form a single mixture a dangerously explosive combination is obtained. To minimize this danger it has been the practice to introduce the caustic alkali at as last a time as possible, the resultant mixture being used without further delay because the explosiveness of the mixture increased with its age. Obviously, this resulted in considerable waste of solutions because unless all of the mixture was employed within a relatively short interval after its preparation, in the interest of safety the unused prepared solutions were required to be destroyed. The present invention accordingly has as one of its objects the provision of silvering solutions which react with sufficient rapidity to not only render their use suitable in a spraying process but which also eliminate the necessity of using accelerating agents which when combined with silver nitrate tends to form a dangerously explosive mixture.

I have found that in order to obtain most satisfactory results by the use of the spray method, certain compounds, such as the sulphates, hydrates and nitrates of hydroxylamine and of hydrazine, serve most effectively as silver reducing agents, such agents forming the subjects matter of my prior applications Serial Nos. 235,661 and 301,584, respectively filed October 18, 1938, and October 27, 1939. These compounds of hydroxylamine and hydrazine are acid in character and in certain instances I have found that the neutral compound, glyoxal, (otherwise known as ethanedial, oxaldehyde and biformyl) may be more advantageously employed. This neutral compound not only provides a more stable reducer solution than do the aforesaid acid compounds, but it also produces a solution which lasts indefinitely, which is not obnoxiously odorous in use and which is less poisonous and toxic than the acid reducer solutions. Also, I have found that glyoxal may be employed in less quantities

than the aforesaid acid compounds for a given proportion of silver nitrate and moreover that by using glyoxal as the reducing agent the content of ammonium hydroxide in the silver ammonio nitrate solution may be materially reduced without decreasing the effectiveness of the silvering process. Thus, the use of glyoxal as a reducer for silvering mirrors and like surfaces effects a considerable saving in material costs.

Accordingly, it is among the objects of the present invention to provide a method whereby a neutral compound, such as glyoxal, may be employed as a reducing agent in the production of silvered mirrors and the like by the spray method aforesaid.

In the use of glyoxal as a reducing agent for silvering mirrors by the spray process, separate silver and reducing solutions are prepared for subsequent atomization and mixing together in the immediate vicinity of the surface to be coated, the spraying apparatus being of any suitable type, such as is described, for example, in my pending applications aforesaid or in the pending application of Austin H. Downs, Serial No. 279,613, filed June 17, 1939.

While the composition of these solutions may vary, of course, depending upon conditions of use and effects desired to be obtained, it is preferred that they be produced in accordance with the following exemplary formula:

Solution A	Solution B
This is preferably a solution of silver ammonio nitrate which is prepared by dissolving 3 oz. of silver nitrate and 2 to 2.5 oz. of ammonium hydroxide in one gallon of water.	This reducing solution is prepared by dissolving 2 oz. of glyoxal in one gallon of water.

It is to be understood that in the above formula for the several solutions A and B, the proportions stated are not intended to be critical, are approximate and may be varied within reasonable limits. For example, I have found that by increasing materially the proportion of ammonium hydroxide employed, the speed of reaction between the silver ammonio nitrate and the reducing agent may be so decreased that an extremely thin or transparent film of silver may be obtained, a result which would have been practically impossible were it not for the control obtained by reducing the speed of reaction. Similarly, other results and effects may be obtained by varying within rather wide limits the proportions of the other ingredients employed. Experience has demonstrated, however, that the above stated proportions produce very desirable results for general purposes. It will be understood that, if desired, either of the solutions A or B, may contain exclusively all of the ammonium hydroxide.

In the use of the Solutions A and B as above prepared, approximately equal quantities of each are respectively maintained in separate containers therefor, as shown and described in my pending applications aforesaid, in order to insure against the accidental or unintentional exhausting of one solution supply without at the same time exhausting the other, thereby obviating the possibility of spraying only one solution upon the surface to be silvered. Also, where such containers are supported in elevated position so as to provide a gravity feed for the solutions to the spray apparatus, by maintaining equal solutions in the containers the maintenance of equal

head pressures is insured, thus providing for equalized delivery of the separated solutions to the spray nozzles.

It will be understood, of course, that the separate silver and reducing solutions A and B are simultaneously atomized and sprayed upon the surface to be coated in such manner as to effect an intimate mixing of the atomized solutions in the immediate vicinity of the surface to be coated whereon they react to deposit an adherent film of metallic silver of homogeneous density. Not only is this film of uniformly even thickness throughout but it is more homogeneous due to the substantial absence of pin-holes. Moreover, should any water be present upon the glass surface as would normally tend to interfere with proper deposition of the metallic silver thereupon, it is washed down and thoroughly removed by the force of the spray directed against the inclined surface of the glass. A further and important advantage of the present method resides in the fact that the solutions A and B may be employed at ordinary room temperatures, in contradistinction to the older methods which usually require heat in the application of the silvering solution.

