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Stone, Jr. et al.

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[54] IMAGE COPYING APPARATUS

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[51] **Int. Cl.** **G03b 29/00**

[58] **Field of Search** 95/12, 13, 14; 346/110; 178/DIG. 1; 355/3, 20, 5

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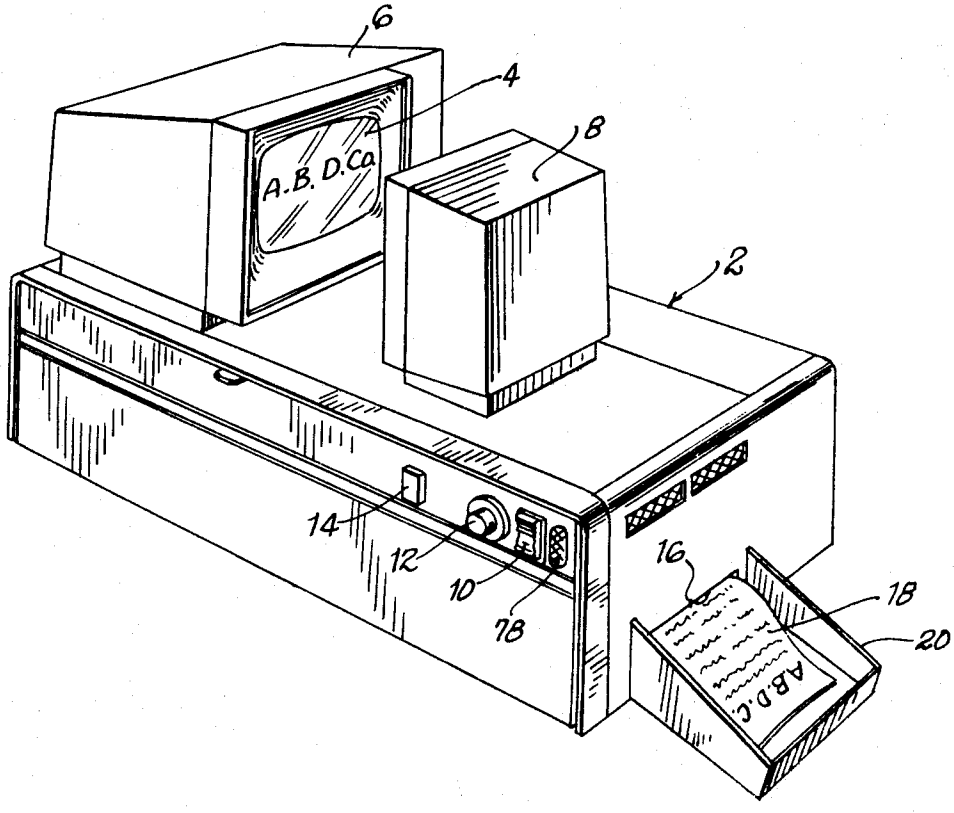
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[57] **ABSTRACT**

Apparatus for producing on paper a copy of images projected onto a viewing surface such as a cathode ray tube comprises elements for focusing the image onto the surface of electrostatic copying paper to expose the paper and means to then subsequently develop the exposed image. The apparatus is arranged so that the copy can be made while the surface on which the image is projected is available to be viewed by an observer. The disclosure includes means permitting the remote control of the apparatus as well as means whereby copies of images appearing on more than one viewing surface may be made.

