United States Patent [19]

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[54] **COPYING MACHINE**

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[52] **U.S. Cl.** **355/78,** 355/113

[51] **Int. Cl.** **G03b 27/04**

[58] **Field of Search** 355/99, 100, 106, 355/107, 113, 78, 119, 11, 67, 70

[56] **References Cited**

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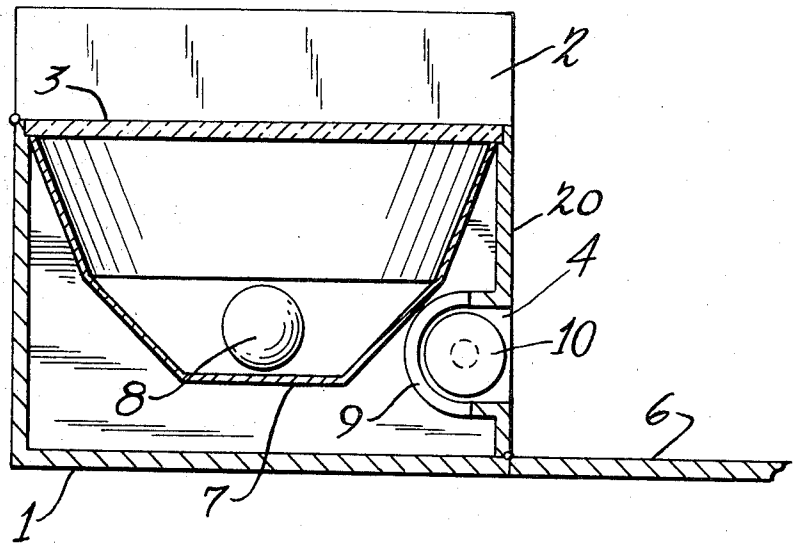
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Assistant Examiner—Alan Mathews
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[57] **ABSTRACT**

A copying machine has a flat translucent exposure surface to receive an original in pressure contact with an intermediate sheet, for exposure, a double angled light reflector disposed below the exposure surface, a pair of bulbs projecting through opposite side walls of the reflector and a low-mass, low-wattage heater for heating the intermediate sheet in pressure contact with a copy sheet arranged in a recess near a side wall of the reflector.

