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[54] MIRROR HAVING ELECTRICAL HEATING MEANS

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[51] **Int. Cl.** **H05b 1/00**
[58] **Field of Search** 219/219, 543

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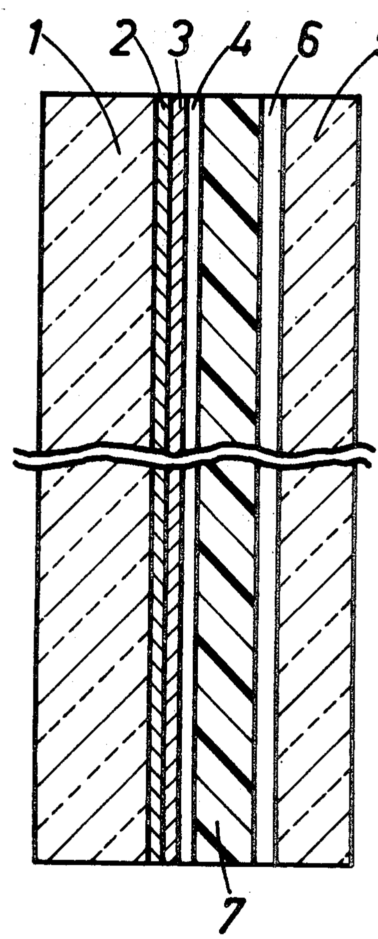
[57] **ABSTRACT**

A mirror comprising a sheet of chemically tempered glass has a light reflecting coating on one face thereof and an electrically conductive heating element positioned either on the other face of the glass or on a face of a second glass sheet. A layer of electrically insulating material is positioned between the heating element and light reflecting coating and this layer may constitute the sheet of glass, a sheet of plastic, or a space having a gaseous medium therein. The heating element is connectable to a source of electricity and generates heat by the Joule effect. The heating element is in heating relationship to the mirror so that this generated heat is transmitted to the mirror.

20 Claims, 10 Drawing Figures



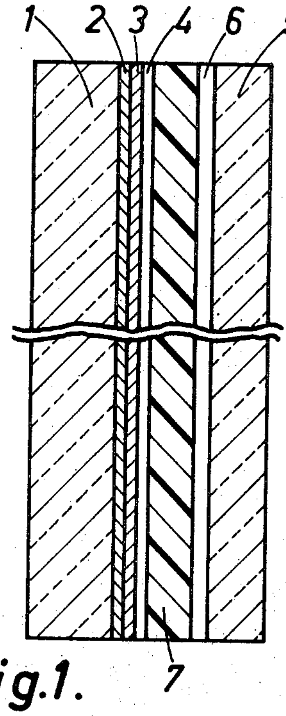


Fig.1.

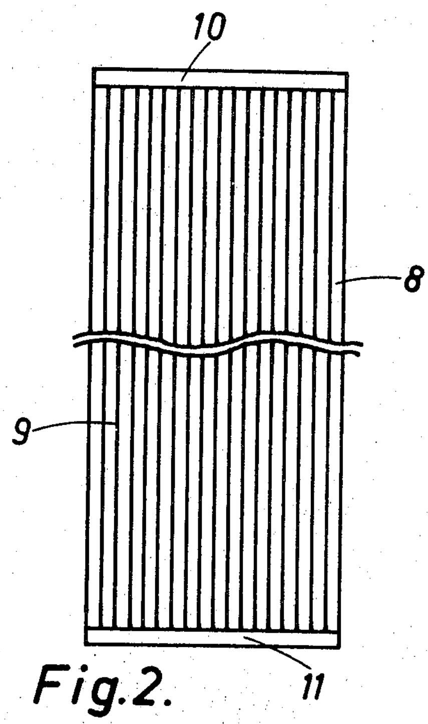


Fig.2.

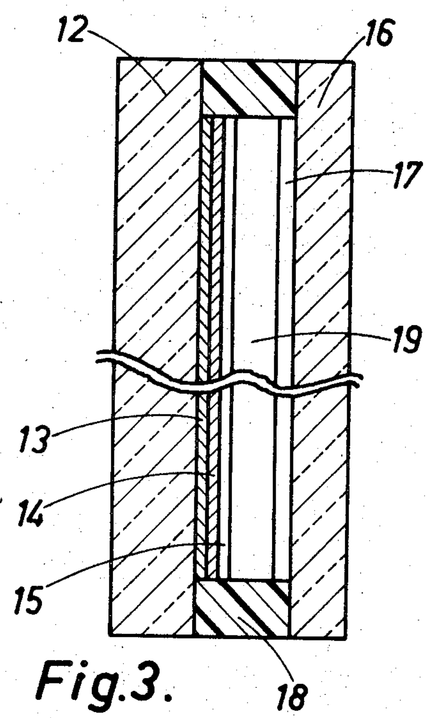


Fig.3.

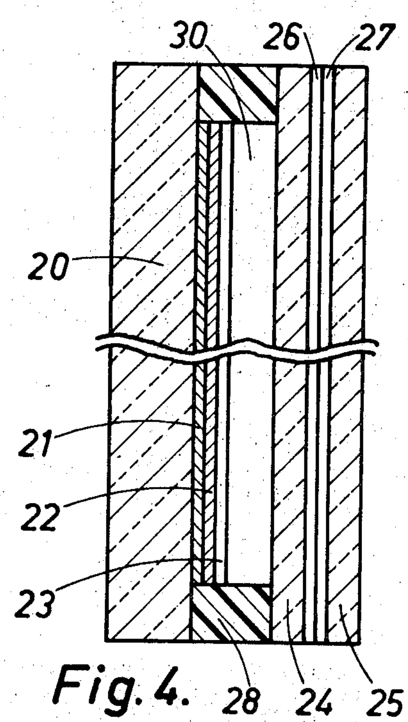


Fig.4.