6 Claims, 5 Drawing Figures



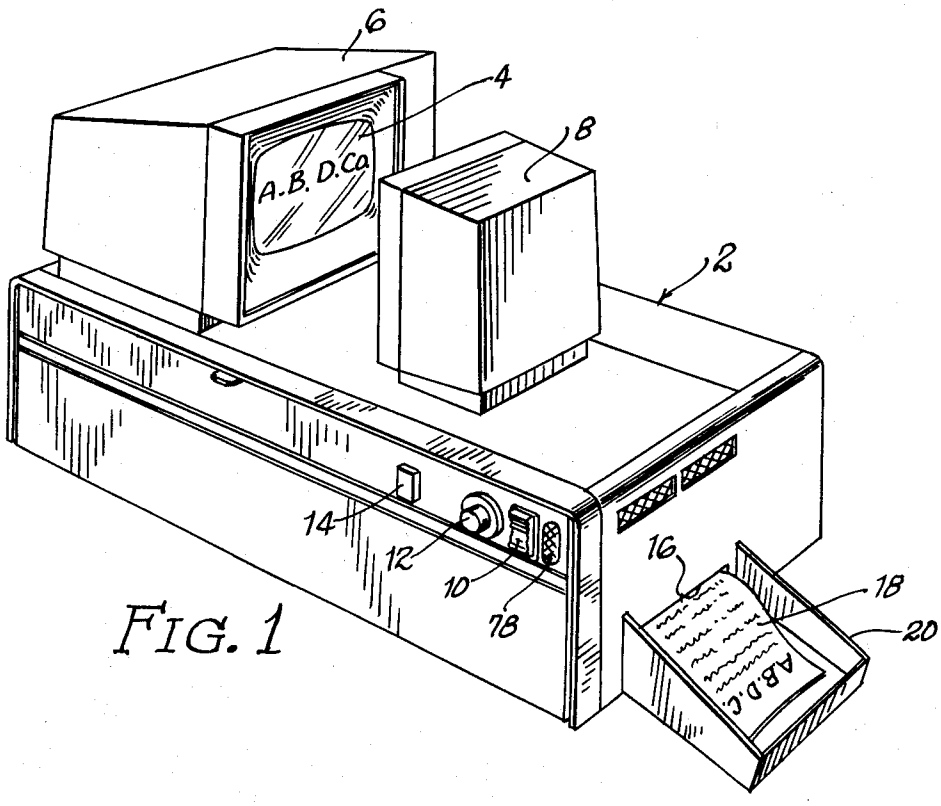


FIG. 1

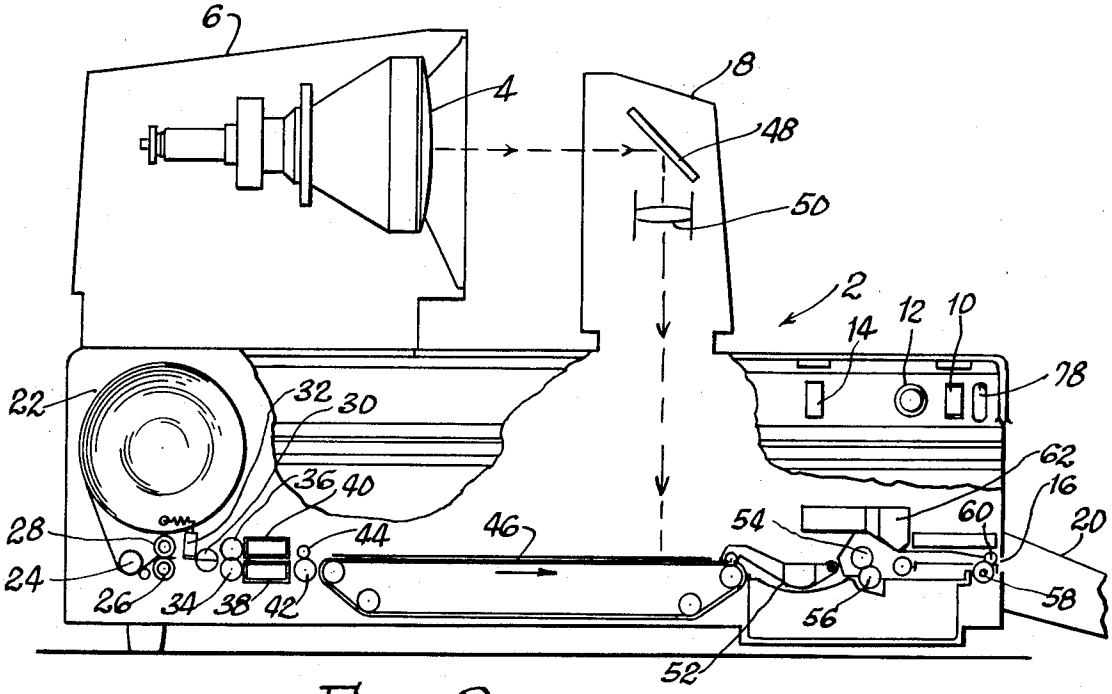


FIG. 2