10 Claims, 12 Drawing Figures



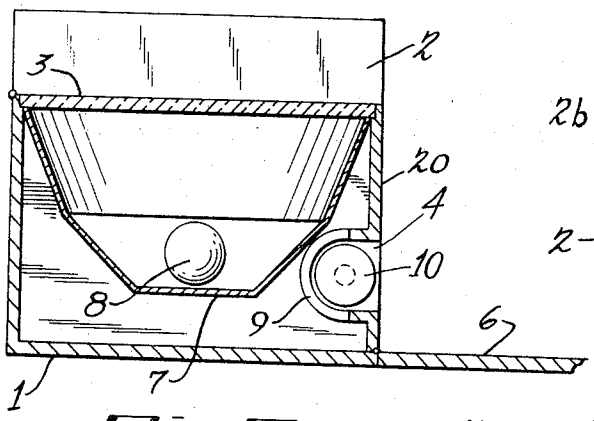


Fig 3

Fig 1

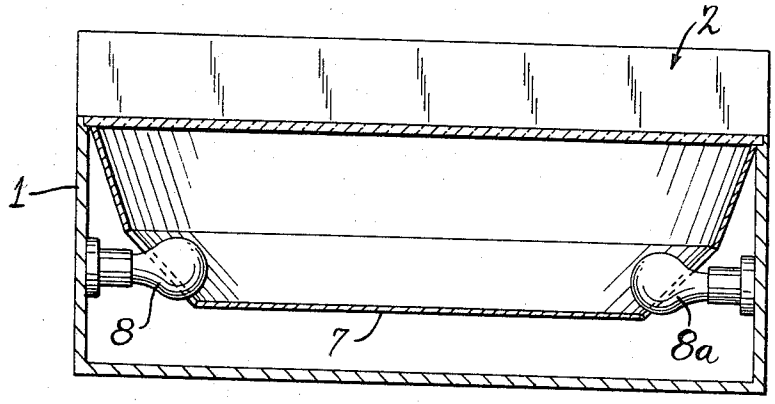


Fig 2

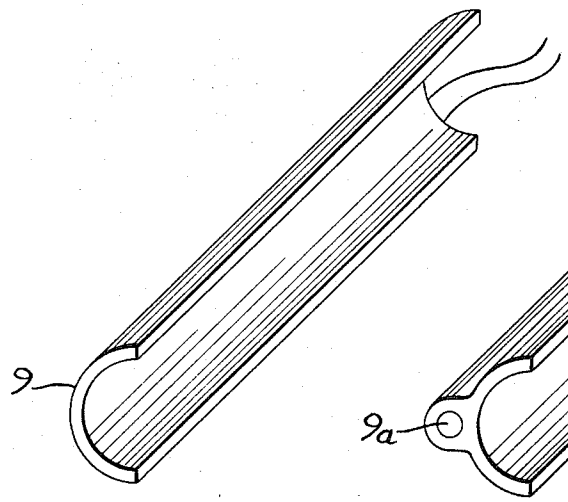


Fig 4

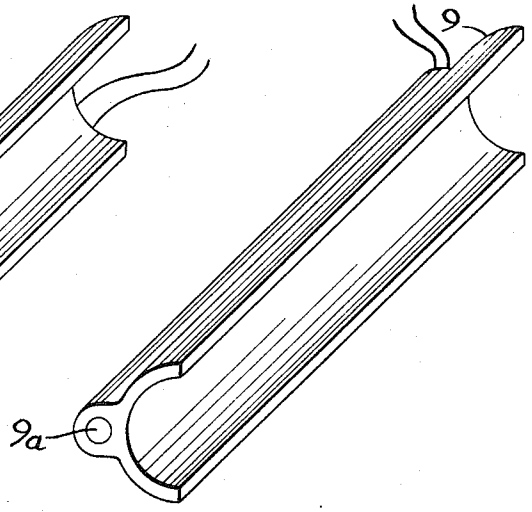


Fig 5

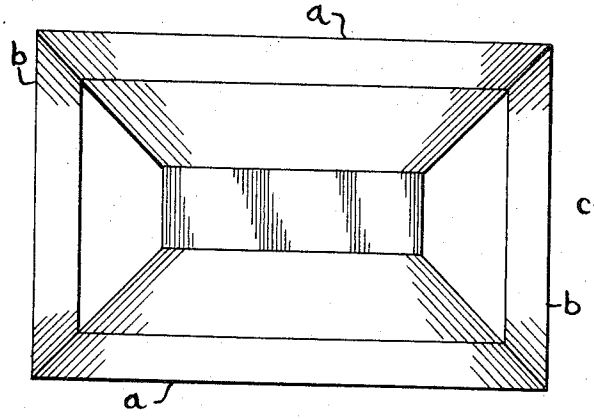


Fig 6

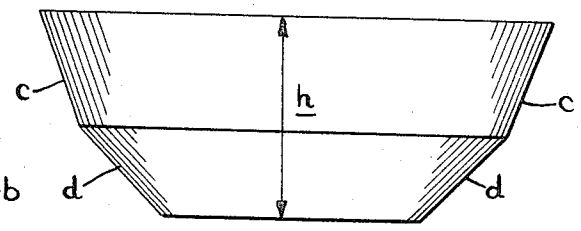


Fig 6a

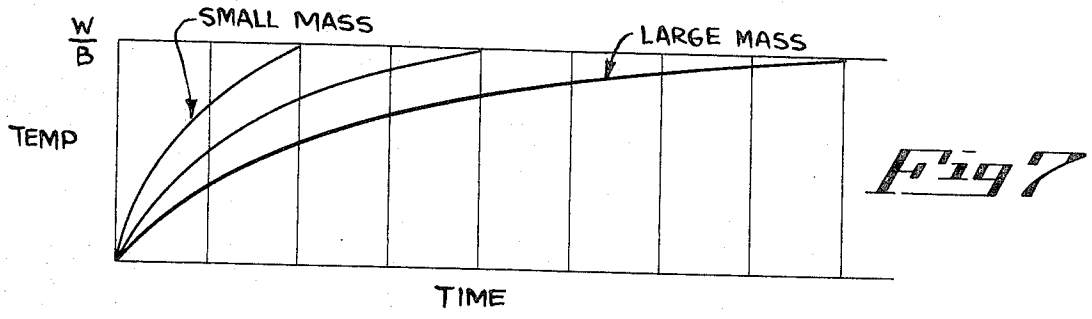


Fig 7

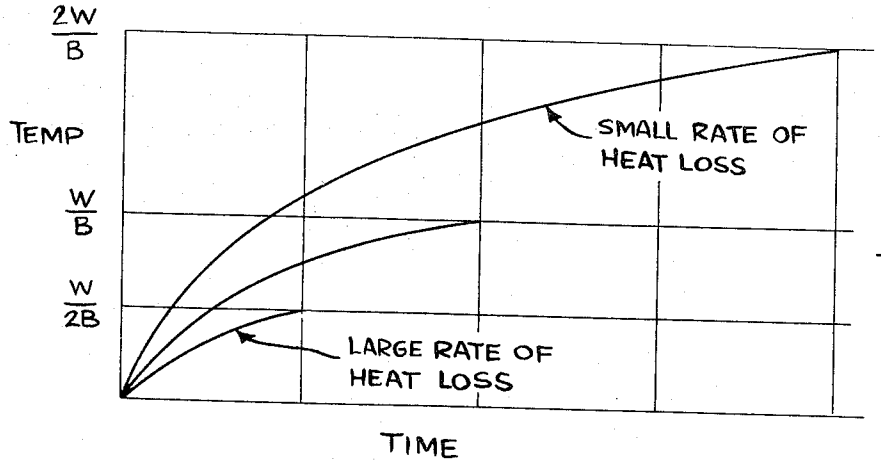


Fig 8

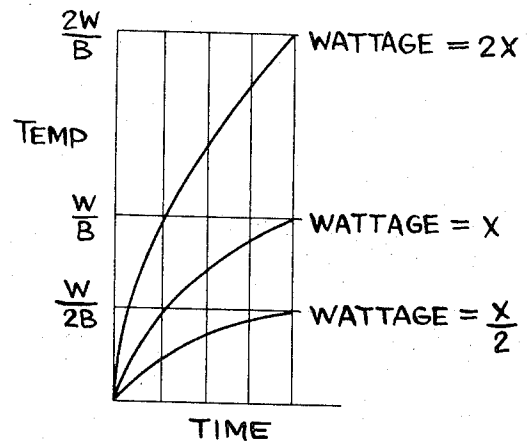


Fig 9

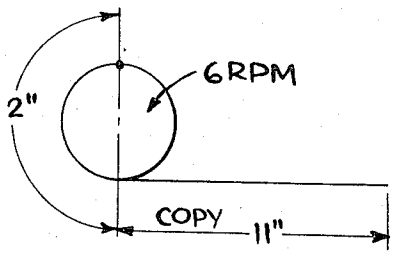
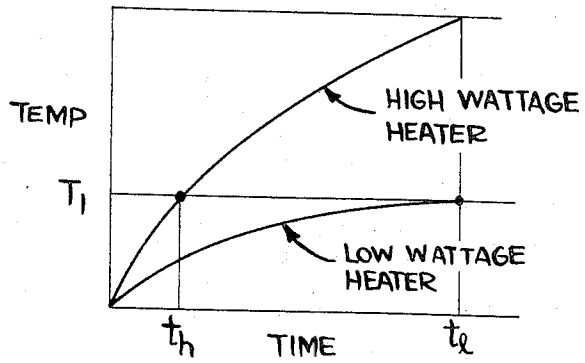


Fig 11



t_l = TIME REQ'D. FOR LOW WATTAGE HEATER TO REACH WORKING TEMPERATURE, T_1

t_h = TIME REQ'D. FOR HIGH WATTAGE HEATER TO REACH WORKING TEMPERATURE, T_1

Fig 10

COPYING MACHINE

BACKGROUND OF THE INVENTION

This invention relates generally to copying machines and more particularly to portable, small size copying machines designed for making copies of original documents by a process involving exposing an original to light through an intermediate paper in pressure contact therewith and heating the exposed intermediate in pressure contact with a receptor copy paper.

