Oct. 16, 1928. 1,687,510

M. PIPKIN

ELECTRIC LAMP BULB

Filed June 29, 1925 2 Sheets-Sheet 1

Fig. 1

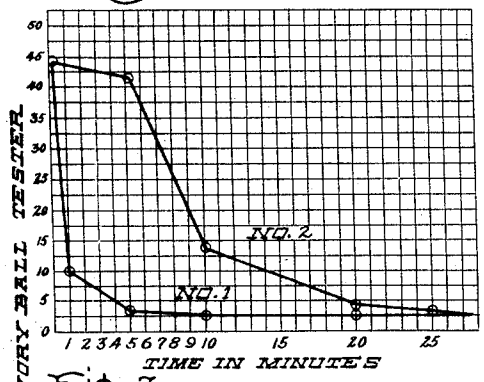

Fig. 2

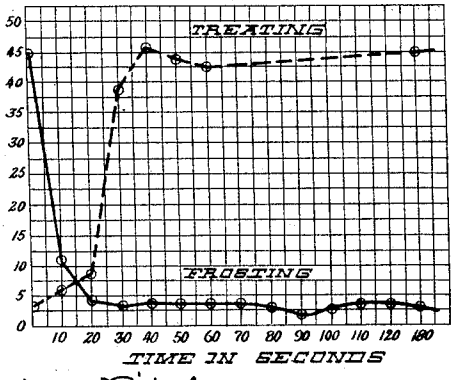

Fig. 3

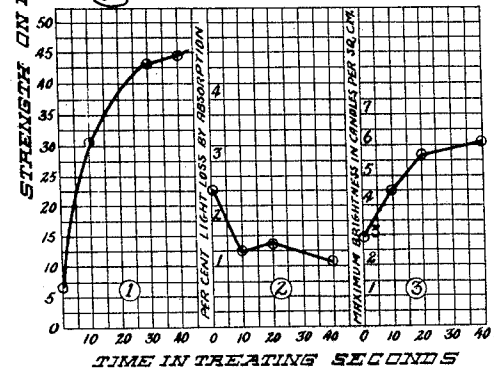

Fig. 4