I have found that the solutions A and B aforesaid may be applied to the surface of the glass to be coated by directing the same through atmosphere in the form of streams which are not necessarily atomized, but which, as in the case of atomized sprays, are directed against the surface to be coated with sufficient force to instantly drive all excess portions of the solutions from said surface, thereby preventing the formation of stationary puddles of the reacting solutions upon the surface. I have found that when the mixing of these streams occurs in the immediate vicinity of the glass surface to be coated so as to effect the necessary reaction of the solutions and deposition of the metallic silver at the instant when the mixed solutions impinge against the glass surface, the desired silver film is obtained. This reaction is so rapid that if the solutions are slowly brought together or are permitted to remain upon the glass surface in the form of relatively stationary pools or puddles for a period longer than is required for the silver to adhere to the glass instantaneously as it deposits out of solution as the product of reaction of the solution, the metallic silver does not adhere to the glass at all, or if some adherence of the silver upon the glass does occur in the regions where the solutions remain upon the glass, the continuing reaction of the latter immediately lifts the silver from the glass.

The present method is particularly adapted for coating with silver other transparent materials such as are obtained from synthetic resins, cellulose derivatives and the like and which ordinarily so deleteriously affect and impair the reaction of the usual silvering solutions applied in the customary manner as to produce unsatisfactory mirrors. Also, it will be understood that the present invention is not limited in its application solely to the silvering of glass for mirror purposes, but instead may be generally employed for providing any surface with a reflective or decorative film of silver, depending upon whether the material, the surface of which is so treated, is transparent or opaque.

What is claimed as new and useful is:

1. A method of coating a surface with a film of metallic silver having a high coefficient of reflection which comprises preparing and maintain-

ing in separated relation separate solutions of silver ammonio nitrate and a reducing agent therefor, in simultaneously introducing approximately equal quantities of said solution into a jet of compressed air, said solutions being entrained in said jet in the immediate vicinity of its discharge into atmosphere whereby said solutions are atomized and intimately mixed together for reaction to produce metallic silver which is adapted to be applied in the form of a homogeneous film over the surface to be covered, said reducing solution containing glyoxal and directing the mixture thus formed against the surface to be covered.

2. A method of depositing an adherent film of metallic silver having a high coefficient of reflection upon the surface of a body which comprises directing against said surface a compressed air spray in which are atomized and intimately mixed separately formed solutions adapted to react with one another to produce metallic silver, one of said solutions containing silver nitrate and ammonium hydroxide and the other solution containing glyoxal.

3. A method of depositing an adherent film of metallic silver having a high coefficient of reflection upon the surface of a body which comprises preparing and maintaining in separated relation separate aqueous solutions of silver ammonio nitrate and a reducing agent therefor, in simultaneously projecting approximately equal quantities of said solutions through atmosphere in the form of independent streams, said streams being so related and directed relatively to each other that said solutions are intimately mixed together for reaction in the immediate vicinity of said surface to produce metallic silver which is adapted to be applied in the form of a homogeneous film over said surface, said reducing solution containing glyoxal, the silver nitrate and the glyoxal being included in mutually exclusive solutions and directing the mixture thus formed against the surface to be covered.

4. A method of depositing an adherent film of metallic silver having a high coefficient of reflection upon the surface of a body which comprises preparing and maintaining in separated relation separate solutions of silver ammonio nitrate and a reducing agent therefor, in simultaneously projecting through atmosphere approximately equal quantities of said solutions in the form of streams so related as to effect an intimate mixing together of said solutions in the vicinity of the surface to be coated for reaction to produce metallic silver forming a homogeneous reflecting film upon said surface, said reducing solution containing glyoxal.

5. A method of depositing an adherent film of metallic silver having a high coefficient of reflection upon the surface of a body which comprises preparing and maintaining in separated relation separate solutions of silver ammonio nitrate and a reducing agent therefor, in simultaneously projecting through atmosphere approximately equal quantities of said solutions in the form of streams so related as to effect an intimate mixing together of said solutions in the vicinity of the surface to be coated for reaction to produce metallic silver forming a homogeneous reflecting film upon said surface, said reducing solution containing glyoxal, the streams being directed against the surface to be coated with sufficient force to instantaneously drive all excess portions of the solutions from said surface whereby to prevent the formation of stationary puddles of the reacting solutions.

6. A method of forming a film of metallic silver upon the surface of a body which comprises mixing in air a liquid spray containing silver ammonio nitrate and a liquid spray containing a reducing agent for said silver ammonio nitrate, and directing said mixed spray against the surface of the body to be covered, the reducing agent being glyoxal, said metallic silver deposit having a high coefficient of reflection at both the back and front surfaces thereof.

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