Oct. 15, 1946. A. G. THOMAS 2,409,454

ELECTRONIC DEVICE

Filed Jan. 27, 1944

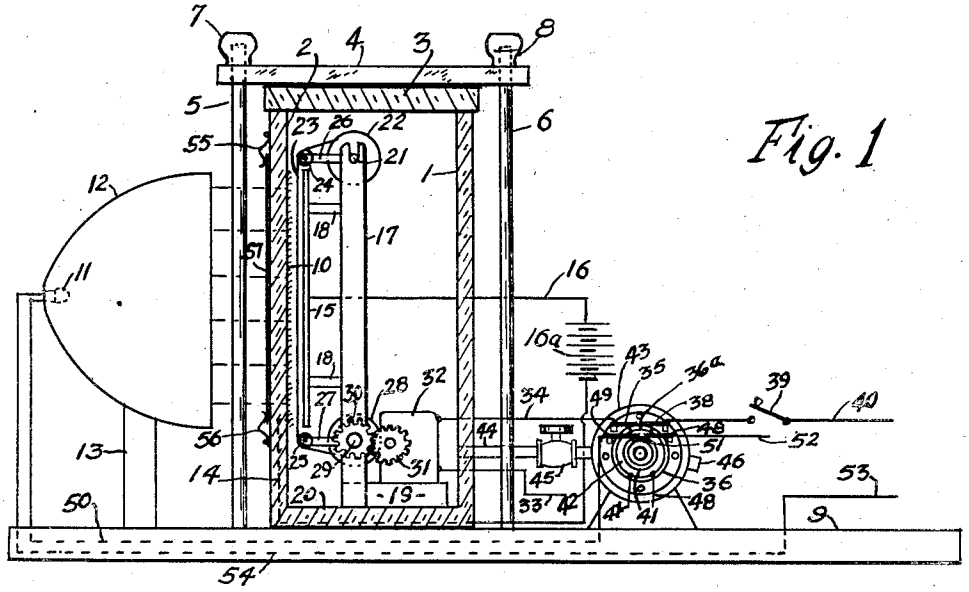

Fig. 1

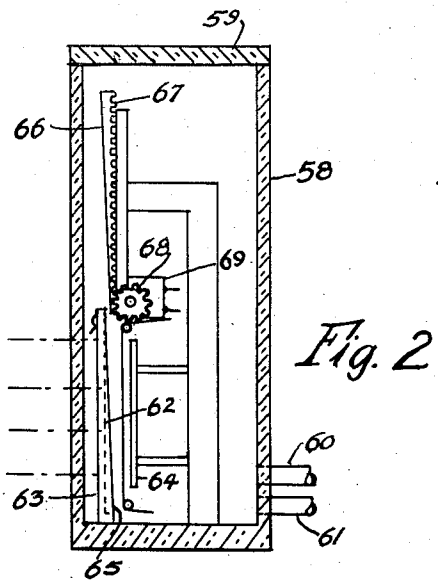

Fig. 2

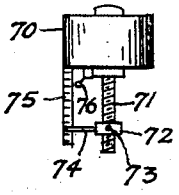

Fig. 3

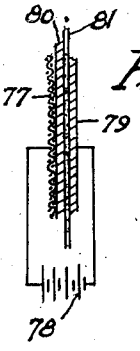

Fig. 4

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ELECTRONIC DEVICE

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21 Claims. (Cl. 250—41.5)

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This invention relates to electronic devices and particularly to reproducers for copying letters, maps, drawings, photographs and the like.

Many reproducers have been marketed depending upon various processes such as gelatin images, photographic reproductions, blue printing, and others. All of these methods are relatively slow, however, and are somewhat cumbersome in operation; besides requiring liquid chemicals or vapors for development. In contrast, my electronic reproducer is fast, requires no chemicals, and provides accurate copies in small or large quantities in a minimum of time.

A primary object is to provide an electronic reproducer that will furnish copies of drawings, pictures, letters, and the like at reasonable cost and quickly.

Another object is to provide an electronic reproducer that will be automatic in operation; producing a given number of copies after being set properly.

A further object is the provision of an electronic reproducer which can be used to make copies of different originals, without breaking the vacuum.

An additional object is to provide an electronic reproducer the photosensitive surface of which is protected from harmful atmospheric or other influences when the vacuum is broken.

Other objects will appear in the following description.

In the drawing:

Figure 1 is a side elevation, in part section, of my electronic reproducer, showing a lamp, the glass or other transparent container, driving motor, evacuating pump, and other associated parts.

Figure 2 is a fragmentary side elevation, in part section, of a variation of my electronic reproducer in which the photosensitive surface is covered before air is admitted to the container.

Figure 3 is a plan view of a driving motor with automatic cut-off to stop the motor after a predetermined number of copies are made.