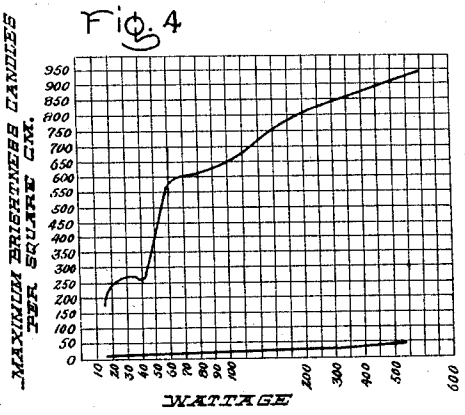

Fig. 6

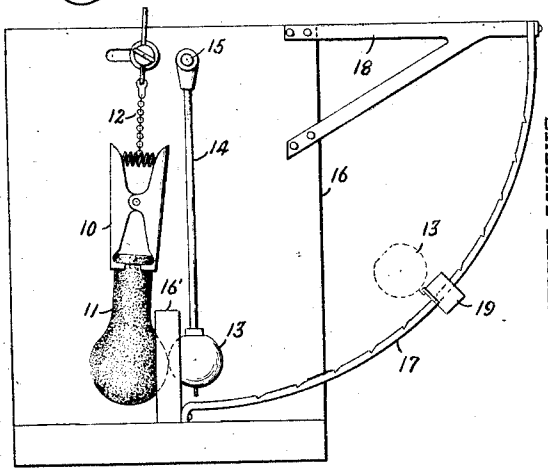

Fig. 5

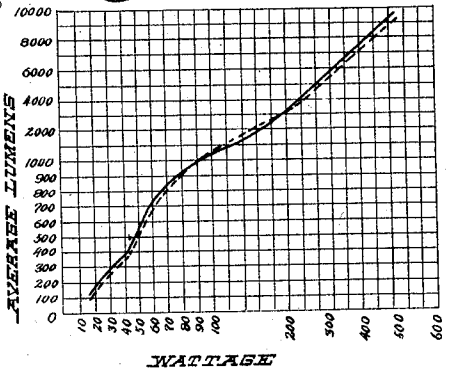

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Fig. 7

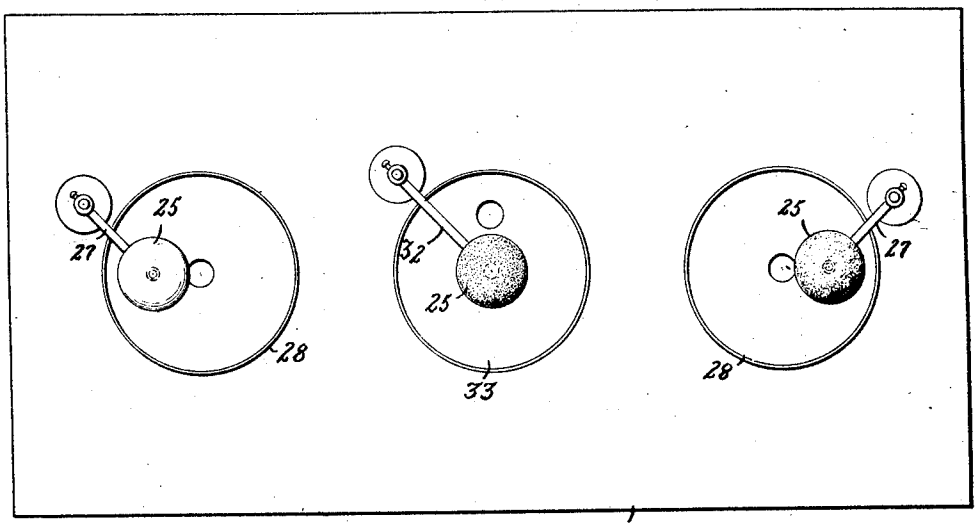
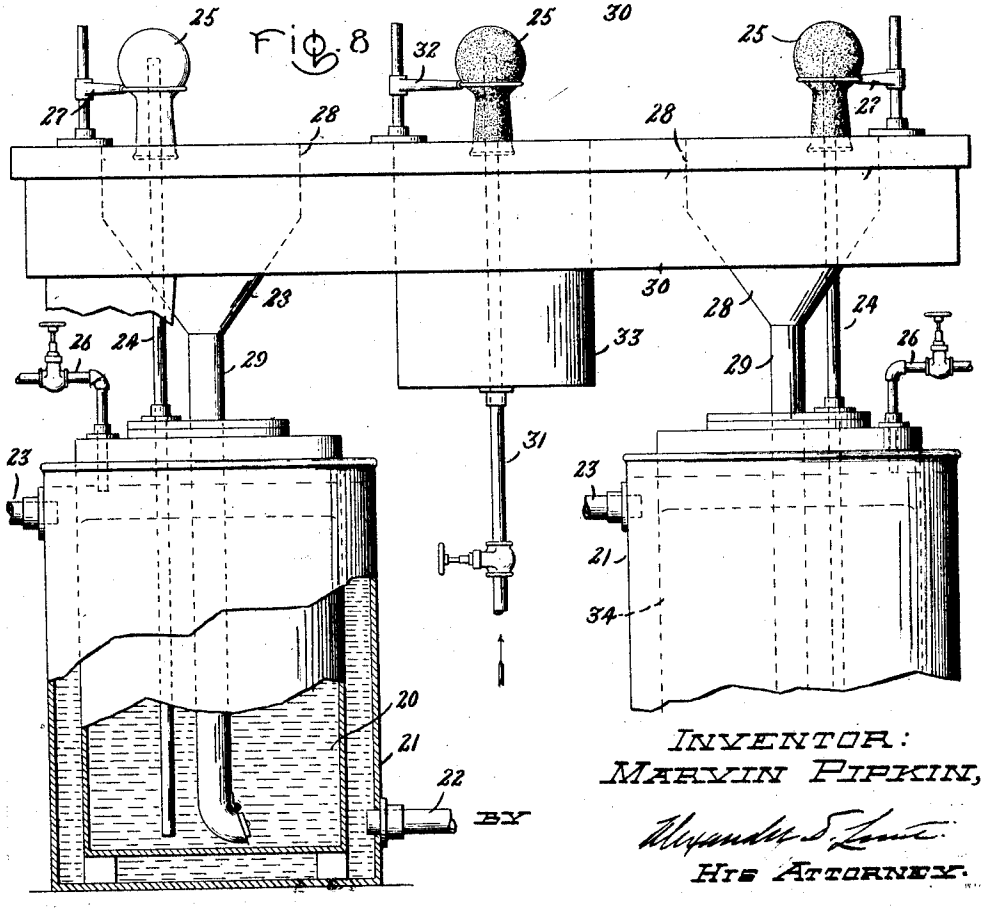