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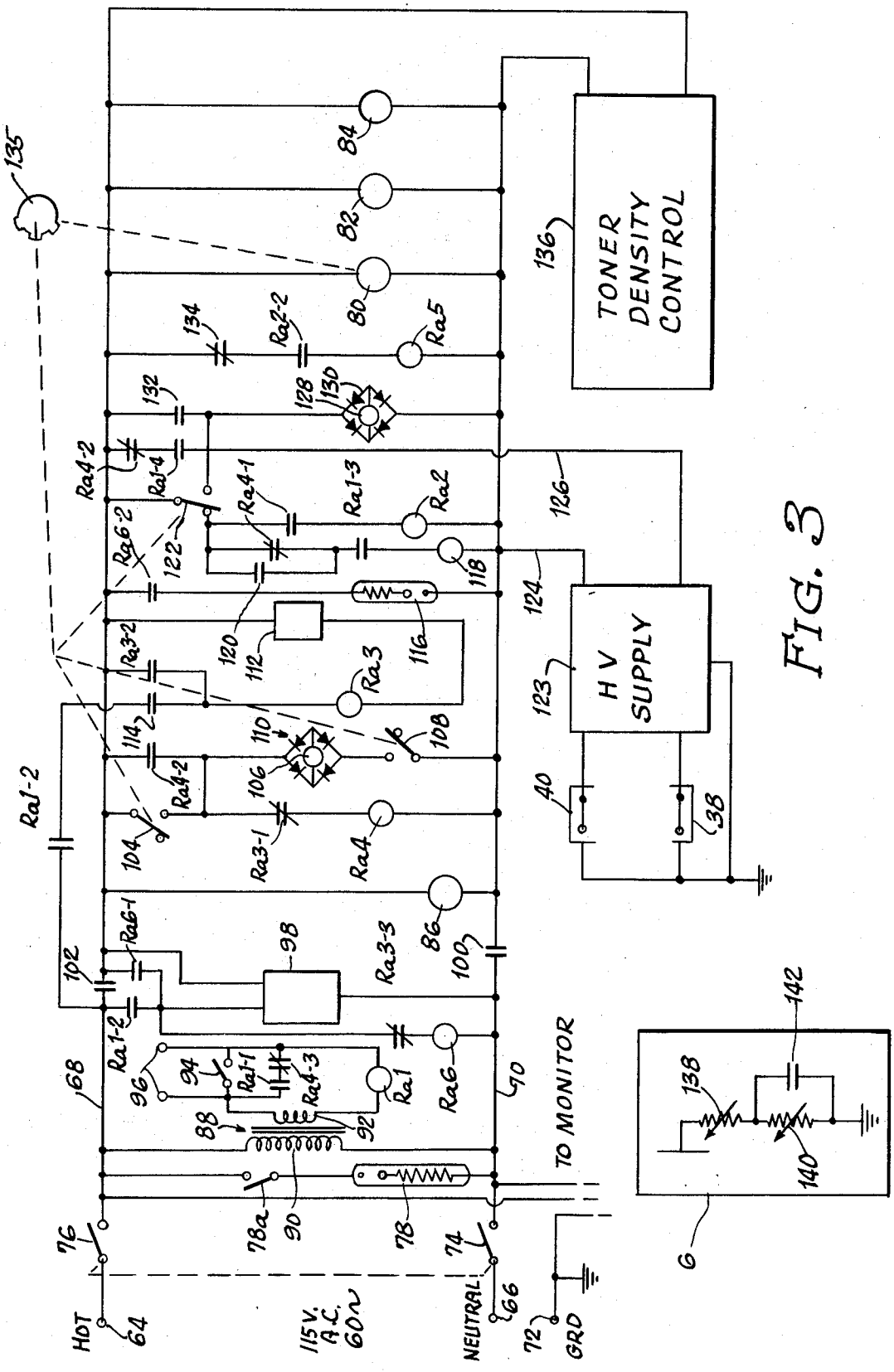
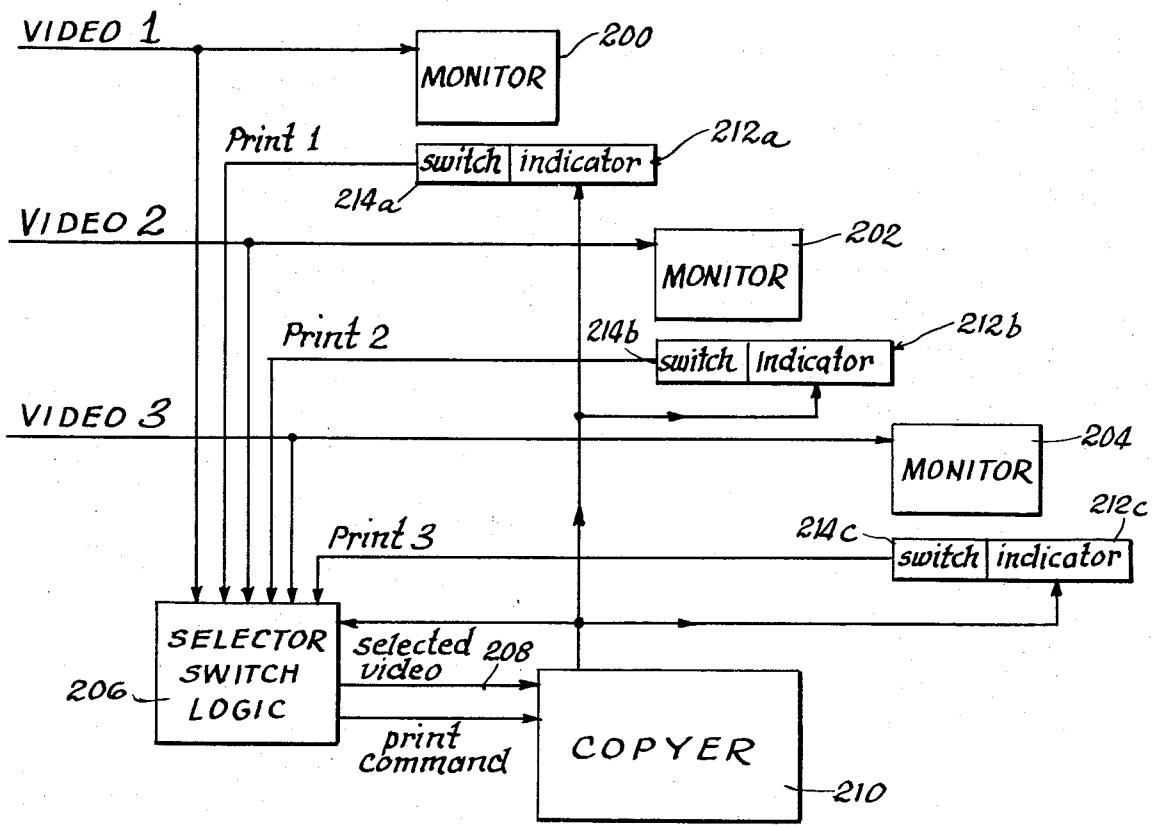

