July 5, 1938. L. E. CALKINS ET AL 2,122,512

METHOD OF MAKING INSIDE FROSTED ELECTRIC LAMP BULBS

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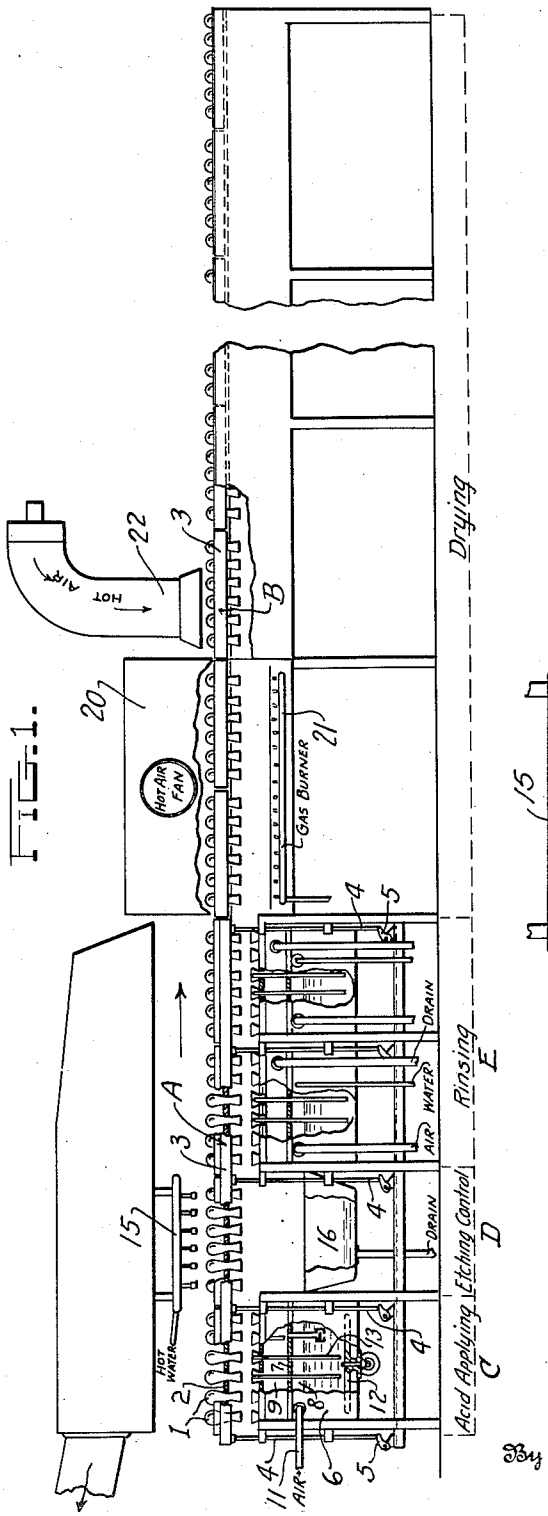


FIG. 1.

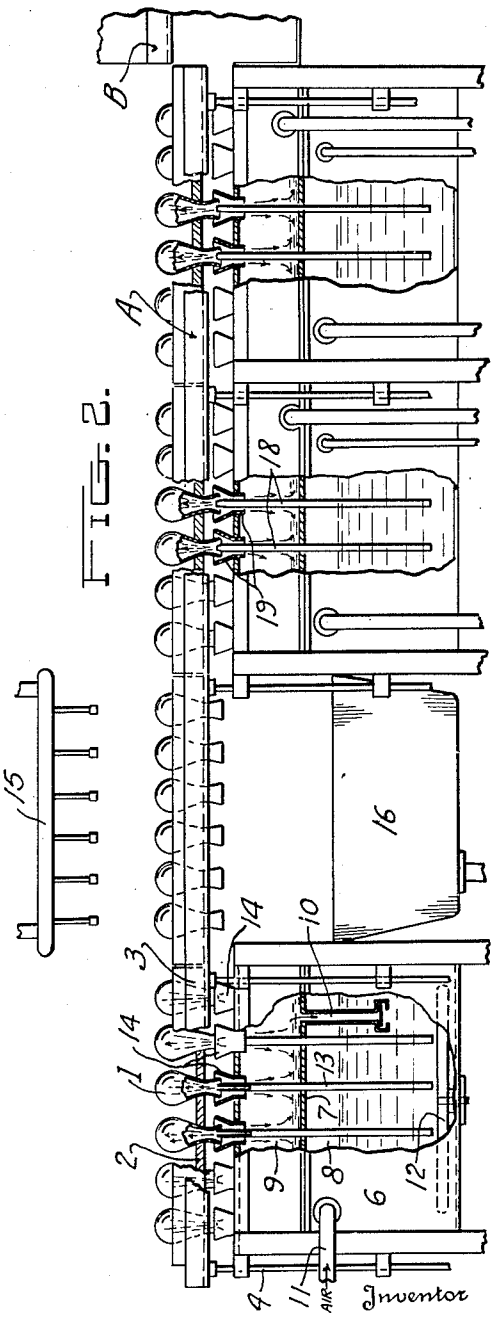


FIG. 2.