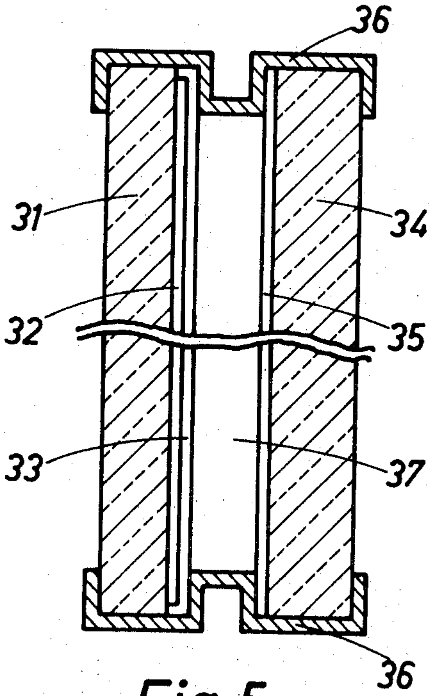


Fig. 5.

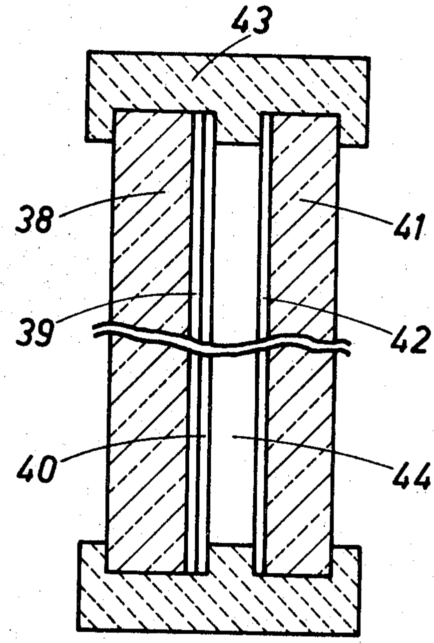


Fig. 6.

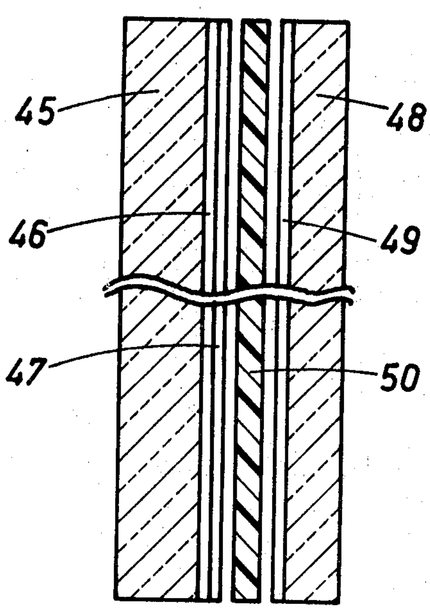


Fig. 7.

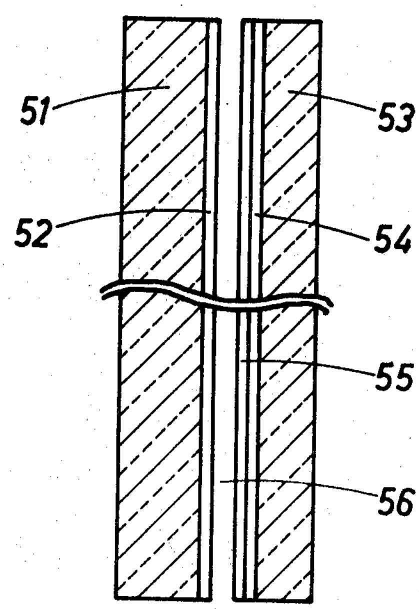


Fig. 8.

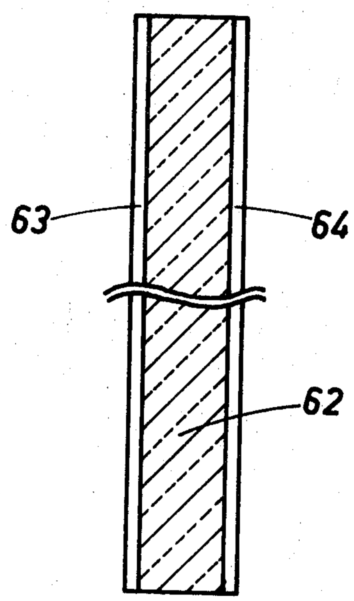


Fig.10.

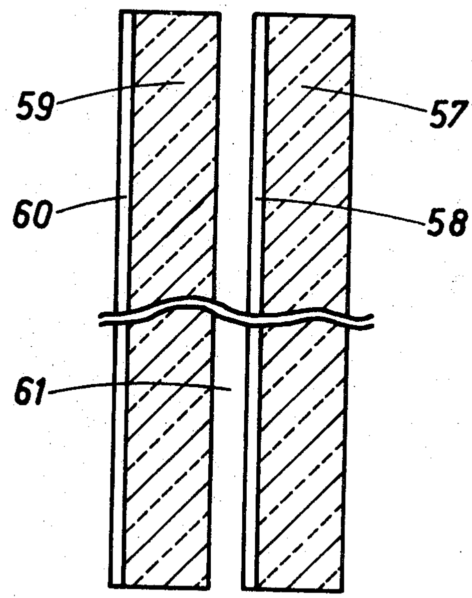


Fig.9.