Fig. 8



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Patented Oct. 16, 1928. 1,687,510

UNITED STATES PATENT OFFICE.

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ELECTRIC-LAMP BULB.

Application filed June 29, 1925. Serial No. 40,152

My invention relates to bulbs for electric lamps and more particularly to frosted bulbs for such lamps. This application is a continuation in part of my application Serial No. 690,672, filed February 4, 1924.

An important feature of my invention is an improved method of frosting bulbs and other thin glassware on the inside. Inside frosting has advantages over outside frosting. This is particularly true in the case of illuminating glassware since better diffusion with lower absorption of light is obtained. Another advantage of the inside frosting, which applies generally, is that the outer surface of the article is left smooth and, therefore, does not collect dirt easily and may be easily cleaned. There are other instances where inside frosting is desirable to improve the appearance or to perform other functions in the operation of the device. The preferred method of frosting is by removal of material, that is, by etching, rather than by application of coatings. However, as heretofore produced, bulbs and similarly thin articles thus frosted on the inside have been fragile to such a degree as to occasion prohibitive breakage. Bulbs ordinarily used for incandescent lamps are between 10 and 90 mils in thickness, averaging between 15 and 70 mils, and apparently, the application of the inside frost by etching has weakened them so that they have been very easily broken. The object of my invention is to produce an inside frosted glass bulb which will be much stronger than those heretofore produced.

The prior art makes no distinction between the methods of inside and outside frosting. The frosting on the outside has been accomplished by sand blasting or by the use of a chemical frosting medium. Frosting by etching is to be distinguished from the etching without frosting as the former produces a fine grained rough surface which appears more or less white while such etching without frosting produces a surface which is substantially colorless. The unfrosted etched glass is not sufficiently diffusing for lamp bulbs. The preferred method of frosting is by the use of a chemical medium. For lime glasses the presence of an ammonium compound in addition to the hydrofluoric acid seems to be necessary. The effect is improved by the addition of finely divided inert materials such as barium sulphate. In some cases the presence of sodium salts such as sodium sulphate is of advantage. Dextrin or flour may also be added in order to cause better adherence of the mixture to the glass surface. The degree of frosting depends upon three factors; first, the strength of the frosting mixture as indicated by the percentage of hydrofluoric acid present; second, the temperature of the mixture; and third, the time during which the bulb is exposed to the frosting mixture. Ordinarily the stronger the mixture, the higher the temperature, and up to a certain point, the longer the time, the greater the degree of frosting. When the inside surface of a lamp bulb is subjected to these frosting mixtures to the extent necessary to produce a practical frost, that is, one which will produce the proper light diffusion, the article becomes extremely fragile. I have found, however, that if the bulb is given a further treatment, which I term a strengthening treatment, in which it is subjected to an etching or frosting treatment of lower degree than that to which it was first subjected, it becomes quite strong. Indeed, it may be made practically as strong as the original clear glass bulb. The use of a weaker etching medium for the treating step is preferable to lessening the time or temperature. An etching solution becomes weaker with use and so, good results may be sometimes secured by using, for the strengthening treatment, the used frosting solution.