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136
138
140
142
6
38
40
80
82
84
86
Ra1
Ra1-1
Ra1-2
Ra1-3
Ra1-4
Ra2
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Ra3
Ra3-1
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Ra3-3
Ra4
Ra4-1
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Ra5
Ra6
Ra6-1
Ra6-2

FIG. 3



MULTIPLE DISPLAYS WITH SELECTOR

FIG. 4.

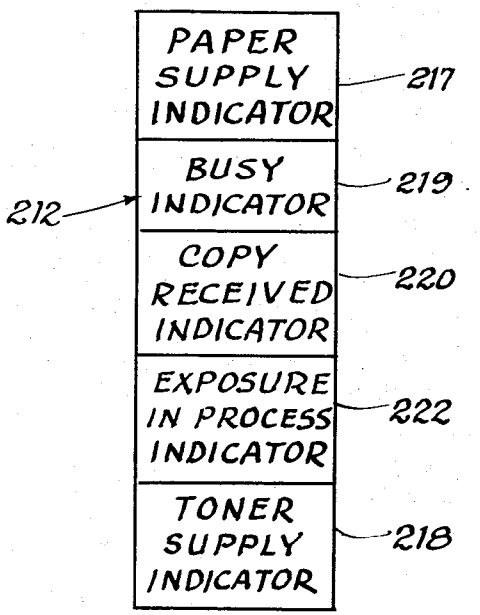


FIG. 5

IMAGE COPYING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to improvements in image reproducing apparatus. More specifically, it relates to the combination of such apparatus with a means for projecting an image on a viewing surface so that copies of that image may be reproduced.

There are numerous situations wherein images are projected onto surfaces to be viewed by observers. The commonly used apparatus for this purpose is a cathode ray tube. The images projecting onto the surfaces of such tubes very frequently are data consisting of alphabetic and numeric characters and symbols of various kinds. The primary purpose of such image projection is to permit a viewer to observe that data, yet there are numerous occasions where it is desired to have a copy of the data as projected for various purposes. Heretofore, a problem has existed when such copies are desired for the copying apparatus interposed in the front of the viewing surface has not permitted that surface to be visible to the viewer while the copy is being made. Further, to permit the copy to be made and at the same time permit the viewing surface to function for its primary purpose the copying apparatus has had to be manipulated into a position to make the image and then removed when the exposure for image reproduction purposes has been made so that the viewing surface can once again be visible to the observer.

It is an object of this invention to provide an apparatus for copying images projecting onto viewing surfaces while at the same time permitting the viewing surface to function as such.

When cathode ray tubes are used for the projection of data in business and industrial environments they are normally used throughout a business or working day and not infrequently on more than one shift. Thus, they are subjected to relatively long hours of usage in relatively short periods of time. Such tubes, of course, have limited lives so that it becomes necessary to replace them periodically. The life of such a tube can be prolonged if it is operated at lower intensities. It has been found that it is possible to operate such tubes at lower intensities and still provide sufficient contrast to permit an observer to view images projected on its surface comfortably in normally lit rooms. When so operated it becomes possible to increase the intensity of or brighten the image only when it is desired to make a copy of that image so that its life is thereby prolonged.

Therefore, it is an object of this invention to provide a novel means for making copies of images on the viewing surfaces of cathode ray tubes while at the same time prolonging the life of such tubes.

In many situations where images are projected onto viewing surfaces and copies of those images are desired, it is not necessary to provide for copies of every image being projected in the same location simultaneously. For instance, in the office of a stockbroker, different persons may have available to them cathode ray tube data display systems and only one of those persons may at a particular time desire to have a copy of the image he is looking at. Were each cathode ray tube provided with its own copying apparatus there would, in such situations, be an unnecessary expense associated with the purchase and service of such equipment.

Therefore, it is still another object of this invention to provide a system for copying images from more than one displayed device which system may be under the control of more than one operator.

SUMMARY OF THE INVENTION

The foregoing and other objects of the invention are achieved in one embodiment wherein means is provided to focus a displayed image onto the surface of copying paper in an electrostatic copying machine. The structural configuration is such that the image on the display surface is exposed so that it may be continually monitored by an observer. Included in the apparatus is means for momentarily brightening the viewing surface when it is desired to make a copy of the image appearing thereon. In another aspect of the invention means is provided permitting the remote control of the copying apparatus as well as means permitting it to make copies of images appearing on a plurality of viewing surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself is set forth in the claims appended hereto and forming a part of this specification while the structure and mode of operation of an embodiment may be understood by reference to the detailed description taken in conjunction with the drawings in which:

FIG. **1** is a perspective illustration of an embodiment of the invention;

FIG. **2** is a cross-sectional view of the embodiment of FIG. **1**;

FIG. **3** is a schematic diagram of the electrical control circuit of the embodiment of FIG. **2**;

FIG. **4** is a block diagram illustrating apparatus in accordance with the invention for copying images from more than one viewing surface; and

FIG. **5** is a block diagram illustrating the indicator lights useful with the embodiment of FIG. **4**.