Various models of "table-top" copying machines of this type have been known in the art or are already on the market. For instance, in one known low-cost portable copying machine the intermediate copy sheet is exposed to light—together with the original—on a first curved surface which is illuminated from below and, subsequently, the exposed intermediate sheet with a receptor sheet is thermally developed on another curved surface which is heated also from below. The development is controlled by eye.

In another prior art modification of the copying machine the intermediate copy is exposed to light from above by the aid of a separate illumination cover and thermally developed by contacting with a rotating, heated roller arranged in the body of the machine.

In another prior art modification, the intermediate sheet and the original are both exposed to light by passing them around a series of rollers and through an exposure section. This mode of operation, i.e., causing the intermediate sheet and the original to move in a curved path, precludes the possibility of making copies from books, magazines or other relatively thick original material. Also, when passing an original around a series of rotating rollers, the possibility of causing damage to an important document exists if there were a malfunction of the apparatus.

The disadvantage of such conventional copying machines for such papers resides particularly in the fact that they are relatively expensive due to their relatively complicated structure, using a great number of parts such as an array of bulbs, thermostat, large mass heating rollers, heavy lids and the like. The low-cost copying machines, on the other hand, are usually slow in operation (the exposure time, 20 seconds, and the development time, 25 seconds, for example), and the quality of the resulting copies is not uniform.

It is, therefore, an object of this invention to avoid disadvantages of prior art copying machines for using the aforementioned intermediate and acceptor copy papers.

More particularly, an object of this invention is to provide an inexpensive, portable copying machine having a compact size, a flat exposure surface and which is adapted to process all standard copy sizes.

Another object of this invention is to provide a copying machine which is reliable in operation and has a reduced power consumption.

SUMMARY OF THE INVENTION

The above objects are attained by providing a copying machine for copy papers of the aforementioned type, having a flat translucent exposure surface, a pair of bulbs facing each other beneath said exposure surface, a light reflector disposed beneath said exposure surface and including double angled side walls, the bulbs projecting through the doubled angled side walls in such a manner that one angled surface reinforces the light at the edges of the exposure surface and the other angled surface reinforces the light closer to the center area of said exposure surface, and heat generating means disposed near a recess portion of the light reflector.

The heat generating means includes a roller which is heated by a low-mass, low-wattage heater. The heater and the roller are arranged in a recess space which is defined by the double angle of the reflector and a front lateral wall.

The copying machine of the invention is preferably arranged within a housing having a top cover which serves as a clamp. A lateral wall of the housing is provided with a manipulation slot disposed opposite the heated roller and with a lateral cover for covering the manipulation slot.

BRIEF DESCRIPTION OF THE DRAWING

The invention will now be described in greater detail in the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of the copying machine of this invention with open covers of the housing;

FIG. 2 is an elevational view, partly in section, of the illumination system of the machine of the invention;

FIG. 3 is a side view, partly in section, of the arrangement of the illumination and of the development system in the machine of this invention;

FIG. 4 is a perspective view of the heater element for heating the development roller;

FIG. 5 is another modification of the heater element;

FIG. 6 is a plan view of the double angled reflector;

FIG. 6*a* is an elevation view of the reflector of FIG. 6;

FIG. 7 is a temperature-time characteristic of the mass of the heater;

FIG. 8 is a temperature-time characteristic of the rate of heat loss in the heater;

FIG. 9 shows a temperature-time characteristic in response to wattage changes;

FIG. 10 is a temperature-time characteristic of heaters without thermostat and with thermostat; and

FIG. 11 illustrates parameters influencing the development time of a copy.

DETAILED DESCRIPTION

Referring now to FIG. 1, there is illustrated an outlook of the copying machine of this invention. The housing 1 has a first cover, such as, for instance, a top cover or lid 2 hinged to the body of the housing 1. The top cover 2 is utilized for clamping the original of the copying paper to be exposed against the exposure surface 3 on the upper surface of the housing body. Clamp means, such as, for instance, magnets 2*b* or a pair of clamps with eccentrics (not illustrated), hold the lid 2 in its closed position. The top lid is removable from the body by virtue of slip-joint hinges which permit separation of these pivotally connected members. This permits using the lid to clamp thick originals such as books. Simultaneously, within the lid or top cover 2 can be arranged a shelf 2*a* for storing the copying papers. The inner wall of the lid 2 is with advantage provided with a resilient pad such as, for example, a foam rubber pad 2*c* for producing a uniform contact against the exposure surface 3. The exposure surface 3 has the form of a translucent flat platen of the size which suits most of the standard paper forms. A lateral wall 20 of the

