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[73] Assignee **The Singer Company**
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[33] **Germany**
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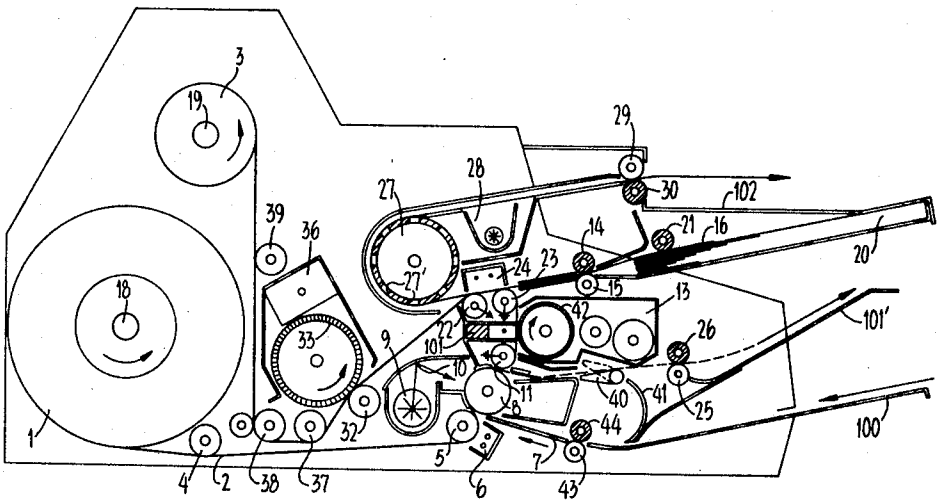
[54] **COPYING APPARATUS**
4 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **355/16,** 355/64
[51] **Int. Cl.** **G03g 15/00**
[50] **Field of Search** 355/3, 12, 16

[56] **References Cited**
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ABSTRACT: The various components necessary to provide electrostatic reproductions of originals are arranged in a manner such that the apparatus is dimensionally more compact. The photoconductive web moves in a substantially U-shaped path from a supply reel through a charging station, an exposure station, developer station and an image transfer station to a takeup reel. Similarly, the original sheets are moved in a U-shaped path and into contact with the photoconductive web while the copy sheets are fed individually in a similar U-shaped path coincident with the photoconductive web for transfer of the developed image.