MIRROR HAVING ELECTRICAL HEATING MEANS

The conventional mirror which comprises a sheet of glass having a silver coating on a face thereof is susceptible to fogging or misting from the moisture condensed from the atmosphere. In order to prevent this fogging of the mirror it has been proposed to pass electric current through the silver coating. It was contemplated to develop heat by the Joule effect in the optical or light reflecting layer so that this heat will be transmitted to the glass sheet by virtue of the intimate contact between the silver coating and the glass. THe conduction of heat from the silver layer to the glass would heat the glass sufficiently to raise the temperature of the surface of the glass above the dew point of the atmosphere in contact with the mirror.

This proposed heating of the mirror had several disadvantages. It was not possible to manufacture the mirror in accordance with high safety standards required for those mirrors which were to be installed in bathrooms where the air humidity is high. Further, the higher the humidity of the atmosphere in which the mirror is to be used, the greater must be the electrical heating current in order to heat sufficiently the mirror to raise its temperature above the dew point of the atmosphere. A further problem was that the requirement for the light reflecting coating to also perform a heating function imposed additional restrictions on the specifications to which this light reflecting coating must be made and applied.

It is therefore the principal object of the present invention to provide a novel and improved mirror having an electrical heating element.

It is another object of the present invention to provide a mirror whose temperature can be safely raised by means of an electrical heating element associated therewith, which is simple in construction and safe in operation.

It is an additional object of the present invention to provide a novel and improved manner of mounting an electrically conductive heating element in heat relationship to a mirror.

The objects of the present invention are achieved and the disadvantages of the prior art as described above are eliminated by the present invention. The present invention essentially discloses a mirror having a support sheet with a light reflecting coating on one side thereof. The mirror is also provided with electrically conductive material constituting a heating element or heating elements which can be connected to a source of electrical energy for generating heat by the Joule effect. THe electrically conductive heating element is electrically insulated from the light reflecting coating completely or partially by at least one intervening layer of electrically insulating material which intervening layer or one of the intervening layers, if there is more than one layer, may be constituted by the support sheet.

The insulating layer may comprise a layer of organic material between the heating element and light reflecting coating or a sheet of organic polymeric material between these coatings. The heating element may be in the form of an electrically conductive coating on the support sheet. This coating may be transparent and thus can be applied to the front face of the mirror in front of the light reflecting coating.

There may also be provided a second sheet upon which is applied the heating element in the form of an electrically conductive material. This second sheet may be spaced from the support sheet and separated therefrom by an air gap, by electrically insulated material or by a sheet of plastic.

The mirrors constructed according to the present invention provide several significant advantages. Since the heating and optical or light reflecting functions are performed by different components of the mirror the thickness and chemical composition of the light reflecting coating can be selected independently of any considerations of the heating function. This represents a significant improvement over known mirrors wherein a high degree of light reflectivity must be provided by a coating or layer which must also function as a resistance heating element. Secondly, an important safety factor is obtained by providing an electrical insulation of the heating element from the sheet of glass coated with the light reflecting layer. It may appear that the electrical insulation of the heating elements from the mirror glass is a disadvantage since this glass is the structure which must be heated. In actual practice, however, the increase in the safety of the mirror more than compensates for any slight additional heating current which may be required because of the presence of the electrical insulation. A further advantage obtained by providing an electrical insulation between the heating element and the light reflecting coating is that it is now possible to construct a mirror in which sufficient heat can be generated so that the mirror can function as a heating source or a space heater.

Various insulating materials can be employed to form at least one insulating layer between the electrical heating element and the light reflecting coating. Materials can also be used which form an insulating layer in the form of a coating.

Other objects and advantages of the present invention will be apparent upon reference to the accompanying description when taken in conjunction with the following drawings, which are exemplary, wherein;

FIG. 1 is a cross-sectional view of an electrically heated mirror incorporating the present invention;

FIG. 2 is a front elevational view of a glass support sheet upon which the electrically conductive material is applied in a plurality of spaced zones;

FIGS. 3 and 4 are cross-sectional views of two modifications of electrically heated mirrors according to this invention;

FIGS. 5 and 6 are cross-sectional views of two further modifications wherein the sheets are in spaced relationship;

FIGS. 7, 8 and 9 are cross-sectional views of additional modifications wherein the mirror comprises a plurality of layers or sheets; and

FIG. 10 is a cross-sectional view of another modification of the invention wherein the mirror comprises a single coated sheet.

Proceeding next to the drawings wherein like reference symbols indicate the same parts throughout the various views a specific embodiment and modifications of the present invention will be described in detail.

The mirror illustrated in FIG. 1 comprises a transparent sheet 1 of chemically tempered float glass having on one face a highly visible light reflecting coating 2 of metallic silver, a coating layer 3 of copper to protect the silver coating, and a coating 4 of protecting paint or varnish. These elements correspond with the components of a conventional mirror.

The mirror of FIG. **1** further comprises a second sheet **5** of chemically tempered glass precoated with a layer **6** of metallic gold to define an electrically conductive element. This layer **6** is connected to a source of electricity by means of electrical conductors or wires, not shown in the drawing, which are soldered to the heating element **6**. These wires may be soldered to opposite edges of the sheet **5** to function as electrical contacts on the completed mirror.

The sheet **5** with its coating **6** is secured to the sheet **1** by an intervening layer **7** of polyvinylbutyral foil which is softened in situ by subjecting the assembly to heat and pressure. The heating element **6** may comprise an all-over coating of electrically conductive material or this element may comprise an electrically conductive coating applied to one or more band-like zones on the surface of sheet **5**.

The heating efficiency of the mirror of FIG. **1** is very high because the resistance heating element **6** is enclosed between glass sheets and the heat generated as a result of electric current flowing through the layer **6** is used predominantly to increase the temperature of the laminate in order to keep the mirror free of condensed moisture. The heating effect is considerably greater than it would be if heat were generated by passing electric current through the silver layer **2** since the layer **2** must be appreciably thicker than the gold layer **6** in order to assure the necessary high degree of light reflection.