housing 1 is provided with a manipulation or development slot 4 through which the exposed copying papers are fed between a heater element 9 and a roller 10 driven by a constant speed motor (not illustrated) and after a time, predetermined by virtue of the proper combination of roller diameter and motor speed, the developed copies are discharged at the opposite edge of the slot 4. The lateral wall 20 is also provided with an exposure control knob 5 and with a protective side cover 6 which covers the manipulation slot 4 and the control knob 5 when the machine is in inoperative condition. To keep the manufacturing and operating costs of the machine at a minimum, the exposure surface 3 is illuminated by a light source including only two bulbs 8 and 8*a* of any standard, commercial type, for instance. In accordance with a preferred embodiment, at least a portion of each bulb 8 and 8*a* projects through opposite walls of a double angled light reflector 7 and are disposed opposite each other symmetrically to the center of the reflector 7, as illustrated in FIG. 2. The configuration of the light reflector 7 is illustrated in more detail in FIG. 6 and FIG. 6*a*. The lateral sloping walls of the reflector are angled in such a manner that the set of upper wall portions reflects the light to the edges marginal area or of the copy and the set of lower surface portions reflects the light to the central area further in from the edge. The development of the illumination system of this invention is based upon well-known scientific theories, such as inverse square law, for direct illumination, and the like. Nevertheless, in practice, a certain empirical solution in the final design is necessary to determine by a series of carefully controlled trials the effect of the variation in: reflectivity, as a function of angle of incidence or wavelength of the light energy; and the location of the filament in the low-cost light bulbs 8 and 8*a*.

It is known that if a light source is positioned at a great distance from the exposure platen of a copying machine, variation in light intensity on the platen is reduced. Prior art copying machines which increased the distance of the light source from the platen resulted in an intolerably large and cumbersome configuration. An alternate solution, namely to position many small light sources close enough to the platen as to achieve a satisfactory uniformity of illumination and, in addition, a compact size of the machine, has the disadvantages that the manufacturing costs increase considerably and the operational reliability is reduced.

The light reflecting chamber 7 in the copying machine of this invention is designed so as to provide sufficient uniformity without resorting to either of the two aforementioned disadvantageous alternatives. The arrangement and location of bulbs, as well as the reflector configuration, provide an optimum compromise between cost, uniformity of light on the exposure platen 3, and the maximum size of paper to be copied, thereby providing excellent copy quality, such as dense black characters together with a clean, white background, compact size of the machine and simultaneously a low manufacturing and operational cost.

Provided that the exposure platen 3 is suited to the copying of 8½" by 14" documents, the preferred dimensions of the light reflecting chamber 7 illustrated in FIG. 6 and 6*a* are as follows:

Side *a* 14½" ± ⅜";

Side *b* 9¼" ± ⅜"; the height *h* of the chamber 5½" ± ¼"; the angle between the side *c* of the upper angled surface and the vertical equals approximately 20° ± 5°; and the angle between the side d of the lower angled surface and the vertical equals 45° ± 5°.

The center of the filaments of the incandescent lamps 8 and 8*a* lies approximately 3¾" ± ½" from the bottom of the exposure platen 7 and about 4" ± ¼" from the outer edge of the platen 7.

The reflecting material is preferably an aluminum foil or an equivalent.

The inwardly sloping angled surfaces of the light reflecting chamber 7 make it possible for the development roller 10 to be located in the recess space between the lateral wall 20 and the outer wall of the reflecting chamber 7. (FIG. 3)

Another feature of the copying machine of the invention is the particular arrangement of the heating element 9a for the development roller 10. The heater element 9a is a low-wattage, low-mass member designed according to the following principles: In heat transfer the relationships are mathematically expressed by the following equations:

$$T = T_o + W/B\ (1 - e^{-ABt})$$

Where:

T = Temperature, at any time

T_o = Starting temperature

W = Wattage input

B = a constant which determines the rate of heat loss of the mass

t = time

A = mass

The temperature-time characteristics as illustrated in FIG. 7 show that the relationships of the parameters in the above equation are correct.