Figure 4 is a fragmentary end view, in part section, of a selenium type of reproducer.

In Figure 1, container 1 is made of glass or other transparent material, although wall 2 only can be transparent if desired. This container has top 3 which may be pressed tightly against the upper edge of container 1 in air-tight manner, by means of cross plate 4 which is provided with suitable holes through which end-threaded rods 5 and 6 pass. Thumb nuts 7 and 8 may be screwed down on rods 5 and 6 to apply pressure

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to plate 4 and consequently to top 3 to effect a seal. A suitable gasket may be provided. The bottom ends of rods 5 and 6 are screwed into base 9 which may be of any suitable material.

Top 3 may be hinged or clamped to container 1 so that plate 4 and rods 5 and 6 may be eliminated. Any suitable clamp may be used but should preferably be quickly manipulated. In this case it would be preferable to have wall 2, or a part thereof, of glass and the rest of the container, including top 3, of metal. A suitable seal between the glass and metal would be provided.

The inner surface, or at least a portion of the inner surface of wall 2, is covered with semi-transparent photo-emissive surface 10 which is adapted to emit electrons in proportion to the intensity of light rays from electric lamp 11 held at the focus of parabolic reflector 12 which is fastened to support 13 fixed to base 9. Any suitable source of parallel light rays may be used however, or in some cases even illumination through ground glass could be used.

Surface 10 may be made by depositing a thin layer of silver on the inner glass surface of wall 2. Then a thin layer of caesium or other photo-emissive material may be deposited over the silver by evaporation or otherwise. The top surface of the silver may be oxidized before depositing the caesium, by glow discharge or in other manner.

The silver is electrically connected to conductor 14 which leads to the negative pole of battery or other potential source 16a, the positive pole of which is connected to nickel or other metal plate 15 by means of conductor 16. Plate 15 serves as the anode and is fastened to upright 17 by means of posts 18. Upright 17 may be of insulating material and is suitably fastened to base 19 which may be set upon or fastened to container base 20.

The photo-emissive surface 10 may consist of a variety of materials such as potassium hydride, silver, caesium-on-silver, or the like. It is preferable that this photo-emissive surface be of such material that it will not be materially damaged by exposure to the atmosphere. Since many metals eject electrons upon exposure to light, a variety of useful substances are available. The methods of making photo-emissive surfaces are well known and consequently will not be described in detail.

Upright 17 and a similar slotted upright on the opposite side of base 19 support rod 21 which carries spool 22 around which electrically sensi-

tive paper 23 is wound. This paper is fed over guide rollers 24 and 25 supported on arms 26 and 27 and similar arms attached to upright 17 at the opposite end of spool 22. The paper may rub against anode plate 15 if desired, or may be slightly separated from it as shown. Paper 23 is wound upon bottom spool 28 which is rotated by shaft 29 having bearing in uprights 17. Gear 30 is fastened to the end of shaft 29 and is meshed with gear 31 which is driven by reduced speed motor 32 fastened to base 19.

Motor 32 is supplied electrical energy through conductor 33, sealed in container 1, and through conductor 34, similarly sealed and leading to brush 35 pressing against metal slip ring 36 a short section 36a of which is made of porcelain, mica, or other insulating material. Brush 38 also presses against slip ring 36 and is connected to a pole of switch 39 the other pole of which connects to line wire 40. Energy is therefore supplied to motor 32 when switch 39 is closed and when the metal portion of slip ring 36 bridges the brushes 35 and 38.

Slip ring 36 and smaller slip ring 41 are rotated at reduced speed by motor 42, by means of epicyclic or other suitable reduction gears. Motor 42 drives evacuating pump 43 which removes air or other gas from container 1 through connected pipe 44, which is sealed in container 1; when valve 45 is open. The air is exhausted through outlet pipe 46. This pump may be of any suitable type and may include an auxiliary high vacuum mercury vapor or similar pump. The pump should have sufficient capacity so that container 1 can be evacuated to the desired low pressure in a minimum of time, within several minutes or less preferably.

Motor 42 is supplied energy through conductors 47 and 48. a suitable switch being provided.

Brush 49, supported on the motor frame, is connected with wire 50 leading to lamp 11. Brush 49 presses against slip ring 41 which is of insulating material such as mica, fibre, bakelite or the like, except for relatively short arcuate portion 51 which is made of metal. This conducting portion is placed radially in alignment with insulating portion 36a of slip ring 36, so that lamp 11 will be lighted when motor 32 is stationary. Brush 48, supported on the motor frame, also presses against slip ring 41 and is connected to line wire 52. The other cooperating line wire 53 is connected to the other terminal of lamp 11 by means of wire 54 which may be passed through base 9.

Spring clips 55 and 56 are fastened to the outside of wall 2 and serve to hold letter 57 or other object to be copied, flat against the surface. A glass plate may be placed over letter 57 to press it against wall 2, if desired.