DETAILED DESCRIPTION

Referring first to FIG. **1**, there is shown apparatus in accordance with the invention which comprises an electrostatic copying device in a housing **2**. Mounted at one end of the housing is the viewing surface **4** of a cathode ray tube. The cathode ray tube is of the conventional type and has associated with it the necessary known electronic circuit so as to cause desired images to be displayed on the surface **4**. A shield **6** is provided to protect the tube and its associated circuitry. Extending above the surface of the housing **2** and confronting the viewing surface **4** is an enclosure **8** in which is mounted optical means, to be described later, for projecting the image appearing on the surface **4** into the interior of the housing **2**. Suitable control means such as an on-off switch **10**, a timing adjust knob **12** and a print pushbutton **14** are provided on the surface of the housing for operation by a user. An opening **16** at one end of the housing is provided for the discharge of a finished copy **18** into a receiving container **20**.

FIG. **2** illustrates in greater detail an embodiment of the invention that has been found to be satisfactory. The copying machine disclosed is of the electrostatic type wherein paper coated with a material such as zinc oxide, which enables the paper to accept and hold an electrical charge for a short period of time, is used. The paper becomes photoconductive when light impinges on its surface and a charge which has been previously placed thereon is lost in those areas struck by the incident light. After paper has been exposed, it is coated with a toner consisting of charged particles suspended in a suitable carrier which are attracted to the exposed area. Thus, a latent image on the copy paper is developed to produce a visible image. After drying, the copy is then discharged from the copier as such machines are in general well known and in common use so that only that much of such a machine is shown and described as is necessary to provide an understanding of the invention.

Apparatus in accordance with the invention includes a source of copy paper coated as described above. This source may be a roll of such paper **22** mounted at one end of the machine. The free end of the roll is fed under a transverse horizontal guide roll **24** between a pair of paper feed rolls **26** and **28**. The paper feed rolls are motor driven to advance paper from the roll of copy paper **22** when a copy is desired to be made. A cutter consisting of a revolving knife **30**, extending transversely horizontally, and a fixed knife **32**, likewise extending transversely horizontally, is arranged so that the paper passes between the two edges of these knives. When the desired length of paper has moved through past the edges of the two knives, the knife **30** is rotated to cut it. A pair of

driven forwarding rollers **34** and **36** advance the paper between a pair of charging elements **38** and **40**. The charging elements **38** and **40** consist of exposed wires suitably housed and on opposite sides of the copy paper. One wire is supplied with a relatively high voltage of one polarity while the other is supplied with a relatively high voltage of the opposite polarity. In this manner, the entire surface of the paper is charged The paper with its coated surface facing upwardly then advances between a driven roller **42** and a back up roller **44** onto the surface of a moving belt **46** supported on transversely extending horizontal rollers.

The copy paper now severed from the roller and with its surfaces charged is advanced by the moving belts **46** to a copying position wherein the belts are stopped. When in this position, the electrical control circuit, in a manner to be explained in detail hereinafter, causes the image on the surface **4** to brighten to a point where it is sufficient to expose the charged paper resting on the upper surface of the belts **46**. The image from the surface **4** is projected onto the surface of an inclined mirror **48** mounted in the enclosure **8** and reflected downwardly through a suitable lens system onto the surface of the copy paper. When thus exposed, the coated surface of the copy paper selectively discharges creating a latent image to be developed by the application of toner material thereto.

To this end the exposed copy paper enters a trough **52** in which there is a quantity of the liquid carried toner sufficient to cover the paper so that the toner particles of a polarity opposite to that of the charged surface of the paper will be attracted to that surface to form the image. The now developed paper passes through a pair of squeegee rollers **54** and **56** and in between a pair of discharge rollers **58** and **60** to be discharged through the opening **16** into the receptacle **20** as a finished copy. A blower **62** may be provided to direct warm air over the copy in order to dry it.