In the drawing, Fig. 1 is a diagram showing the effect of inside frosting on the strength of a bulb; Fig. 2 is a diagram showing the results of the strengthening treatment comprised by my invention; Fig. 3 is a diagram showing the effect of the strengthening treatment on the strength, the light absorption and the diffusion of the bulb; Fig. 4 is a diagram showing the variation of the various sizes of lamps in maximum brightness; Fig. 5 is a diagram showing the variation in absorption; Fig. 6 is an elevation of a bulb strength tester; Fig. 7 is a plan and Fig. 8 is an elevation partly in section of an apparatus for applying the frosting and strengthening treatments.

In Fig. 1 the ordinates represent the strength of the bulb as determined by the ivory ball tester hereinafter described. The abscissas represent the time in minutes during which the inside of the bulb is subjected

to the frosting mixture. There are two curves. In obtaining curve No. 1, the following frosting mixture was used:

	Per cent.
Ammonium bifluoride	36
Dextrin (powder)	10
Barium sulphate	28
Sodium bi-sulphate	5
Water	21

This mixture contained 11.9% hydrofluoric acid. The temperature was 20° centigrade. For test No. 2 the above mixture was diluted with water and the mixture used was constituted as follows:

	Per cent.
Ammonium bi-fluoride	25
Dextrin	6.9
Barium sulphate	19.32
Sodium bi-sulphate	3.45
Water	45.33

The temperature was 20° centigrade. The frosting mixture contained 8.34% hydrofluoric acid. In test No. 1 and test No. 2 a fresh solution was used in each bulb frosted. In both cases the mixture was poured into dry bulbs and allowed to remain for the time specified. In test No. 1 five sets of bulbs were tested, each set containing five bulbs. The tests were made at zero, one minute, five minutes, ten minutes and twenty minutes. The average showed an initial strength of 44.8; 9.8 after one minute; 2.6 after five minutes; 2.2 at ten minutes and about the same at twenty minutes. The bulbs which were frosted for one minute did not have enough frosting to make them practical for use. In test No. 2 a similar number of bulbs were tested and the average was 44.8 at zero; 42.2 at five minutes; 13.8 at ten minutes; 4.2 at twenty minutes and 2.6 at twenty-five minutes. The bulbs frosted for five minutes were almost like clear bulbs. Those for ten minutes had just a slight haze but were unsuitable for use in lamps.

A bulb having a strength less than 7, which is about 16% that of the clear bulb, would be too fragile for handling commercially. In practice it is aimed to keep the strength above 20 or about 45% that of the clear bulb. It is apparent therefore from the above test results that when the frost was sufficient to produce practical diffusion, the bulb was prohibitively weak.

Fig. 2 shows the effect of the strengthening treatment comprised by my invention. The frosting mixture used had an acidity of 11.8% hydrofluoric acid and the temperature was 50° centigrade. The mixture was sprayed over the inside of the bulb for five seconds, and after five seconds it was sprayed again and this continued for the period of the test. The time is indicated in seconds and represents the time during which the frosting mixture was in contact with the bulb. The clear bulbs were washed out with water at about 45° centigrade just before being sprayed. The curve marked "Frosting" was derived from five sets of bulbs of five bulbs each. The average showed a strength of 44.8 at zero; 11 at 10 seconds; 4.2 at twenty seconds; 3 at thirty seconds, and so on as indicated in the full line curve. The bulbs frosted for ten seconds had only a slight haze and were unsuited for practical use. Those frosted for twenty seconds were not uniform. Those at thirty seconds were better, and from then on the bulbs were suitable.