As shown more clearly in FIG. 8, the variation of B (heat-loss characteristic) changes not only the stabilization temperature, but the time constant as well. When stabilizing the temperature in the machine of this invention, the heat-loss characteristic B is not manipulated, but it is simply kept low.

The diagram in FIG. 9 shows that the change of wattage changes the equilibrium temperature, but has no effect on time to get to that temperature.

The diagram in FIG. 10 illustrates the action of a thermostat in the heating system. Let us assume that the working temperature of the heater is supposed to be at T_1. A high wattage heater gets up to working temperature T_1 much sooner; however, to keep the heater from overheating, a thermostat was necessary in prior art heaters. In the copying machine of the invention, the employed heater has such a low wattage that heat will never go above the working temperature T_1. On the other hand, to avoid a long waiting time, the mass of the heater has been reduced in accordance with the lowermost characteristic as shown in FIG. 8.

The development time in the machine according to the invention has been reduced by increasing the length of the heater part, namely by increasing the diameter of the development roller 10 and, accordingly, of the matching section of the heater 9 as shown in FIG. 5. In this manner, the linear speed at which the copy paper is passed through is increased, and the temperature of the heater is adjusted for the reduced development time. For instance, if the development roller 10 rotates at 6 rpm, copy paper is in contact with heated area for five seconds (one half of the 10 seconds it takes for the

roller to make one full revolution), regardless of the diameter of the roller. Nevertheless, the rate of speed of the copy passing through the developing slot is proportional to the diameter of the roller so that the time required for a copy to pass through the development system is reduced by increasing the diameter of the heating roller.

While the invention has been described in connection with only one specific embodiment, it will be readily apparent that numerous modifications thereof may be readily made. It is, therefore, intended by the appended claims to cover all such modifications and variations as come within the true spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. A copying machine, for use in making copies of an original by exposing the original to light through an intermediate sheet in pressure contact with the original and subsequently heating in a heating step the exposed intermediate sheet in pressure contact with a copy sheet comprising, in combination,

a translucent exposure surface having outer edges and adapted to receive said intermediate sheet and original superimposed,

a light reflecting chamber disposed below said exposure surface and including

a first set of side wall elements, each element of said first set sloping inwardly from an outer edge of said exposure surface terminating in a common plane below said exposure surface, and

a second set of side wall elements remote from said exposure surface each element of said second set sloping inwardly from the juncture between an element of said first set and said common plane at an angle different from that of said first set the inner surface of all said elements being reflective,,

a light source arranged in said reflecting chamber in such a manner that the first set of side wall surfaces reinforces the light, emanating from said source, at the marginal area of said exposure surface and the second set of side wall surfaces reinforces the light near the central area of said exposure surface, and

heat generating means adapted for the heating step, dispoed near a side wall of said reflecting chamber.

2. A copying machine according to claim **1**, wherein said heat generating means include a roller and a low mass, low-wattage heater arranged along said roller.

3. A copying machine according to claim **1** further comprising a housing including a wall portion having a paper development slot disposed frontally near said heat generating means, a first cover operable for resiliently clamping against said exposure surface an original and a paper to be exposed including a hinge and releasable locking means.

4. A copying machine according to claim **3** further comprising a second cover hinged to said wall portion and being operable for protecting said paper development slot.

5. A copying machine according to claim **1**, said light source including a pair of incandescent electric bulbs.

6. A copying machine according to claim **3**, wherein the hinge means of said first cover are releasable, thereby rendering said top cover removable relative to the housing.

7. A copying machine according to claim **1**, wherein said light source includes incandescent electric bulbs at least a portion of which project through opposite side wall elements into said light reflecting chamber and are disposed substantially symmetrically relative to the center of said exposure surface.

8. A copying machine according to claim **1**, wherein said translucent exposure surface is flat.

9. A copying machine according to claim **1**, wherein said translucent exposure surface is transparent.

10. A copying machine according to claim **7**, wherein said first set of said wall elements is sloping inwardly from a vertical at an angle between 15° to 25° and said second set is sloping inwardly from a vertical at an angle between 40° to 50°.

* * * * *