An electrical control circuit which may be used in the embodiment of the invention described and also may be used to provide a remote control capability as well as to provide a basic ability to permit the apparatus to operate in a system where more than one copier is being used is shown in FIG. **3**. The electrical circuit may be supplied by a conventional alternating current source of 115 volts at 60 hertz applied across the terminals **64** and **66**. In a conventional three wire system, the terminal **64** may be connected to a high voltage bus **68** while the terminal **66** is connected to a neutral bus **70**. A ground connection **72** would also be provided. In order to initiate operation in the system, a main power switch, the on-off switch **10**, is actuated to close its contacts **74** and **76** to energize the buses **68** and **70**. The closure of that switch will apply voltage across the buses **68** and **70** between which are connected a float switch **78***a* in series with a light bulb **78** to indicate low toner level and will at the same time energize transformer **88** having a primary winding **90** connected across the buses **68** and **70** which excites a low voltage secondary winding **92**. A drive motor **80**, blower motor **82**, fan motor **84** and toner pump motor are connected across the buses **68** and **70** to be energized when a copy is desired. Connected in series across the secondary winding **92** are the contacts **94** of the of the pushbutton **14** and the operating coil of a relay R *a***1**. Connected in parallel with the contacts **94** are a pair of terminals **96** which extend to a remote control unit to permit remote operation of the apparatus. Also connected in parallel with the contacts **94** are the normally open contacts R*a***1–1** of the relay R*a***1** connected in series with the normally closed contacts R*a***4–3** of another relay R*a***4**. A timer **98** which may be of the solid state type utilizing resistive and capacitive elements to determine the basic timing function is included in the circuit to be energized when the apparatus is started up and to remain energized as long as it is in use but effective to render the circuit, including the various motors thereof, inoperative if the contacts **94** are not closed within a predetermined interval after the last closure. This is accomplished by providing a pair of contacts **100** and **102** controlled by the timer **98** in the buses **68** and **70** which are normally opened but which are closed upon the energization of the timer **98** and are opened again at the end of the predetermined interval fixed by the adjustment of the timer.

Connected in parallel with the timer **98** is the operating coil of a relay R*a***6**. This coil is connected through the normally closed contacts R*a***3–3** of a relay Ra**3** and the normally open contacts R*a***1–2** of the relay Ra**1** and its own normally open contacts R*a***6–1**. The operating coil of the relay R*a***4** is connected across the buses **68** and **70** in series with the normally closed contacts R*a***3–1** of the relay Ra**3** and the normally open contacts **104** of a cam-operated switch. A solenoid **106** effective to operate a clutch coupling the rotary cutter bar **30** to the drive mechanism is connected in series with the normally open contacts R*a***4–2** and the contacts **108** of another cam-operated switch. The solenoid **106** may be of the direct current variety energized from the output terminals of a rectifier bridge **110**. An exposure timer **112** is connected to the bus **68**, the operating coil of the relay R*a***3** and through its own normally open contacts **114** and the normally closed contacts R*a***1– 2** of the relay Ra**1** and also through the normally open contacts R*a***3–2** of the relay R*a***3**. In order to provide an indication that the apparatus is in use, a busy lamp **116** is connected in series with the normally open contacts R*a***6–2** of the relay R*a***6** across the buses **68** and **70**.

In order to provide for feed of the copy paper from the roll **22**, the operating coil of a solenoid **118** effective to clutch the feed rollers **26** and **28** to the drive mechanism so that they may be driven thereby is connected through the normally open contacts R*a***1–3** of the relay Ra**1** and through a pair of parallel contacts, one normally open, **120**, being operated by the timer **112** and the other being normally closed, the contacts R*a***4–1** of the relay R*a***4**. These elements are connected to the bus **68** through the contacts **122** of another cam-operated switch. Also connected to contacts **122** is the operating coil of relay R*a***2** which is connected to those contacts through the normally open contacts R*a***4–1** of the relay R*a***4**. Arranged to be energized from the buses **68** and **70** is a high voltage direct current power supply **123** connected by a conductor **124** to the bus **70** and a conductor **126** through the normally open contacts R*a***1–4** and the normally closed contacts R*a***4–2** to the bus **68**. The output of the power supply **122** is supplied to the high voltage charging elements **38** and **40**.

A main power clutch is controlled by the operating coil of a solenoid **128** connected across a rectifier bridge **130** which in turn is connected across the buses **68** and **70** through the normally open contacts **132** controlled by the timer **112**. Another control relay has its operating coil R*a***5** connecting in series with the normally open contacts R*a***2–2** of the relay Ra**2** and the normally closed contacts **134** of the timer **112**. A cam **135** driven by the motor **80** has lobes operating the switches **104**, **108** and **122** at desired times. Also included in the control circuit is a control panel **136** having the function of maintaining the density of the toner at a desired value.

Shown in this same figure is an outline of the housing **6** for the cathode ray display apparatus. Inasmuch as this apparatus is conventional and in wide use, only that portion of it which is operative to make the desired copy is shown herein. This portion includes a brightness control adjustable resistor **138** connected in the video amplifier circuit in a conventional manner. Connected in series with the adjustable resistor **138** is another adjustable resistor **140** shunted by a pair of normally opened contacts **142** operated by the relay R*a***2**.

This operation of this circuit is as follows. When the contacts **74** and **76** forming a part of on-off switch **10** are closed, power is applied to the low toner level indicating circuit, including indicator light **78**. Likewise, power is supplied to the transformer **88**. When it is desired to make a copy, the contacts **94** operated by pushbutton **14** are momentarily closed which causes the relay R*a***1** to be energized. When the relay R*a***1** is energized, its contact R*a***1–1** closes completing a holding circuit so that that relay remains energized. At the same time the relay contact R*a***1–2** closes causing the timer **98** to become energized as well as causing the relay R*a***6** to operate.