Inventor
Lyle E. Calkins &
Ormonde S. Levi

By Owen & Owen
Attorneys

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FIG. 3.



Inventors
Lyle E. Calkins &
Ormonde S. Levi

By Owen & Owen,

Attorneys.

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METHOD OF MAKING INSIDE FROSTED ELECTRIC LAMP BULBS

Lyle E. Calkins and Ormonde S. Levi, Toledo, Ohio, assignors to Save Electric Corporation, Toledo, Ohio, a corporation of Ohio

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2 Claims. (Cl. 41—42)

This invention relates primarily to the inside frosting of electric lamp bulbs, and also to the character of frosted surface produced, whereby such ware has the requisite strength against breakage and the desired brightness reduction with minimum light absorption for commercial use.

Inside frosted lamp bulbs have features of advantage in use over outside frosted or other types of light diffusing bulbs, and a considerable demand has developed in the trade for lamps with such bulbs. In the past, difficulty has arisen in the inside frosting of such bulbs due to the frosting methods ordinarily employed, when applied to the inside of a bulb, effecting such a weakening of the bulb as to render it fragile for commercial handling.

It has heretofore been found, however, that if a lamp bulb frosted on the inside in the usual manner is given a second or additional frosting treatment of lower degree than that to which it was first subjected, it becomes sufficiently strong for commercial handling, the strengthening action in such case being supposedly occasioned by the changing of the frosting pits or depressions from sharp angular to rounded form. It is further found, however, that while such treatment when first applied materially strengthens such bulbs against breakage, they weakened with age to such an extent that within a very few months the bulbs in many cases become so fragile as not to permit commercial handling without breakage.

The primary object of the present invention is the provision of a solution and method for producing, by a single acid or etching treatment, an inside frosted electric lamp bulb of highly efficient light giving qualities and of suitable strength over a prolonged period for commercial handling, and which does not have rounded etching pits or depressions.

A further object of the invention is the production of an inside frosted electric lamp bulb of a strength suitable for commercial handling and which will, with a minimum of absorption of light, sufficiently diffuse the emitted light of the associated light source as to prevent any objectionable glare, thus giving maximum light emission, increasing the lamp life at designed efficiency and improving the ultimate lamp quality.

In the drawings, Fig. 1 is a more or less diagrammatical side elevation of an apparatus employed in the practicing of our inside bulb frosting method, with parts broken away, and with the bulbs in the first three stages in raised position; Fig. 2 is a similar fragmentary enlarged view of the first three stages of the apparatus with the bulbs in lowered positions in such stages, and Fig. 3 is a reproduction of a photomicrograph enlarged five hundred times of the inside frosted surface of a bulb frosted by our method.

The present invention resides (1) in the frosting solution employed; (2) in the method of applying the solution and the subsequent treatment of the bulbs in the inside frosting thereof, and (3) in the bulb itself produced by such method characterized by the form of its inside frosted surface and by the strength and light transmitting qualities of the bulb.

The frosting solution preferably employed may be divided into three parts, i. e., "A" the acid part, containing the acid and acid fluorides; "B" the crystalline part, containing the crystalline fluorides, sulphates and water, and "C" the binder part, containing molasses for increasing the consistency of the compound and giving it the requisite viscosity.

(A) Part "A" preferably comprises the following ingredients in substantially the proportions noted:

Ammonium acid fluoride	33 lbs. 3 oz.
Hydrofluoric acid (approximately 60%)	10 liters

These materials are put into a drum of rubber, or other suitable acid resisting material, and rolled or agitated until complete solution takes place.