According to the present invention it is preferred that the heating element is in the form of an electrically conductive coating on the support sheet. By utilizing the heating element in the form of a coating the assembly of the components of the mirror are facilitated and there is achieved a very good heat distribution over the area of the mirror. The electrically conductive coating can be transparent for certain applications. It is therefore possible for the electrically conductive coating through which the heating current is passed to be positioned on the mirror in front of the light reflecting coating. While this particular arrangement is not preferred it is particularly adaptable for mirrors in which a high degree of safety is not a prime consideration but in which it is desired to provide in front of the light reflecting coating a transparent coating which can impart color by reflecting light in a particular part of the visible spectrum. The chemical composition of the electrically conductive coating or coatings can thus be selected to achieve the required selective light reflection.

Where the electrically conductive coating is positioned behind the light reflecting coating the electrically conductive coating can then be either transparent or opaque.

Instead of the above described electrically conductive coating there may be provided an electrical resistance element in the form of a wire or wires. The wires can project from the margins of the mirror to function as integral contacts connectable to a voltage source. This arrangement of the wires avoids the necessity for terminals to be soldered to the mirror.

The heating element in the form of a conductive coating may extend over at least the greater portion of the area of the mirror. This will enable a uniform heat distribution to be achieved over the entire mirror or at least over the most important portion thereof.

By positioning the silver layer **2** and gold layer **6** between the glass sheets as described above these layers are effectively protected against abrasion and corrosion. Under certain circumstances it may be desirable to apply a further coating onto the gold layer **6** in order to prevent adhesion to the polyvinylbutyrâl foil **7**. Such a layer may comprise Bi_2O_3.

In another embodiment (No. **2**) of the mirror shown in FIG. **1** sheets **1** and **5** were of ordinary soda-lime glass of the following composition by weight: 72% SiO_2, 12.5% Na_2O, 0.09% K_2O, 9.4% CaO, 3% MgO, 3% Al_2O_3, 0.01% Fe_2O_3. The sheets were 3 mm. in thickness and each measured 62.5 cm × 45 cm.

The sheet **1** was coated with a layer of silver **2**, a protective layer of copper **3** and a layer **4** of paint or varnish to protect the silver layer. The layers **2**, **3** and **4** were of the conventional thicknesses used in the manufacture of mirrors and known in the art.

On sheet **5** there was applied a coating **6** of bismuth oxide, a layer of gold and a further layer of bismuth oxide. The optical thicknesses of the first and second bismuth oxide layers were 50 and 150 A, whereas the gold layer had an optical thickness of 100 A.

The intervening sheet **7** comprised a sheet of polyvinylbutyral 0.4 mm. in thickness.

The gold layer was connected to a source of electrical current having a potential of 30 volts. The power consumption of the mirror was 65 watts which was sufficient to keep the mirror free from misting under the high humidity conditions such as would by encountered in a bathroom. The connection from the gold layer to the source of electric current was made by conductor wires which were electrically connected to the gold layer at the opposed shorter sides of the mirror by electrodes formed by band-like deposits of copper applied by flame-spraying. The width of the electrodes was about 5 mm.

The electrical power which is supplied to the electrical heating element depends upon the utilisation of the article. In general, a power of 250 watts/m^2 suffices to maintain the temperature of the mirror sufficiently high to prevent misting. A higher electrical power, e.g. of the order of 1,000 Watts/m^2, will normally be appropriate in the case that the mirror has also to serve as a heating panel, i.e. as a space heater.

In a modification of the above described Embodiment No. 2 constructed as shown in FIG. **2**, the gold layer was replaced by a heating element consisting of an electrically conductive coating applied along seven spaced parallel bands or strips on the sheet **5** and along marginal end zones to form electrodes which were connected to a source of electric current at 220 volts. With this heating element the voltage of the electric current source was increased even though the optical thickness of the electrically conductive coating forming the heating element remained the same, namely, 100 A. As a result, the temperature of the mirror was maintained considerably higher than when an all-over gold layer was used as the heating element.

In an embodiment (No. **3**) of a mirror constructed as shown in FIG. **2** an electrically conductive coating was applied on the surface of an ordinary glass sheet **8** measuring 102 cm × 78 cm to form seventeen spaced parallel conductive threads or bands joined by marginal end electrodes **10**. Each of these strips **9** was one meter in length and 0.6–0.7 mm. in width with the thickness of each strip being 10 to 15 microns. The strips were spaced a distance of 43 mm. apart. The conductive strips **9** were formed of an aluminum alloy comprising 95 percent by weight of aluminum and 5 percent by weight of antimony. The strips were formed by abrasion transfer wherein a rotating disc composed of the alloy was guided along the surface of the glass sheet **8** in frictional contact therewith.

The electrodes **10** and **11** were formed by flame-spraying copper onto the surface of the glass sheet. The electrodes were connected to an 8 volt source of electrical current. The power consumption of the mirror was 240 watts which was sufficient to maintain the mirror free from misting in conditions of high atmospheric humidity.

In another embodiment (No. **4**) of the invention similar to Embodiment No. **2** the heating element comprised a layer of SnO_2. This layer was deposited chemically on a glass sheet **5** measuring 45 cm × 60 cm and the layer had a thickness of 1,000 A. The layer was connected to a source of electrical current at 220 volts at which the power consumption of the mirror was about 70 watts.