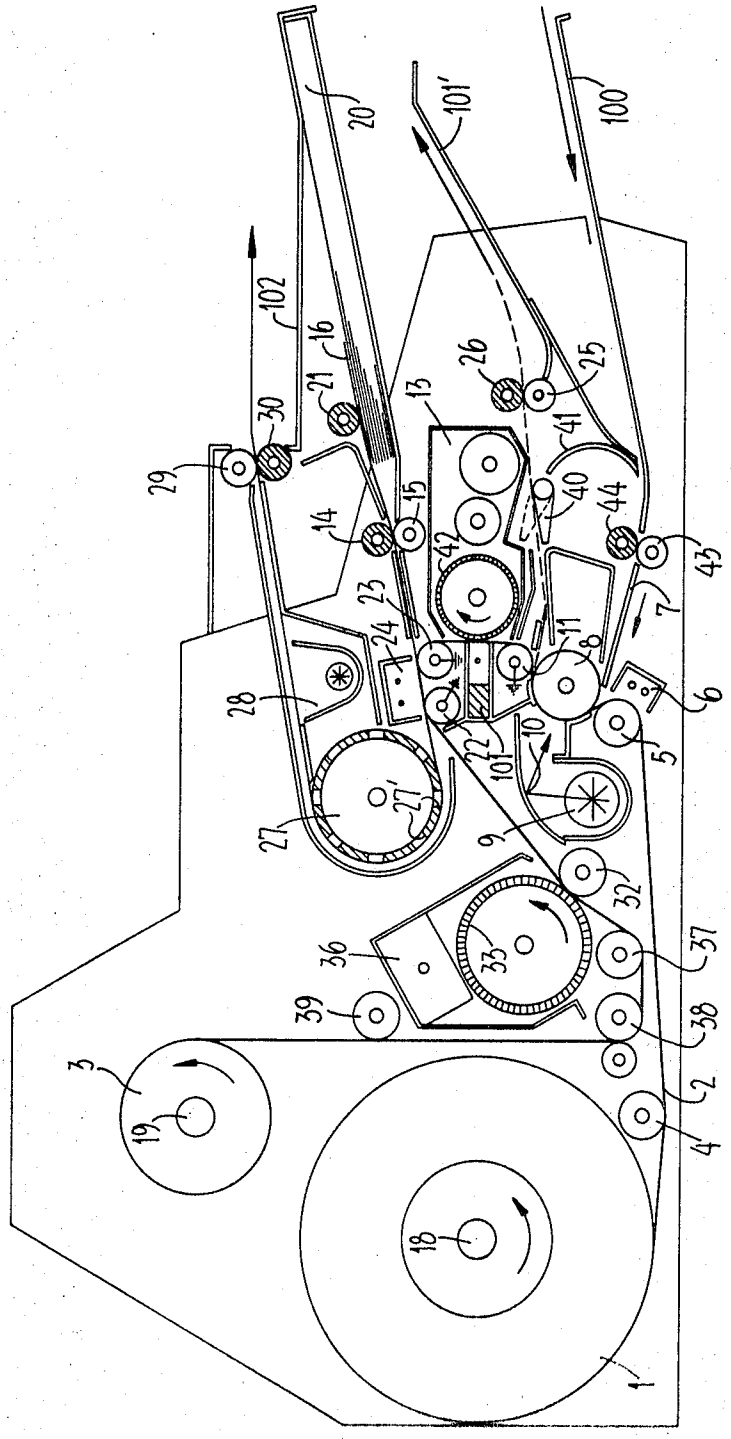


Fig. 1

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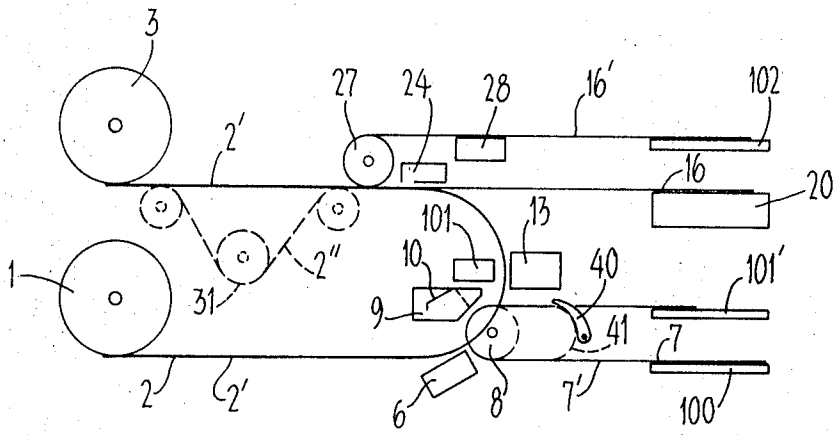


Fig_2

COPYING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to an electrophotographic apparatus, more particularly to the spatial arrangement of the various components utilized to effect an electrostatic reproduction of an original on one or more sheets of copy paper. In known types of electrostatic copiers such as the type utilizing an electrophotographic plate in the form of a drum, the drum diameter and axial length is the first consideration in the overall dimensions of the reproduction apparatus. Generally, the diameter of the drum is sufficient to provide a circumferential surface upon which an electrostatic latent image of standard size documents such as legal documents may be formed. Around the drum are clustered the various components necessary to the electrostatic reproduction of a document. These elements include the corona charging device, the optical exposure system, the developer housing and a conveyor system for moving copy sheet material into contact with the drum for transfer to the developed latent image from the drum surface to the copy sheet. Also included is a fusing, or fixing, station and a cleaning device for removing the remaining developer powder from the drum. In locating these various components around the drum, for cooperative relationship therewith, a housing of sizable dimensions is required. The trend today in the design and manufacture of business or office machines is toward smaller and more compact machines.

SUMMARY OF THE INVENTION

In accordance with the present invention, an electrophotographic plate in the form of a paper web or tape having a photosensitive surface coating is passed through the machine in a substantially horizontal U-shaped loop from a supply reel to a takeup reel. Likewise, the original to be copied, as well as the copy paper for receiving the reproduction, travel in substantially horizontal U-shaped paths, respectively, relative to the path of travel of the paper tape, the copy paper path being superimposed and spaced from the path of travel of the original.

The various components necessary to the function of the apparatus are advantageously arranged between the legs of the U-shaped path of travel of the photoconductive tape and between the path of the copy paper and that of the original. By this arrangement and the functional grouping of the various components along the path of travel of the tape, a small, low profile structure is possible. It is, therefore, an object of the present invention to provide an electrostatic copier in which the various steps are performed in a single machine of small, compact construction.