(B) Part "B" preferably comprises the following ingredients in substantially the proportions noted:

Sodium acid sulphate	11 lbs. 1 oz.
Sodium fluoride	11 lbs. 1 oz.
Water	6 liters

These ingredients are put into a rubber mill preferably containing bronze balls. This material is milled usually for at least three hours, or until it contains no lumps or unground materials. At the beginning of the run, pressure is generated in the mill by the chemical reaction which takes place therein, and care should be taken to release this pressure. The mill should be watched for about fifteen minutes for this purpose. It is preferable to use hot water to increase the solubility of the materials. It is found that the hotter the water the more speedy the action.

(C) Part "C" preferably comprises:

Molasses	12 liters

A commercial grade of molasses is used. The presence of the molasses in the solution retards

the flow of the liquid by acting as a binder, and also retards, due to its viscosity, the rate of reaction of the solution. The change of viscosity of the molasses with temperature allows an easy method of controlling the etching action, and this is obtained by the application of heat to the outside of the bulb during the etching operation, as hereinafter described. It is found that by applying water to the outside of a bulb during the etching operation and by varying the time, the flow and temperature of the water, the formation of the crystalline structure of the etched surface can be controlled.

When part "B" has been sufficiently milled, part "A" is added thereto and the whole is then preferably milled for at least half an hour or until a thorough mixing has taken place. This mixture is then turned into a wooden tub and part "C" added, stirring well while adding. The solution which is now ready for use has a light brown creamy appearance and a consistency substantially equal to No. 10 motor oil.

The sodium fluoride contained in part "B" controls more or less the crystalline structure by stabilizing the viscosity of the solution. The sodium fluoride does not dissolve to any great extent and the fine particles thereof in suspension in the solution form nuclei for crystal formation of ammonium, sodium and calcium silica fluorides (or fluosilicates). This crystalline structure is quite important in obtaining the desired strength characteristics of an inside frosted bulb.

There is also another use for the sodium fluoride in the solution. When sodium acid sulphate is mixed with sodium fluoride in aqueous solution, an exothermic reaction takes place, causing heat to be given off. This reaction forms some free sulphuric acid, sodium sulphate, hydrofluoric acid and sodium acid fluoride along with sodium acid sulphate and sodium fluoride. All these substances are in a state of delicate chemical balance, and it is believed that this equilibrium tends to stabilize the concentration of acid, sodium fluoride, sodium acid fluoride and sulphates in solution. In order to prove our contentions in this respect, the concentrations of sodium acid sulphate were varied. It was found that the addition of only 1% more of sodium acid sulphate to the solution completely changed the properties of the frost. The matt became coarse and could not be easily controlled. When less sodium acid sulphate was added, the frost was not heavy enough and was too fine in crystalline structure to properly diffuse light.

It is found that part "B", when used alone, will etch the glass, but the reaction is too slow for commercial use, due to the low hydrofluoric acid content. When, however, parts "A" and "B" are thoroughly mixed together and part "C" added, a powerful frosting solution is obtained and one which, when used in connection with the method hereinafter described, will produce an inside frosted bulb which is sufficiently strong against breakage to permit ordinary commercial handling, will effect a proper diffusion of light emitted therefrom to prevent objectionable glare or brightness, and will have a greater lumen output with consequent higher initial rating than other inside frosted bulbs now made of which we are aware.

In practicing our invention in the inside frosting of a lamp bulb, the frosting solution above described is first applied in stream or jet form under low pressure (about 1½ to 2 lbs.) up into the interior of the bulb, so that the stream strikes the central top closed portion of the bulb, flows evenly down the sides and discharges from its lower open end. The solution is applied over a period of about ten seconds.

Immediately following the application of the acid the bulb is subjected to an external hot water treatment to control the etching action of the acid adhering to the inner surface of the bulb. Hot water is caused to flow onto and down around the closed end of the bulb discharging from its lower end, and the temperature of the water and time applied are important items in the etching operation in controlling the degree of etching and consequent crystalline structure of the frost surface to produce the desired results. The temperature of the water preferably should be approximately 63° C., and the water should be of sufficient quantity to completely cover the bulb. The time of application varies, depending on the bulb size, but for most sizes the time is about ten seconds.

The bulb is next subjected to a thorough internal washing to entirely remove the etching acid therefrom and thus stop any further etching action. This washing is preferably accomplished by discharging a stream of water under relatively high pressure (about 15 lbs.) up into a bulb from a rather small orifice (about $\frac{1}{8}$th of an inch in diameter). For most satisfactory results the temperature of the water should be from 50° to 95° C.

After washing, the bulb is thoroughly dried preferably by directing hot air thereagainst, both inside and outside, and is then ready for use in a lamp. The bulb may also be held over a flame to facilitate drying. Nothing new is claimed for the washing and drying operations.