The relay Ra6 when operating closes its contact Ra6–2 energizing the busy light 116 to indicate that the device is in use. Upon the energization of the timer 98 its contacts 100 and 102 close energizing the motors 80, 82, 84 and 86 as well as the toner density control 136. These contacts will remain closed as long as the device is in use and for a predetermined time thereafter. The energization of the relay Ra6 caused it to close contacts Ra6–1 which completed a holding circuit to maintain that relay in an energized state.

If multiple copies are desired, the paper feed cycle for the subsequent copy can be made to occur simultaneously with the developing cycle of the previous copy, thereby reducing the time for making copies. To that end either contacts 94 or terminals 96 can be maintained continuously closed by suitable operating means such as a pushbutton.

The energization of the relay Ra1 caused it to close its contacts Ra1–3 completing a circuit for the paper feed solenoid 118 through the contacts Ra1–3. Likewise, the circuit for the high voltage power supply 122 was completed because the relay contacts Ra1–4 were closed.

With the energization of the motor 80, the cam 135 began to rotate so that the contacts 122 were moved from their normally opened to their closed position interrupting the circuit for the paper feed solenoid 118. The cam lobe operating the contact 122 is shaped to maintain it in its operated position for a period of time overlapping the operating times of the switches 104 and 108. The operation of the contacts 122 interrupted the circuit for the paper feed solenoid 118 causing it to drop out. At a time later the cam 135 closed the contacts 104 momentarily causing the relay Ra4 to pick up. When relay Ra4 picked up, its contacts Ra4–3 opened causing the relay Ra1 to drop out. At a still later time the contacts 108 were operated momentarily by the cam 135 to complete a circuit for the cutter operating solenoid 106 so to sever the desired length of copy paper. When the contacts 122 revert to their normal position, a circuit is complete to pick up relay Ra2 because the contacts Ra4–1 are now closed while the circuit to high voltage supply is interrupted causing it to turn off.

The energization of the relay Ra2 is now possible because the relay Ra4 had previously picked up and locked itself in through contact Ra4–2. Relay Ra2 picking up closed its contacts Ra2–2 causing relay Ra5 to pick up through normally closed contacts 134 operated by the timer 112. Also, the timer 112 began to time out for a predetermined period representing the exposure time. At the end of that period the timer 112 operated to energize a relay forming a part of that timer. The energization of that relay opened the contacts 134 causing the relay Ra5 to drop out. During the period the relay Ra5 was energized, it closed a pair of contacts 142 in the brightness control circuit of the cathode ray tube shunting the adjustable resistor 140 and causing the images on the surface of the tube to brighten. At this point the copy paper which had been previously drawn from the roll 22 and cut to a desired length had moved forward to stop on the upper surface of the belts 46 so that the now brightened image on the surface 4 was reflected by the mirror 48 through the lens system 50 to impinge on that surface selectively discharging it in accordance with the appearance of the image.

Also, at the end of the timing interval fixed by the timer 112 the operation of its contacts 132 once again energized the clutch solenoid 128 and caused the relay Ra3 to become energized through now closed contacts 114. When the solenoid 128 was energized and its associated clutch engaged, the cam 135 once again rotated. The energization of the relay Ra3 opened its contacts Ra3–1 causing the relay Ra4 to become de-energized. The de-energization of the relay Ra4 opened its contacts Ra4–1 causing the relay Ra2 to drop out. After the exposure had been completed and the contacts 132 operated by the timer 112 the clutch controlled by the solenoid 128 caused the belt to advance the now exposed paper into the trough 52 to pass through the toner bath in order that the latent image could be developed. The further rotation of the cam 135 again first closed the switch 122 which had no effect for the circuit to the solenoid 128 had been established through the now closed contacts 132. The continued rotation of the cam 135 at a later time closed the switch 104. At a still later time the switch 108 was operated from its normally closed position interrupting the circuit for the energized relay Ra3 causing that relay to drop out. The de-energization of that relay also caused all of the contacts operated by the timer 112 to revert to their normal positions. With the dropping out of the relay Ra3 the relay Ra6 dropped out opening the circuit to the timer 98 so that the predetermined time interval for that timer began to time out. The continued rotation of the cam subsequently permitted the switch 120 to return to its normal position interrupting the circuit for the solenoid 128 operating the main clutch disengaging that clutch. The cycle then continued for the remainder of the time interval fixed in the timer 98 at the end of which interval that timer opened its contacts 100 and 102 de-energizing the buses 68 and 70 causing the apparatus to revert to the stand-by condition.

The operation of the apparatus was such that after the sheet had passed through the trough 52 the excess toner had been removed therefrom by the rollers 54 and 60 and dried by the hot air from the blower 62 and passed through the opening 16 into the receptacle 20.