Other objects and advantages will appear from the following description of a preferred embodiment as illustrated in the accompanying drawings in which:

FIG. 1 is a longitudinal sectional elevational view of the machine in which the parts necessary for an explanation of the invention are shown diagrammatically; and

FIG. 2 is a schematic of the device exemplifying the U-shaped arrangement of parts.

The invention is shown as embodied in the device of FIG. 1, wherein a photoconductive plate 2 comprises a tape or web which may be of paper having a surface coating of a photosensitive material such as zinc oxide. In its path of travel, the tape 2 is taken from a supply roller, or reel, 1, passes adjacent a charging station, an exposure station, a developer station, an image transfer station, and a cleaning station to be wound on a takeup reel. Following the complete winding of the tape 2 onto the takeup reel 3, the tape may be rewound on the supply reel 1 for reuse. Each of the reels 1 and 3 is suitably supported on spindles 18 and 19, respectively, in superimposed axially-parallel relationship, the spindles 18 and 19 being selectively driven to control the takeup or the rewinding of the tape 2.

From the supply reel 1, the tape 2 travels in a substantially horizontal path over guide rollers 4 and 5 with the photosensitive surface facing downwardly and, as it passes over roller 5, the photosensitive surface of the tape is charged by means of a corona-generating device 6. Upon leaving roller 5, the path of the tape is directed upwardly and inwardly in contact with substantially one-half the circumferential surface of an exposure roller 8, thence over a guide roller 11. Exposure roller 8 is axially parallel to rollers 5 and 11, with its peripheral surface spaced only sufficiently from rollers 5 and 11 and out of contact therewith to permit the entry and ejection of an original sheet 7 to be copied.

At this point in time, that is, immediately upon charging the moving tape 2, an original sheet 7 to be copied is moved by feed rollers 43 and 44 from a guide plate or table 100 into the nip of exposure roller 8 and tape 2, the original 7 being moved in timed relation to the linear speed of the tape. As the original sheet 7 and a charged area of tape 2 pass together over roller 8, a light source 9 and reflective surface 10 become effective by reflex image to form a latent electrostatic image of the original on the charged photosensitive surface of the moving tape 2.

As the tape 2 continues to move in its path and as the latent image bearing area of the tape passes over roller 11, the original sheet 7 is separated therefrom and ejected by means of suitable rollers 25 and 26 into a tray 101'. Thus, it can be seen that the original sheet 7 moves in a substantially horizontal U-shaped path from table 100 over exposure roller 8 and onto ejection tray 101', the roller 8 forming the closed end of the U-shaped path. Upon separation of the original sheet 7 from the tape 2, the path of the original sheet may be selectively altered by means of a diverter gate 40, which gate is effective in the position shown in FIG. 1 to direct the original sheet against an arcuately formed guide plate 41 for return into the bite of the feed rollers 43 and 44, whereupon the original is reengaged with a freshly charged area of the tape 2 for the formation of an electrostatic latent image thereon. It, therefore, becomes apparent that in the active position of the diverter gate 40 shown in FIG. 1, multiple reproductions of an original sheet 7 may be selectively controlled.

Upon separation of the original sheet 7 from the tape 2, the electrostatically-formed latent image area continues in its path upwardly from guide roller 11 over a guide roller 23. In the relatively short run of the tape 32 between rollers 11 and 23, the electrostatic image thereon is dusted with developer powder by the conventional brush 42 rotating in the developer powder reservoir 13. The development of the latent image is enhanced by the use of a bias corona device 101 positioned between rollers 11 and 23 within the loop of the tape 2 and adjacent the back or nonimage bearing surface of the tape for cooperation with the brush 42.

As the tape 2 with the developed latent image thereon continues in its movement, the path of travel of the tape is reversed as it passes over guide rollers 23 to a guide roller 22 at a slight angle to the horizontal. Rollers 22 and 23 are axially parallel and are closely spaced, one from the other, with a corona discharge element 24 positioned directly above and spaced from the run of the tape between rollers 22 and 23.

Immediately upon development of the latent image during the movement of the tape, a sheet of ordinary copy paper 16 is separated by means of a roller 21 from the supply of paper 20. This sheet of copy paper is then moved by transport rollers 14 and 15 at an equivalent speed and in timed relation to the linear speed of the tape 2 in a plane coincident with the plane of the run of tape between rollers 22 and 23 and beneath corona discharge element 24 to effect transfer of the developed latent image from the tape onto the copy paper 16. During the movement of the copy paper 16 with the tape 2, and prior to its release from transport rollers 14 and 15, the leading edge of the copy paper is grasped by and adheres to the surface of the separator roller 27. In order to effect the separation of the copy paper from the tape, a series of

apertures 27' are provided in the wall of the cylindrical roller 27. The apertures 27' in one-half of the wall, circumferentially of the roller 27, are open to a subatmospheric pressure within the cylindrical roller. Thus, the paper copy 16 is moved in a U-shaped path from the paper supply 20 over cylindrical roller 27 to the finished copy repository 102.