An apparatus for practicing the invention is illustrated in Figs. 1 and 2, and includes successively arranged means for imparting the successive treating steps above described together with means for directing the movement of trays of bulbs successively from one position to another in the frosting method.

The bulbs 1 to be frosted are mounted in convenient numbers in trays 2 and such trays are moved from end to end of the apparatus along laterally spaced guide rails 3, in the present instance of angle iron. The rails are divided into a rear section A and a front section B, the rear section being vertically movable and mounted for such purpose on uprights 4 resting at their lower ends on lever arms 5, whereby a rocking of such arms effects a predetermined raising or lowering of the trays on such section. Disposed under the movable section A are the acid applying unit C, the etching control unit D, and the washing unit E of the apparatus.

The acid applying unit C, as illustrated, includes a tank 6 divided by a horizontal partition 7 into a lower compartment 8 for the frosting solution and an upper drainage compartment 9, which latter has communication with the first compartment through one or more drainage tubes 10, each provided with an outwardly opening check-valve. Air under controlled pressure is supplied to the compartment 8 through a conduit 11, and a solution agitating means 12 is provided in the bottom portion of the compartment. A solution discharge tube 13 extends upwardly from near the bottom of the compartment 8 through the top of the compartment 9 and terminates at its upper end in a restricted discharge nozzle in central vertical register with the lower open end of a respective bulb 1 in the superposed tray 2,

one tube being provided for each bulb in the tray. The discharge orifice of each tube is preferably about one-quarter inch in diameter. A drainage funnel 14 is provided through the top of the compartment 9 in free surrounding relation to each tube nozzle and has its upper flared mouth end of suitable size to freely receive the lower end of a registering bulb when in lowered solution receiving position, as shown in Fig. 2. The bulbs in the first tray 2 being lowered into receiving relation to the discharge tubes 13, the controlled air pressure of approximately one and one-half to two pounds from the line 11 is turned into the solution compartment 8 and the solution thereby forced up through the several discharge tubes into the registering bulbs 1, striking the top portions of the bulbs, flowing down the sides thereof in entirely covering relation to the inner surfaces of the bulbs and discharging from the open lower ends of the bulbs around the respective discharge tube nozzle into the registering drainage members 14. The solution passes from the members 14 into the drainage compartment 9 and thence returns through the drainage tube 10 to the compartment 8.

With the present apparatus, in which a comparatively small capacity solution tank 8 is employed, the bulbs are subjected to three successive shots of the solution instead of one continuous shot, inasmuch as the solution is not returned to the tank as rapidly as it is discharged under pressure through the tubes 13, so that the small quantity of solution in the tank would be exhausted before the completion of the single operation. The solution is discharged into the bulbs for a total period of about ten seconds, and it is found that the results are the same if the discharge is single or divided into several shots. By utilizing three shots, each of about two seconds' duration, sufficient time elapses between shots for the return solution to replenish the tank supply to take care of the next shot.

When the application of the acid to the bulbs has thus been completed, the tray of bulbs is moved to the next position D where water is discharged onto the tops of the bulbs from an overhead supply means 15. The water thus discharged passes down around the bulbs in complete enveloping relation thereto and discharges from their lower ends into a drainage tank 16. The trays have their bottoms sufficiently open to permit the free drainage of the water therethrough around the bulbs. The temperature of the water is approximately 63° C. and the discharge is for approximately ten seconds. If the temperature is reduced the time is increased, and vice versa. The applying of the solution to the interior of the bulb and the external hot water treatment could both be effected in one position, except for the drainage water getting into the solution.

After the water treatment at position D, the trays are advanced to position E where hot washing water is discharged into the bulbs through discharge pipes 18 and drained back therefrom through funnel members 19 in substantially the same manner as in handling the solution in position C. The washing water is preferably discharged at a pressure of about fifteen pounds, and the best results are obtained by having the temperature of the water from 50° to 95° C. This same washing operation takes place at two successive stages of advancing movement of the trays along the apparatus, so as to effect a thorough washing of the bulbs and to permit the washing operation to consume approximately twice the time of each of the preceding operations.

After the washing operation, the trays are advanced step by step through a drying oven 20 in which hot air is circulated around the bulbs and in the bottom of which is provided a gas burner or other flame discharging means 21 to apply heat to the lower open ends of the bulbs. As the trays of bulbs advance along the apparatus, they may be subjected to a further drying action by the discharge of hot air thereto from a conduit 22.