Motors 32 and 42 may be synchronous motors or of any suitable type. The motor speeds or reduction gearing, or both, should be so chosen that paper 23 will be moved through the maximum frame length or effective image length, when slip rings 36 and 41 are rotated through one revolution.

While motor 32 is shown at bottom, it is preferable that spool 28 be placed at the top so that the exposed paper can be easily reached. The whole assembly could be slipped out if desired; flexible or sliding motor contacts being provided for that purpose.

Paper 23 may be of any suitable electrically sensitive type such as iode paper or commercial Teledeltos. In fact, it is not essential that it be

electrically sensitive since the electrons can be made to burn their images in the paper or other material.

In operation, a roll of the paper on spool 22 is placed in the device and the other end is attached to shaft 29 of spool 28. Then top 3 is placed in position and thumb nuts 7 and 8 are screwed down to press plate 4 against top 3 to effect an air-tight seal. Valve 45 is then opened and motor 42 is energized to evacuate container 1 quickly. When the desired degree of vacuum is reached, as indicated by a suitable gage or after a predetermined time interval, letter or drawing 57 is placed as shown and switch 39 is closed. When this happens motor 32 will move paper 23 through a frame length, then will stop for a brief period during which time lamp 11 will be lighted so that the light will pass through letter 57 and will cause an electron pattern to be liberated from photo-emissive surface 10, the density of the electrons corresponding in inverse relation to the opacity of the letter 57. The electron image will be accelerated by positively charged anode 15 so that an image will be made on paper 23, by electron bombardment. This image can be made visible and permanent or the electrically charged condition of the paper can be used to affect the rate of taking up ink if a printing art process is desired.

As the motors continue to revolve, a succession of copies will be made. After the desired copies are made, letter or other object 57 can be changed if desired without breaking the seal of container 1.

In case letter 57 is not translucent, a reflected image can be projected on wall 2, by means of a suitable lens system.

When the desired copies are obtained, switch 39 is opened and motor 42 is similarly stopped. Thumb nuts 7 and 8 are then screwed up so that top 3 can be lifted and the exposed paper bearing the images can be removed.

It is obvious that paper 23 could be moved by solenoid action, with a cooperating ratchet. Many other variations can easily be made.

In fragmentary Figure 2, container 58 has top 59 and two sealed-in pipes 60 and 61 which may be connected to an exhaust pump and a source of inert gas such as argon, nitrogen, helium or the like, respectively.

Photo-emissive surface 62 on transparent plate 63 serves as the cathode to produce an electron image pattern which is accelerated toward anode 64. Inclined rubber or other rim 65 is provided around the periphery of plate 63 so that inclined plate 66 will seal off photo-emissive surface 62 from the atmosphere when plate 66 is pressed down against rim 65. Plate 66 is moved vertically by means of integral rack 67 and cooperating pinion 68 driven by motor 69 which may be suitably energized. When the container has been evacuated, plate 66 is raised to the position shown, before use. As a further precaution against damage to surface 62, inert gas may be admitted to the container through pipe 61 when top 59 is removed. This gas may be directed against surface 62. The letter to be copied may be placed against plate 63 inside, if desired.

In Figure 3, motor 70 may be used to drive the paper or the pump. Collar 72 is provided with ratchet or pin 73 which may be adjusted to allow the collar to be slipped laterally on threaded motor shaft 71 so that collar 72 may be set, by means of attached pointer 74 and cooperating scale 75 fastened to motor 70, to allow a predetermined

number of copies to be made before collar 72 is moved by rotating shaft 71 until it strikes and opens switch 76 which stops the motor.

In Figure 4, metal screening 77 is connected to one pole of battery or other current source 78 the other pole of which is connected to metal plate 79. Thin selenium plate 80 is pressed against preferably moist electro-sensitive paper 81 which is pressed against plate 79. If then a letter is pressed against screening 77 by means of a glass plate or otherwise, then the current conducted by the elemental areas of the selenium will be according to the opacity of the letter so that an image will be made on paper 81. Light is, of course, directed through the letter.

Many changes of detail can, of course, be made without departing from the general principles I have disclosed. For instance, electrically energized magnets or solenoids can be used to force plate 66 against rim 65 when it is desired to protect surface 62. The energization of the magnets can be made automatic when the top 59 is removed, or before. Likewise, the introduction of inert gas can be made automatic.

In the specification and claims, the word "light" denotes radiation of any suitable kind, whether of visible wavelengths or invisible such as infra-red, ultra-violet, X-ray, or other radiation.

What I claim is:

1. The method of making reproductions of typewriting, printed matter, drawings or the like, comprising, forming a light image of the object to be copied, transforming said image into an electron image, and directing said electron image against material adapted to be visibly changed in character or color by electron bombardment.