In accordance with the teaching of this invention the mirror disclosed herein can also function as a space heater in the room in which it is installed, usually a bathroom. In a further embodiment (No. **5**) such a mirror has the general construction of the mirror shown in FIG. **1** and comprises a glas sheet **5** of thermally tempered glass having a thickness of 5 mm. The sheet **1** was a sheet of ordinary soda glass manufactured by the float process in which the molten glass was applied on the surface of a bath of molten tin. The thickness of sheet **1** was 6.35 mm. The sheet was subjected to a chemical tempering treatment which involved immersing the sheet in a bath of molten potassium nitrate at a temperature of 470°C. During the period of immersion, sodium ions contained in surface layers of the sheet were replaced by potassium ions deriving from the bath of molten potassium nitrate. Since the potassium ions were of a greater diameter than the sodium ions which they replaced, the ion exchange set up compressive surface stresses in the glass sheet while the internal layers of the glass were in tension. The planeity of the faces of the sheet was excellent.

The heating element **6** was formed by depositing on the sheet **5** a layer of bismuth oxide (Bi_2O_3), layer of gold, and then a further layer of bismuth oxide. These three layers had optical thicknesses of 50 A, 100 A and 150 A respectively. These layers were applied onto an area of the sheet **5** measuring 60 cm × 45 cm. Copper electrodes were deposited in contact with the gold layer at the extremities of the shorter side of the coated area.

The use of tempered glass sheets enabled a higher electrical power input to be used than was possible with the mirrors of the preceding embodiment (No. **4**). The electrodes were connected to a source of electrical current at 70 watts under which conditions the power consumption was 1,400 watts/m² and the mirror was maintained at a sufficiently high temperature to serve as an effective space heater.

In a further modification the heating layer comprised layers of gold applied along three bands running parallel with the longer dimension of the sheet and along transverse zones electrically connecting the three bands in series. With this heating element it was possible to use an input voltage of 220 volts.

Still another embodiment (No. **6**) of an electrically heated mirror, serving also as a space heater, was made in the general form illustrated in FIG. **1**. The sheet **1** was a sheet of soda-lime glass of ordinary composition (as described in Embodiment No. **2**) 3 mm. in thickness. On this sheet **1** a light reflecting layer of silver was deposited and this layer was protected by a copper layer **3** and a paint layer **4**. The thicknesses of the layers **2**, **3** and **4** were 100 mμ 200 mμ and 0.3 mm.

The heating panel component comprised a sheet **5** of thermally tempered glass 4 mm. in thickness, on which electrically conductive strips **9** (FIG. **2**) composed of an aluminium alloy, the number and dimensions and spacing of the threads, and the composition of the aluminium alloy being as specified in Embodiment No. **3**, were formed by abrasion transfer. The threads were connected in parallel by end electrodes **10**, **11** (FIG. **2**) formed by deposited copper, also as specified in above.

The mirror and heating panel components were secured together as a laminate by means of an interposed sheet **7** of polyvinylbutyral 0.38 mm. in thickness.

Bonding these sheets of coated glass by a sheet of plastic material is advantageous since it provides a high resistance to damage of the coatings and a secure bonding of the coated sheets by means of the intervening plastics sheet. The components of the mirror can be readily united under heat and pressure to cause the plastic sheet to serve as a bonding medium with or without the interposition of additional adhesive.

The mirror was connected to a source of electric current at 10 Volts, under which conditions the power consumption was of the order of 700 Watts which was sufficient for heating a room of small dimensions.

A still further embodiment (No. **7**) of an electrically heated mirror of the form shown in FIG. **1** was made in the manner described in Embodiment No. **5** with however the modification that the sheet **5** was replaced by a sheet of thermally tempered glass and the heating element was composed of a layer of SnO_2, 200 A in optical thickness. The mirror was connected to a source of electric current at 220 Volts under which conditions the power consumption was 1,400 Watts/m².

Another embodiment (No. **8**) of an electrically heated mirror of the form shown in FIG. **3** was made, incorporating a mirror component, comprising the sheet **12** and the coating **13**, **14** and **15**, which was of conventional construction e.g. as described in Embodiment No. **2**. As indicated in FIG. **3** the coatings did not extend to the margins of the sheet **12**. The heating component comprised a layer **17** of In_2O_3 deposited on a sheet of glass **16** of ordinary composition. A peripheral marginal zone of the sheet **16** was left uncoated. The mirror and heating panel components were secured to an intervening peripheral spacer **18** made of silicone which was glued to the uncoated margins of the sheets **12** and **16**, and forms an endless joint between them to seal the interior space **19**.

The dimensions of the mirror were 62 cm × 45 cm. The layer **17** of In_2O_3 was formed by chemical deposition in situ and had an optical thickness of about 800 A.

The heating element was connected to a source of electric current at 200 Volts under which conditions the power consumption was of the order of 250 Watts/m².

Another embodiment (No. **9**) of an electrically heated mirror was made which was similar to that described in Embodiment No. **8** but wherein the heating element was constituted by strips of copper applied along spaced parallel bands, and along transverse connecting zones, so that the heating element was of the kind shown in FIG. **2.** In use, the electric current flows through strips **9** in parallel. An electrically conductive coating or coatings on spaced parallel zones is favourable for achieving a relatively high density of the heating current for a given applied voltage. In cases in which the electrically conductive coating or coatings is or are present in front of the light reflecting coating responsible for the mirror effect, the degree of light transparency of the electrically conductive coating or coatings is not so critical in the case that the coating or coatings is or are on spaced zones of the substrate.

There were ten parallel copper strips, equally spaced across the width of the sheet **16** and having a length of 58 cm, a width of 0.5 cm and a thickness of 0.01 mm. The copper strips were glued onto the surface of the sheet **16** by means of a layer of polyvinylbutyral 0.4 mm. in thickness.

The heating element was connected to a source of electric current at 1.2 Volts, under which conditions the power consumption was 75 Watts which was sufficient to keep the mirror free from misting in an atmosphere of high relative humidity.