In Fig. 2 the broken line curve marked "Treating" was derived from the results of tests in which five sets of bulbs of five each were used. The bulbs treated had been frosted and showed an average strength of 3.2 on the ivory ball tester. The mixture used contained 7.44% hydrofluoric acid, 40% barium sulphate and 2% dextrin. The procedure followed was the same as followed in the case of the frosting, i. e. the mixture was sprayed over the interior surface of the bulb. The curve shows that the initial strength was 3.2; that after thirty seconds treatment the strength was 39.6; and that after this time the strength rose to substantially the same as that of the clear bulb. It has been found in practice that thirty seconds under these conditions is a desirable period and the curve shows that during this time the strength increased from 3.2 to 39.6, or 11.37%.

In order to obtain comparative information regarding the effect of exterior and interior frosting, tests were conducted in which a uniform selection of lime glass bulbs was made. These were divided into two portions. One portion was frosted inside and the other on the outside. Of the portion which was frosted on the inside some were given the strengthening treatment and some were not, and the amount of the strengthening treatment was varied. The strength tests were obtained from samples and lamps were made from the remaining bulbs. The lamps were the ordinary tungsten 115 volt, 40 watt lamps of the vacuum type and made according to standard practice. Photometric tests were then made of the lamps so as to determine the maximum brightness in candles per square centimeter which indicates the amount of diffusion. The absorption by the bulb was also determined, the loss in lumens being expressed in percentage. The results showed the average for the clear bulbs to be strength 44.8; absorption 0; and maximum brightness 201.8. Lamps frosted on the outside showed strength 44.8; absorption 5.13; and maximum brightness 5.36. Lamps frosted on the outside for a longer time showed strength 44.8; absorption 3.96; and maximum brightness 5.4. Lamps frosted on the inside but which were not given the strengthening treatment showed strength 6.8; absorption 2.25;

and maximum brightness 3.02. Lamps frosted on the inside and given the strengthening treatment comprised by my invention for ten seconds showed strength 30.4; absorption 1.22; and maximum brightness 4.5. Those treated for twenty seconds showed strength 42; absorption 1.27; and maximum brightness 5.6. Those treated for forty seconds showed strength 44.8; absorption 1.07; and maximum brightness 5.92. These results indicate that the inside frosted lamps have greater diffusion and lower absorption than the outside frosted lamps. They also indicate that by the strengthening treatment the strength is brought up so that the lamp can be practically handled, and that while the maximum brightness is increased, or in other words, the diffusion is reduced, still the absorption is lessened. Moreover, the diffusion is substantially as good as that of the outside frosted lamps.

Fig. 3 is a diagram showing the effect of treating. Curve 1 shows the strength, curve 2, the absorption and curve 3 the maximum brightness. The treating solution had an acidity of 5.2% hydrofluoric acid and the temperature was 55° centigrade. These curves indicate that treating enormously increases the strength of the bulb. It increases the maximum brightness somewhat but not to an objectionable extent and at the same time this is compensated for to a certain extent by the lowering of the absorption. The curve shows that, after a treatment of ten seconds, the strength had been increased from 6.8 to 30.4, while the brightness had been increased from 3 to 4.5, and on the other hand the absorption had been lowered from 2.25 to 1.22.

The tests upon which the curves shown in Fig. 4 are based were made to show the relation between the maximum brightness of the inside frosted bulb lamp and the corresponding clear bulb lamp for the various wattages. The curve shows the following values:

Wattage	Maximum brightness (clear)	Maximum brightness (inside frosted)	Per cent
15	176	2.33	1.3
25	261	4.1	1.6
40	259	5.2	2.0
60	596	9.2	1.55
100	632	12.3	2.0
100 (daylight)	269	6.4	2.4
200	807	19.9	2.6
500	925	39.0	4.2

These tests indicate that for ordinary incandescent lamps, the average maximum brightness for inside frosted lamps, frosted according to my invention, is below 4.5% of that of the clear bulb lamp of the same wattage. Heretofore bulbs inside frosted so that the maximum brightness of the frosted lamp was below fifty per cent of that of the clear bulb lamp had a strength below 16% of that of the clear bulb.