2. The method of making reproductions of typewriting, printed matter, drawings or the like, comprising, forming a light image of the object to be copied, transforming said image into an electron image, and directing said electron image against material adapted to be chemically changed by electron bombardment visibly to reproduce said image in or on said material.

3. An electronic device comprising, a container having a light transmitting wall, a closure for said container, a translucent coating of photoemissive material on at least a portion of the inner surface of said wall, an electrically conducting plate substantially parallel with said wall, electrical conductors connected with said coating and said plate, electrical means connected with said conductors for charging said plate positively with respect to said coating, a pair of rollers within said container, means to support said rollers, and electrical means operatively connected with at least one said roller to rotate said roller.

4. An electronic device comprising, a container having a light transmitting wall, a closure for said container, a translucent coating of photoemissive material on at least a portion of the inner surface of said wall, an electrically conducting plate substantially parallel with said wall, electrical conductors connected with said coating and said plate, electrical means connected with said conductors for charging said plate positively with respect to said coating, a pair of rollers within said container, means to support said rollers, electrical means operatively connected with at least one said roller to rotate said roller, and a sheet of material which may be visibly and permanently changed by electron bombardment adapted to be moved between said coating and said plate by means of said rollers.

5. An electronic device comprising, a container having a light transmitting wall, a closure for said container, a translucent coating of photoemissive material on at least a portion of the inner surface of said wall, an electrically conducting plate substantially parallel with said wall, electrical conductors connected with said coating and said plate, electrical means connected with said conductors for charging said plate positively with respect to said coating, a pair of rollers within said container, means to support said rollers, and electrical means operatively connected with at least one said roller to rotate said roller in a succession of predetermined steps.

6. An electronic device comprising, a container having a light transmitting wall, a closure for said container, a translucent coating of photoemissive material on at least a portion of the inner surface of said wall, an electrically conducting plate substantially parallel with said wall, electrical conductors connected with said coating and said plate, electrical means connected with said conductors for charging said plate positively with respect to said coating, a pair of rollers within said container, means to support said rollers, electrical means operatively connected with at least one said roller to rotate said roller, and an evacuating pump connected with said container.

7. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, and pumping means connected with said container to cause evacuation thereof.

8. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, a sheet of material of a character to be visibly and permanently changed by particle bombardment positioned between said film and said element, and means within said container for moving said sheet.

9. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, a sheet of material of a character to be visibly changed by particle bombardment positioned between said film and said element, and means for moving said sheet through predetermined displacements.

10. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting

character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, a sheet of material of a character to be visibly changed by particle bombardment positioned between said film and said element, and means including a motor within said container for moving said sheet.

11. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, and illuminating means fastened to said device to direct light through said portion and said film.

12. An electronic device comprising, a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, illuminating means fastened to said device to direct light through said portion and said film, and automatic means connected with said illuminating means to cause illumination of said film for predetermined intervals.

13. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, a sheet of material of a character to be visibly changed by particle bombardment positioned between said film and said element, and automatic means for moving said sheet through a succession of predetermined displacements with predetermined stationary intervals between said displacements.

14. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, illuminating means associated with said device to direct light through said portion and said film, a sheet of material of a character to be visibly changed by particle bombardment positioned between said film and said element, automatic means for moving said sheet through a succession of predetermined displacements, and automatic means to affect said illuminating means to direct light through said film during stationary intervals of said sheet between intervals of said displacements.

15. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, and automatic means to time the emission of electrons from said film.

16. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, and means within said container to cover said film to prevent exposure to air when said closure is opened.

17. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, an element within said container to cover said film to prevent exposure to air when said closure is opened, and electrical means to actuate said element.

18. An electronic device comprising a container having a closure therefor, at least a portion of said container being of light-transmitting character, a film of photoemissive material within said container and positioned to receive light passing through said portion, an electrically conducting element adjacent said film, electrical conductors connected with said film and said element, means electrically connected with said conductors for establishing an electrostatic field between them, pumping means connected with said container to cause evacuation thereof, and means connected with said container for introducing gas therein to protect said film when said closure is opened.

19. The method of making reproductions, said method comprising the steps of directing light against an object to be copied to produce a light-and-shadow image thereof, allowing said image to strike a photoemissive surface to cause emission of an electron pattern in accordance with said image, and accelerating said electron pattern against material of a character to be visibly

and permanently changed by said electron pattern in accordance therewith.

20. The method of protecting a photoemissive surface of an electronic device having a container adapted to be opened to atmosphere, said method comprising sealing off said surface from the atmosphere while said container is open.

21. The method of protecting a photoemissive surface of an electronic device having a container adapted to be opened to atmosphere, said method comprising surrounding said surface with protecting gas while said container is open.

ALBERT G. THOMAS.