In certain embodiments of the invention the heating element is located between the support sheet and a second sheet. By sandwiching the heating element between component sheets of the mirror, electrical energy saving is promoted due to a reduction in the amount of heat which is dissipated without heating the mirror. The shielding of the heating element is also beneficial from the point of view of safety and for protecting the heating element from damage.

In Embodiment No. **10,** a mirror having the general form shown in FIG. **4** was made, using for the mirror component a sheet **20** of thermally tempered glass, 6 mm. in thickness, having a layer **21** of silver, a layer **22** of copper and a layer of paint **23** of conventional thicknesses.

The heating panel component is of laminated structure and comprised sheets **24** and **25** of ordinary glass, 2.5 mm. and 3 mm. in thickness, respectively, the sheets having been subjected to a chemical tempering treatment of the kind described in Embodiment No. **5.** The sheet **24** was coated on one side with a layer **26** of copper, 100 mμ thickness, by evaporation *in vacuo*. The coated sheet **24** was united with the sheet **25** by a sheet **27** of polyvinylbutyral 0.3 mm. in thickness, to form a laminate. Constructing of the mirror as a laminate is advantageous because the all-over bonding of the several layers renders the mirror resistant to any penetration of air or moisture between the layers, and these layers are securely held in their proper relationship during all normal handling in the course of transportation or otherwise.

The heating panel component thus formed was joined to the mirror component by a spacer comprising a peripheral layer **28** of a silicone, 2 mm. in thickness to seal the interior space **30.**

The use of a bonding medium between the margins of the coated sheets significantly facilitates the assembly of the components of the mirror.

Another embodiment (No. **11**) of an electrically heated mirror of the form shown in FIG. **4** was made in the same way as the mirror described in Embodiment No. **10** with, however, the modification that the heating element **26** was constituted by a layer of polyvinylbutyral covered by a thin film or pellicule of graphite. Electrically conductive contacts or electrodes were connected to the graphite coating before laminating the coated sheet **24** with the sheet **25** by means of the polyvinylbutyral sheet **27.** THe electrodes were connected to a source of electric current at a voltage sufficient to keep the temperature of the mirror sufficiently high to prevent condensation of moisture on the face of the mirror when it was installed in conditions of high relative humidity.

Another embodiment (No. **12**) concerns a mirror of the form shown in FIG. **5** and adapted to serve as a heating radiator.

The mirror comprised two sheets **31** and **34** of ordinary tempered glass measuring 60 cm × 45 cm.

The sheet **31** was chemically tempered using a technique similar to that described in Embodiment No. **5,** and the sheet **34** was thermally tempered.

The chemically tempered glass sheet **31** was coated with a layer **32** of silver 100 mμ in thickness, the peripheral margin of the sheet **31** being, however, left uncoated. The silver layer was covered by a chromium oxide layer **33,** 200 mμ in thickness which was applied by means of a conventional low frequency cathodic sputtering in vacuo, as well known *per se*. The chromium oxide layer completely covered the silver layer and extended onto the marginal zone of the sheet **31** so as to ensure that the silver layer was effectively protected from chemical corrosion and was effectively electrically insulated.

The thermally tempered glass sheet **34** was coated with a layer **35** of tin oxide (SnO_2), serving as heating element. The tin oxide layer was built up by successive chemical depositions of tin oxide to achieve a total layer thickness sufficient to obtain a power distribution of 275 Watts/m^2 under a voltage input of 220 Volts. It was found that it was suitable for the tin oxide layer to have a thickness of 850 A for this purpose.

In a modification, a layer of In_2O_3, of the same thickness, was used in place of the layer of tin oxide.

The sheets **31** and **34,** coated as above described, were held in spaced relation by two frame members **36** made of copper and having tinned inner faces, the said frame members being fitted along opposed margins of the sheets **31** and **34.** The tinned inner faces of the frame members **36** made contact with the tin oxide coating **35** constituting the heating element. The frame members **36** were connected to the opposed poles of a source of electric current to serve as electrodes. For safety reasons, the frame members **36** were covered on the outside by electrically insulating members or material (not shown). The frame members also protect the edges of the sheets.

Because of the presence of the electrically insulating layer **33,** the frame members **36** were insulated from the silver layer **32** so that when the unit was in use no electric current passed through the silver layer.

When the unit is installed so that the frame members **36** are vertical the heat generated in the unit maintains a convection current of air through the space **37** between the coated sheets.

In a modification, the margins of the coated sheets **31** and **34** were held in a frame which comprised, in addition to the frame members **36,** two further frame members which extended along the other opposed margins of the sheets. The coated sheets were thus held in a complete rectangular frame. In this case it was necessary to ensure that the additional frame members were electrically insulating or were electrically insulated from the members **36** in order not to short-circuit the electrical system. In such a modification, it is possible to provide one or more holes in each of two opposed frame members, e.g. in the frame members **36**, in order to ensure equalisation of pressure between the interior space **37** and the surrounding atmosphere.

A mirror substantially the same as that described in Embodiment No. **12** was made, with however the difference that the heating element **35** was constituted by spaced electrically conductive bands to provide a better distribution of the electrical heating current. The electrically conductive bands were also composed of SnO_2 formed by chemical deposition in situ. The bands had a length of 73 cm and a width of 1 cm, and were spaced apart by 0.5 cm. The thickness of the deposited bands resulted in a power consumption of 375 Watts under an alternating applied voltage of 220 Volts.

Another embodiment (No. **14**) comprised a mirror of the general form shown in FIG. **6.** This mirror employed sheets **38** and **41** of ordinary glass, 3 mm. in thickness, which had been subjected to a chemical tempering treatment of the kind described in Embodiment No. **5.**

The sheets **38** and **41** were coated, sheet **38** with a gold layer **39**, 150 A in thickness and with an electrically insulating layer **40** composed of SiO_2, 150 A in thickness, and the sheet **41** with an electrically conductive layer **42** of silver.