FIG. 4 of the drawing illustrates an embodiment of the invention wherein the apparatus is modified to permit a single copier to make copies from more than one cathode ray tube. This embodiment of the invention shows a plurality of cathode ray tubes designated monitors 200, 202 and 204. The conductors carrying the video information to each of the monitors also carries the information to a selector switch means 206 which may in its simplest form consist of a multi-position switch to connect the output of any one of the monitors to a conductor 208 so that as it is displayed on the selected monitor it will be displayed at the same time on a cathode ray tube forming a part of the copying apparatus 210 similar to that apparatus shown in FIG. 1.

The selector switch 206 is a part of a set of individual remote control units 212*a*, 212*b*, 212*c* which may be available to each observer or user of the monitors 200, 202 and 204. Each remote control unit includes respective print switches 214*a*, 214*b*, 214*c* which are connected in parallel across contacts 96 in the circuit illustrated in FIG. 3 and may be used to complete the circuit between those contacts. It further includes respective supplies and status indicators 216*a*, 216*b* and 216*c*. The latter may constitute lights, as shown for indicator 216*a* in FIG. 5, advising the user that there is sufficient paper available in order that copies may be made, light 217; that there is sufficient toner so that copies may be developed, a light 218, the latter being an equivalent remote indicator for the light bulb 78, which is described previously; that a copy is being made, a busy light 219, the latter corresponding to a light such as shown at 116 in FIG. 3; that a copy has been made and the machine is not jammed, a copy received light 220; and that the sensitized paper is being exposed to the image, an exposure in process light 222.

The three monitors are each supplied by a different video signal. This video signal is also supplied to the selector switch logic, 206. Each monitor has a unique print switch to supply the print request to the selector switch logic. When a print request is made the video signal relating to that switch is connected to the video line, 208, feeding the copier 210. (Print switch 214*a* connects video 1, 214*b* connects video 2, and 214*c* connects video 3.)

The same indicators and indicator signals are fed to each monitor station (212*a*, *b*, *c*) and to the selector switch logic. In the most simple configuration the busy signal indicates to the operators that they should not request prints and also causes the selector switch to ignore such requests.

More elaborate logic may be incorporated for additional features.

1. Memory of print request to allow a request at any time. Operation performed in turn.

2. If memory of print request exists, keep print command contacts closed to allow combination of paper feed and develop cycles.
3. Use exposure in process indication to determine when to switch video rather than wait for busy to go off.
4. Allow multiple copies, one for each sequential operation of print switch at time of request.
5. Allow multiple copies with electromechanical or electronic counters set by code transmitted from the remote monitor.
6. Collating copies by multilevel receiving tray positioned by the selector logic.

The apparatus thus provides a means whereby more than one user may have access to a copying device for producing copies of images displayed on cathode ray tubes in a number of different locations.

Thus, it will be understood that any number of changes may be made in the details of construction, arrangement, and operation without departing from the spirit of the invention, especially as defined in the following claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for copying images projected on a cathode ray tube viewing surface comprising means positioned in front of the viewing surface and spaced a distance therefrom, for projecting an image from the viewing surface onto a sheet of copying paper and for allowing direct viewing of the surface by an observer; image copying means comprising: a source of copying paper; means for supplying copying paper from said source; means for severing a desired length of copying paper; means for imposing an electrostatic charge on the surface of the copying paper; means for transporting the charged length of copying paper to a position at which the image on the viewing surface may be impressed thereon to selectively discharge the surface of the copying paper to form a latent image thereon; means for developing the latent image; means for transporting the exposed copying paper through said developing means;

means for controlling the brightness of the image on the surface of the tube; and means for controlling said brightness controlling means to cause the image to brighten when it is desired to expose the surface of the charged copying paper to the image.

2. The apparatus of claim 1 wherein the viewing surface and said projecting means are positioned above said image copying means and said projecting means includes an angled mirror in front of the viewing surface and a lens system for focusing the image onto the surface of copying paper below said lens system.

3. The apparatus of claim 2 including an electrical circuit for controlling said image copying means, said electrical circuit including: a print switch; an exposure timer; means responsive to the operation of said exposure timer, and electrical switch means controlled by said exposure timer.

4. The apparatus of claim 3 wherein said electrical switch means are included in said brightness controlling means and when operated by said exposure timer are effective to increase the brightness of the image for a period of time determined by said exposure timer.

5. Apparatus for copying images selectively from any one of a plurality of cathode ray tube monitors comprising: means for selectively switching the image on any one monitor to another cathode ray tube while at the same time continuing the display of the image on the selected monitor, image copying means comprising: a source of copying paper; means supplying copying paper from said source; means for severing a desired length of copying paper; means for imposing an electrostatic charge on the surface of said copying paper; means for transporting the charged length of copying paper to an exposure position; optical means for projecting the selected image on said another cathode ray tube onto the copying paper in the exposure position to form a latent image thereon; means for developing the latent image; and means for transporting the exposed copying paper through said means and delivering it to the user.

6. The apparatus of claim 5 including an operator control unit having means selecting the monitor having an image on its viewing surface to be copied, means initiating copying of the selected image, means indicating that the image copying means is in use and means for indicating that a copy has been made.

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