It is found that the above method, combined with a frosting solution substantially as above described, produces an inside frosted lamp bulb which is sufficiently strong against impact to permit ordinary commercial handling without breaking, and also that while a lamp bulb frosted by our method will have proper light diffusing qualities its percentage of light absorption is exceptionally low and its lumen output exceptionally high.

All strength tests referred to herein were made on an ordinary type of bump tester such as shown and described in the Pipkin Patent No. 1,687,510, and it is found that inside frosted bulbs which show an impact strength of 7 or more on such tester, when made up into lamps, are sufficiently strong for commercial use.

The following strength readings indicate for each set the average bump tester breakage point for twenty clear bulbs taken at random from regular stock and also for twenty bulbs inside frosted by our method and taken at random, from stock:

First bulb	Clear	Inside frosted	Strength clear bulb 100%
S-14 (10 watt)	87	17	19.5
A-17 (15 watt)	60	12	20
A-19 A5 (25 watt)	42	10	23.8
A-19 H2 (40 watt)	50	11	22
A-21 E4 (50 and 60 watt)	55	12	21.8
A-21 G2 (75 watt)	61	13	21.3
A-23 (100 watt)	47	11	23.4

The average shown for each of the above vertical sets of figures is 57.5 for the clear bulbs; 12.3 for the inside frosted bulbs, and 21.7 for the percentage of strength of inside frosted bulbs to clear bulbs.

If, therefore, the average strength of clear bulbs to reduce breakage by impact is 57.5, and the average minimum commercial strength requirement for inside frosted bulbs is 7, then it is apparent that inside frosted bulbs to resist breakage by impact should have an average strength of 12.15% of that of the clear bulb average.

Lumen output readings for clear bulbs as compared to inside frosted bulbs of the same types and wattages and the percentage of one to the other are as follows:

Bulbs	Clear	Inside frosted	Percentage lumen output clear bulb 100%
A-17 (15 watt)	123.65	122.9	99.50
A-19 A5 (25 watt)	261.00	261.0	100
A-19 H2 (40 watt)	451.70	439.3	97.35
A-21 E4 (50 and 60 watt)	746.70	742.8	99.50
A-23 (100 watt)	1,521.00	1,511.00	99.30

In making the above lumen output tests, twelve bulbs were used in each of the tests and were taken at random from regular stock of the same make of clear and frosted bulbs, respectively, the

frosted bulbs before frosting being as nearly like the clear bulbs as possible to obtain.

The frosted surface produced by our method is of crystalline structure and has sharp angular crests and crevices and is characterized mainly in its difference over ordinary single treatment glass surfaces by the presence of a multiplicity of acicular crystals, as shown in Fig. 3, which is a photomicrograph of such a surface focused on the crests and magnified five hundred times. It is the presence of this acicular form of crystalline structure to which is largely attributed the strength of the inside frosted bulbs, as it is found that when such formation is absent the bulbs in general are too fragile for commercial handling. The frosted surface produced by our method is further characterized and distinguished from the frosted surface produced by the double treatment method described in United States Patent No. 1,687,510 to Pipkin by the absence of rounded crevices, the presence of which in the inside frosted surfaces of lamp bulbs has heretofore been considered necessary to produce the requisite strength in the bulb to prevent breakage under ordinary commercial handling.

Having thus described our invention, what we claim as new, and desire to secure by United States Letters Patent, is:

1. The method of inside frosting thin hollow glassware such as lamp bulbs, which consists in flowing a glass etching solution into and over the interior surface of the ware and controlling the flow of the fluid by the addition of molasses thereto, and then flowing a film of hot water over the exterior of the ware to control the etching action.

2. The method of inside frosting thin hollow glassware such as lamp bulbs, which consists in injecting three successive shots of a glass etching fluid, each for approximately two seconds, against the interior of the ware in a position to flow down over all of the surface to be etched, said solution containing the following ingredients in approximately the proportions named,

Ammonium acid fluoride	33 lbs. 3 oz.
60% Hydrofluoric acid	10 liters
Sodium acid sulphate	11 lbs. 1 oz.
Sodium fluoride	11 lbs. 1 oz.
Molasses	12 liters
Water	6 liters

flowing water at approximately 63° C. over the exterior of the surface for approximately the same length of time that the etching fluid is flowing over the interior of the surface and thereafter washing out the interior of the surface with fluid under a higher pressure than that at which the etching fluid is impinged upon the interior of the ware.

LYLE E. CALKINS.
ORMONDE S. LEVI.