The coated sheets **38** and **41** were held in spaced relation by a frame comprising two opposed members **43** made of a refractory material, and two brass components (not shown) serving as electrodes in contact with the electrically conductive layer **39.** The brass components are formed so that they did not make contact with the silver layer **42.**

The mirror and heating panel components and the frame members were assembled so that, in the finished product, the interior space **44** was hermetically sealed. Prior to being sealed, this space was filled with a dehydrated gas at a reduced pressure. Under these circumstances the silver layer **42** was not subject to oxidation. When such unit is heated, the temperature of the gas in the space **44** rises and the gas consequently expands. The pressure in the space **44** when the unit is in unheated condition is such that the sheets **38** and **41** are brought into substantially flat condition by the higher pressure which prevails in the space **44** when the unit is heated. The appropriate pressure can be determined experimentally, the voltage applied to the heating element being carefully and very gradually increased towards the required operative value in successive tests.

In a modification, sheets **38** and **41** were of different thicknesses. The sheet **41** which bore the silver layer was of substantially greater thickness, e.g. 8 mm., and the sheet **38** was a thinner sheet, e.g. 2 mm. in thickness. In this modification, the sheet **41** remained flat at all times, whereas the sheet **38**, which is hidden from view behind the mirror when the unit is in use, flexes so as to preserve a pressure substantially equal to atmospheric pressure in the space **44.**

Another embodiment (No. **15**) related to a mirror having substantially the structure shown in FIG. **7.** The mirror comprised a sheet of ordinary glass **45**, bearing a silver layer **46** and a protective silicone layer **47**, and a sheet **48** of ordinary glass bearing a heating element **49** composed of a layer of polyvinylbutyral impregnated with graphite, and a sheet of "Mylar" 50 to protect the graphite conductive layer.

The coated sheets **45** and **48** and the "Mylar" sheet **50**, which are shown spaced apart in the drawing in the interest of clarity, were held together by pieces of adhesive tape which were bound around or applied across margins of the sheet assembly.

A further embodiment (No. **16**) of a mirror was made from components which are shown in FIG. **8.** These components include a heating panel component comprising a sheet **53** of thermally tempered glass of ordinary composition, bearing a silver laYer **54**, and a protective thermally insulating top layer **55** made of "Teflon." The second component is the mirror component which comprises a sheet **51**, which is also a sheet of thermally tempered ordinary glass and which bears a conductive layer of aluminium **52.** Electrodes (not shown) are connected to opposed margins of this layer.

This protective coating **55** constitutes an electrically insulating layer between the conductive coating **54** and the light reflecting coating **52** when the different components are brought together in face-to-face contact or when the components are connected in spaced relationship, in which latter case the space **56** between the coated sheets may be very much narrower than that shown in the drawing. The coated sheets **51, 53** may for example be held together by adhesive material applied between the margins of the coated sheets.

The two coated sheets, which are shown spaced apart in the interest of clarity, were held together in face-to-face contact by steel clamping members of U-section which were fitted over margins of the assembled sheets.

Another embodiment (No. **17**) relates to a mirror having components as shown in FIG. **9.** The mirror comprises sheets of ordinary glass **57** and **59.** The sheet **57** bears a light reflecting layer **58** of silver, and the sheet **59** bears an electrically conductive layer **60** composed of tin oxide (SnO_2) to which electrodes (not shown) are connected. The coated sheets were clamped together by a suitable adhesive so that the silver layer **58** was directly contacted by the uncoated face of the glass sheet **59.** The sheets can also be clamped in spaced relation to leave a space **61** therebetween.

As an illustration of specific possible modifications of the mirror described with reference to FIG. **9**, it can be modified in any one or more of the following ways:

a. by interposing a plastics sheet between the sheets **57** and **59**;

b. by uniting the sheets in the alternative relationship i.e. so that the glass sheet **57** contacts the layer **60**;

c. by covering the layer **60** by a protective sheet of plastics material;

d. by adopting features *a* and *c* in combination.

Positioning the heating element on the side of the second sheet away from the support sheet is advantageous, particularly in mirrors which do not have to comply with high safety standards and in which it is desirable for an appreciable amount of generated heat to be radiated from the mirror to enable the mirror to serve as a space heater. When the heating element is on the outer face of the second sheet a protective layer may cover the heating element, particularly in those cases where the heating element is constituted by a coating of electrically conductive material.

A further embodiment (No. **18**) of a mirror in accordance with FIG. **10** was made by applying to one face of a sheet **62** of thermally tempered ordinary glass, a light reflective silver layer **63** and by applying to the other face of the said glass sheet a transparent electrically conductive layer **64** of gold.

This mirror had a golden hue, viewed by reflected light.

The mirror described with reference to FIG. **10** can, for example, be modified by:

a. covering the layer **63** and/or the layer **64** by a protective sheet of plastics material;

b. covering the layer **63** and/or the layer **64** by a sheet of transparent glass.

Various insulating materials can be used for forming at least one insulating layer between the electrical heating element or elements and the light reflecting coating. Examples of insulating materials which are useful in various cases are: TiO_2, ZrO_2, Cr_2O_3, and Fe_2O_3. These materials can be used to form an insulating layer in the form of a coating.

In the most preferred embodiments of the invention the mirror includes, in addition to said support sheet, a second sheet which bears a coating or coatings constituting said heating element or elements.

Such a construction feature affords important advantages. In particular, the mirror components can very easily be assembled because what is involved in this operation is the bringing together of two pre-coated sheets and the preparation of the sheets is relatively simple because they can be independently processed in ways which are most suited to the particular coating compositions employed.