Following the transfer of the developed latent image from the tape 2 onto the sheet of copy paper 16 and the separation of the paper from the tape or web 2, the copy paper is passed over the fusing, or fixing, device 28 which is effective to fix the developed image on the copy paper. As the copy paper 16, bearing the developed image, is passed over the fusing device 28, its leading edge is engaged in the nip of copy ejection rollers 29 and 30, prior to the release of the sheet from the cylindrical roller 27, for ejection of the sheet into the repository 102.

Following the transfer of the developed latent image from the tape onto the copy sheet 16, the path of the tape 2 is diverted downwardly over roller 32. At this point in its travel, a suitable brush 33 becomes effective to remove the residual developer powder from the photosensitive surface of the tape, the brush 33 rotating counter to the direction of travel of the tape. During the operation of the cleaning brush 33, the residual powder removed from the tape is exhausted by means of the suction device 36. Continuing in its movement, the tape 2 travels over guide roller 37 and between rollers 38 in contact with roller 39 and onto the takeup reel 3.

Referring now to FIG. 2, it can be seen that a low profile, more compact design of the apparatus is effected by the proximate arrangement of the many and various components necessary to the function of the reproduction apparatus. As schematically shown in FIG. 2, each of the moving prime elements that come into play during a reproduction operation of the apparatus travel in a substantially horizontal U-shaped path. Such elements constitute the photoconductive tape or web 2, moving in the U-shaped path 2' from the supply reel 1 to the takeup reel 3. It will be noted that although tape 2 is diverted downwardly in the path 2'' indicated by dash line in FIG. 2, through the cleaning station 31, it does not in any way alter the basic U-shaped path of travel of the tape since the cleaning station 31 is positioned between the legs 2' of the hypothetical U-shaped path. The second moving element in the form of the original sheet 7 travels in the U-shaped path 7' over the exposure roller 8, where it is in contact with the tape 2 at the crown portion of the U-shaped, or looped, path 2' of the tape 2 and thence to the ejection tray 101'. As explained above, for multiple reproductions of a single original, such original may be redirected over the exposure roller 8 for a given number of exposures by the selective control of diverter gate 40 and sheet guide 41. The third of the moving elements, that of each copy sheet 16 upon separation from sheet supply 20, moves in the U-shaped path 16' to the finished copy repository 102. Each sheet of copy paper 16 is moved along the lower leg of the U-shaped path 16' in a plane coincident with that of the path 2' of the photoconductive tape, or web 2.

It will be noted that the arrangement of the various components essential to the reproduction of an original onto a copy sheet is such that there is very little, if any, lost motion of the photoconductive tape 2 through each of the stations, that is, from the corona charging station 6 through the exposure station 8, 9, 10 to the developing station 13 and its bias corona 101, to the image transfer corona 24. This is made possible to a great extent by the placement of the exposure lamp and mirror 9 and 10, as well as the bias corona 101, between the legs of U-shaped path 2' of the tape 2. Also, by the placement of the image transfer corona element 24 and the fusing device 28 between the legs of the U-shaped path 16' of the copy paper 16. The substantially horizontal parallel paths 7' and 16' are spaced apart sufficiently only to enable the disposition of the developer powder reservoir 13 therebetween.

It can be seen that a more compact, low-profile electrophotographic reproduction apparatus is made possible by the arrangement of the various components, for the most part, within the confines of the U-shaped path of travel of the photoconductive web and that of each of the related paths of movement of the original sheets and the copy sheets. By this grouping of the various components, the shortest possible travel between the functional stations is made possible.

The invention resides in the combination and arrangement of parts herein described and claimed, it being understood that various changes in the precise embodiment of the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention.