The full line curve in Fig. 5 shows the output in lumens of the clear bulb lamp and the dotted line shows the same for a lamp having a bulb inside frosted by my invention. The small percentage loss in lumens caused by the inside frost will be apparent.

In obtaining the curves of Figs. 1, 2 and 3, the measurement of strength of bulb was made by means of the ivory ball tester shown in Fig. 6. This device consists of a spring clamped holder 10 adapted to receive and hold securely a bulb 11. The holder and bulb are suspended as by means of a chain 12 so as to allow them to swing. The blow is applied by means of an ivory ball 13 which is mounted on a rod 14 pivotally suspended at 15 to the frame 16. The force of the blow delivered by the ivory ball depends upon the length of the arc through which it swings. It strikes the bulb through a circular passage in the block 16′ into which the bulging portion of the bulb extends. A gauge is provided consisting of an arcuate scale 17 suitably graded and supported from the frame 16 by a suitable bracket 18. A slidable marker 19 provides a guide for the starting of the pendulum swing of the ivory ball in each case.

In Figs. 7 and 8 are shown an apparatus which I have devised for the application of the inside frosting and treating. This apparatus comprises a suitable reservoir 20 surrounded by a water jacket 21 having inlet and outlet pipes 22—23. Water may be circulated through the water jacket at a suitable temperature to maintain the frost mixture contained in the reservoir 20 at the desired temperature. The frosting mixture is forced up through the pipe 24 to the bulb 25 by air pressure applied through the pipe 26. A suitable holder 27 is provided which serves to support the bulb. The surplus frosting mixture returns to the reservoir through the funnel 28 and pipe 29. Fresh solution may also be added through the same means. Conveniently mounted on the same frame 30 as the frosting apparatus is the washing means consisting of the water pipe 31 which projects up above the frame so that the bulb 25 may be placed thereover, said bulb being supported in the holder 32. After the bulb has been frosted it is washed by this means and the overflow goes into a reservoir 33. On the same frame is also mounted the apparatus for giving the bulbs the strengthening treatment hereinbefore referred to. This apparatus, as shown, is a duplicate of the apparatus used for the first frosting. As hereinbefore stated, it is preferred to use a weaker solution in the strengthening mixture reservoir 34 from that used in the frosting mixture reservoir 20.

As set forth in my application Serial No. 690,672, filed February 4, 1924, and hereinbefore referred to, the probable explanation of the fact that the bulbs made according to my

invention have a higher strength than those inside frosted by simple application of the frosting treatment which has heretofore been applied to the outside, is that in the latter case the surface of the glass is covered by a multitude of depressions or pits having sharply defined angles while the depressions or pits where my invention is employed are more or less rounded.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A glass electric lamp bulb having its interior surface frosted by etching so that the maximum brightness of an ordinary incandescent lamp comprising such a bulb will be less than twenty-five per cent of that of said lamp with a clear bulb, said interior bulb surface being characterized by the presence of rounded as distinguished from sharp angular crevices to such an extent that the strength to resist breakage by impact is greater than twenty per cent of that of the clear bulb.

2. A glass electric lamp bulb having its interior surface frosted by etching so that the maximum brightness of an ordinary incandescent lamp comprising such a bulb will be less than twenty-five per cent of that of said lamp with a clear bulb, said interior bulb surface being characterized by the presence of rounded as distinguished from sharp angular crevices to such an extent that the strength to resist breakage by impact is greater than forty-five per cent of that of the clear bulb.

In witness whereof, I have hereunto set my hand this 28th day of June, 1925.

MARVIN PIPKIN.