The invention includes mirrors in which there is the support sheet and a second sheet bearing an electrically conductive coating, and in which both sheets are substantially rigid. The assembly of the component sheets is easier when the main components are rigid sheets than when one or each of them is flimsy. In preferred embodiments of the invention, each of said support sheet and said second sheet is a sheet of glass. The use of glass for both sheets is particularly desirable because glass is a very satisfactory substrate material for bearing the electrically conductive coating as well as the light reflecting coating and because mirror production usually proceeds in a flat-glass production factory.

The heating element is constituted by an electrically conductive coating or coatings selected from: Au, Cu, Ag, Al, Cr, SnO_2, In_2O_3 and graphite. For the support sheet and the second sheet preferance is given to the use of glass sheets but sheets of other material can be used. Examples of suitable sheets are ceramic sheets, sheets of vitrocrystalline or vitroceramic material and sheets of plastics, a sheet of wired glass, also sheets comprising a combination of two or more of such materials, with the proviso that sheets which are not transparent cannot be used in front of the light reflecting coating. The plastic material should be capable of withstanding the temperature to which it is raised by the heat generated in the heating element.

The use of sheets of thermally or chemically tempered glass is preferred because tempered glass can have a very high tensile strength and its use is therefore an advantage for the strength of the article. Chemically tempered glass is especially recommended because of its ability to withstand substantial strains imposed by substantial temperature variations.

Various methods may be employed in constructing a mirror according to the invention, for coating the support sheet and the said second sheet. By way of example, a light reflecting layer composed of gold, copper, silver or aluminium can be formed by evaporation *in vacuo*. High frequency sputtering can be used for applying a coating of gold, copper, silver or aluminium whereas a low frequency sputtering technique may be used for deposition layers of gold, silver, copper, bismuth oxide, chromium oxide and cadmium oxide. Layers of SnO_2 and In_2O_3 and various other coating substances can be applied by chemical deposition.

In order to improve the adhesion of a given coating substance to a substrate, the latter may be precoated with a snubbing or attaching layer. For example, a sheet of glass which is to serve as a support sheet can be coated with chromium preparatory to the application of a gold coating so as to improve the gripping of the gold layer.

Various materials suitable for forming a solid insulating layer have already been referred to in the course of the foregoing description. Other insulating materials which can be used include TiO_2, AnO_2, Sr_2O_3, CoO and Fe_2O_3.

The front face of a mirror according to the invention may bear an optical coating, e.g. an anti-reflecting coating, preventing or restricting reflection of light from the front face of the mirror.

The use of chemically tempered float glass is advantageous since such a glass sheet has a precisely flat surface for receiving the light reflecting coating which is desirable for mirrors of high optical quality.

It is understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within the invention as may fall within the scope of the appended claims.

What is claimed is:

1. A mirror comprising a support sheet of glass, a light reflecting coating on a face of said support sheet, a second sheet of glass, an electrically conductive heating element disposed on said second glass sheet in heating relationship to said support sheet, means for connecting said heating element to a source of electricity so that heat is generated by the Joule effect in said heating element, there being a layer of electrically insulating material between said light reflecting coating and said electrically conductive heating element.

2. A mirror as claimed in claim **1** wherein said layer of electrically insulating material comprises an organic material.

3. A mirror as claimed in claim **1** wherein said layer of electrically insulating material comprises a sheet of organic polymeric material.

4. A mirror as claimed in claim **3** wherein said polymeric material comprises polyvinylbutyral.

5. A mirror as claimed in claim **1** wherein said support and said second sheet are substantially rigid.

6. A mirror as claimed in claim **1** wherein said electrically conductive heating element is positioned between said support sheet and said second sheet.

7. A mirror as claimed in claim **1** wherein said electrically conductive heating element is on the face of said second sheet away from said support sheet.

8. A mirror as claimed in claim **7** and comprising a protective layer over said heating element.

9. A mirror as claimed in claim **8** wherein said protective layer comprises a coating of at least one of SiO_2 and a sheet of a polymeric material including polyvinylbutyral.

10. A mirror as claimed in claim **1** wherein said light reflecting coating is between said support sheet and said heating element.

11. A mirror as claimed in claim **10** and comprising an opaque layer between said light reflecting coating and said heating element.

12. A mirror as claimed in claim **1** wherein said support sheet and the light reflecting coating are laminated.

13. A mirror as claimed in claim **1** wherein said support sheet and said second sheet with their respective light reflecting coating and heating element being spaced, and a gaseous medium in the space between said sheets.

14. A mirror as claimed in claim **13** and comprising means permanently securing said support sheet and said second sheet together along their edges.

15. A mirror as claimed in claim **14** wherein said securing means comprises a bonding medium between said sheets at the edges thereof.

16. A mirror as claimed in claim **13** wherein said securing means comprises a frame within which the edges of said sheets are received.

17. A mirror as claimed in claim **1** and comprising removeable means around the edtes of said support sheet and said second sheet for binding said sheets together in face-to-face relationship whereby said sheets can be readily separated.

18. A mirror as claimed in claim **1** wherein said support sheet comprises a sheet of tempered glass having the light reflecting coating on one face thereof, a protective coating overlying said light reflecting coating, a second sheet of glass with said layer of electrically conductive heating element being on a face thereof, and a sheet of plastic material uniting said support sheet and said second sheet between said heating element layer and said protective coating.

19. A mirror as claimed in claim **1** wherein said support is of chemically tempered float glass.

20. A mirror as claimed in claim **1** wherein said electrically conductive heating element comprises a coating of one selected from the group of gold, copper, silver, aluminum, chromium, SnO_2, In_2O_3 and graphite.

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