I claim:

1. An electrophotographic printer comprising:
- a supply reel and a takeup reel;
- a web having a photosensitive surface and adapted to move in a looped path from said supply reel to said takeup reel;
- means for applying a charge to the photosensitive surface of said web;
- an exposure means disposed adjacent said charge applying means;
- a first paper feed means for moving an original sheet in a generally U-shaped path into contact with the photosensitive surface of said web for movement therewith and the formation of an electrostatic latent image of said original on said web by said exposure means;
- ejector means normally operable to continue the movement of the original sheet by said first paper feed means in the U-shaped path subsequent to the formation of a latent image on said web;
- a diverter means disposed between the legs of the U-shaped path of movement of an original sheet by said first paper feed means selectively operable to supersede the operation of said ejector means and enable repeated feeding of a single original by said first paper feed means;
- a developer means for applying powder to the electrostatic latent image on said web immediately subsequent to the operation of said first paper feed means;
- a second paper feed means for moving a copy sheet in a generally U-shaped path operable to engage said copy sheet with the developed image bearing surface of said web for movement therewith, one leg of the U-shaped path of the copy sheet being in a plane coincident with the looped path of said web;
- an image transfer means for effecting the transfer of the developed latent image from said web to said copy sheet upon operation of said second paper feed means and the engagement of said copy sheet with the photosensitive surface of said web;
- a separating means forming the closed end portion of the U-shaped path of travel of the copy sheet effective during operation of said second paper feed means to separate the copy sheet from said web following operation of said image transfer means; and
- a fusing means disposed within the U-shaped path of travel of the copy sheet operable to fix the transferred image on the copy sheet subsequent to the operation of said separating means.

2. An electrophotographic printer comprising:
- a supply reel and a take up reel;
- a web having a photosensitive surface and adapted to move in a looped path from said supply reel to said takeup reel;
- means for applying a charge to the photosensitive surface of said web;
- an exposure means disposed adjacent said charge applying means;
- a first paper feed means for moving an original sheet in a generally U-shaped path into contact with the photosensitive surface of said web for movement therewith and the formation of an electrostatic latent image of said original on said web by said exposure means;

ejector means normally operable to continue the movement of the original sheet by said first paper feed means in the U-shaped path subsequent to the formation of a latent image on said web;

a developer powder reservoir disposed adjacent the image bearing surface of said web along the looped path thereof;

a brush rotatable in the powder within said reservoir operable to dust the latent image bearing surface of said web;

a counter-corona charging element associated with said rotatable brush disposed within the confines of the looped path of said web and adjacent the nonimage bearing surface of the web;

a second paper feed means for moving a copy sheet in a generally U-shaped path operable to engage said copy sheet with the developed image bearing surface of said web for movement therewith, one leg of the U-shaped path of the copy sheet being in a plane coincident with the looped path of said web;

an image transfer means for effecting the transfer of the developed latent image from said web to said copy sheet upon operation of said second paper feed means and the engagement of said copy sheet with the photosensitive surface of said web,

a seperating means forming the closed end portion of the U-shaped path of travel of the copy sheet effective during operation of said second paper feed means to separate the copy sheet from said web following operation of said image transfer means; and

a fusing means disposed within the U-shaped path of travel of the copy sheet operable to fix the transferred image of the copy sheet subsequent to the operation of said separating means.

3. An electrophotographic printer comprising:

a supply reel and a takeup reel;

a web having a photosensitive surface and adapted to move in a looped path from said supply reel to said takeup reel;

means for applying a charge to the photosensitive surface of said web;

an exposure means disposed adjacent said charge applying means;

a pair of coacting rollers rotatable at a speed equivalent to the linear speed to said web for moving an original sheet in a generally U-shaped path into contact with the photosensitive surface of said web;

a feed roller forming the closed end of the U-shaped path of travel of the original sheet operable to move an original sheet with said web for reflex exposure by said exposure means forming an electrostatic latent image on the photosensitive surface of said web;

ejector means normally operable to continue the movement of the original sheet in the U-shaped path subsequent to the formation of a latent image on said web;

a developer means for applying powder to the electrostatic latent image on said web immediately subsequent to the operation of said ejector means;

a paper feed means for moving a copy sheet in a generally U-shaped path operable to engage said copy sheet with the developed image bearing surface of said web for movement therewith, one leg of the U-shaped path of the copy sheet being in a plane coincident with the looped path of said web;

an image transfer means for effecting the transfer of the developed latent image from said web to said copy sheet upon operation of said paper feed means and the engagement of said copy sheet with the photosensitive surface of said web;

a separating means forming the closed end portion of the U-shaped path of travel of the copy sheet effective during operation of said paper feed means to separate the copy sheet from said web following operation of said image transfer means; and

a fusing means disposed within the U-shaped path of the travel of the copy sheet operable to fix the transferred image on the copy sheet subsequent to the operation of said separating means.

4. In the apparatus of claim 3 wherein said exposure means comprises a light source, and

a reflector means for directing light from said light source onto said web for reflex imaging of an original sheet by said feed roller to form an electrostatic latent image on said web, said light source and said reflector means being disposed within the looped path of said web.