Dec. 13, 1966 B. D. EISNER ETAL 3,291,024

PHOTOCOPY MACHINE

Filed May 28, 1964 4 Sheets-Sheet 1

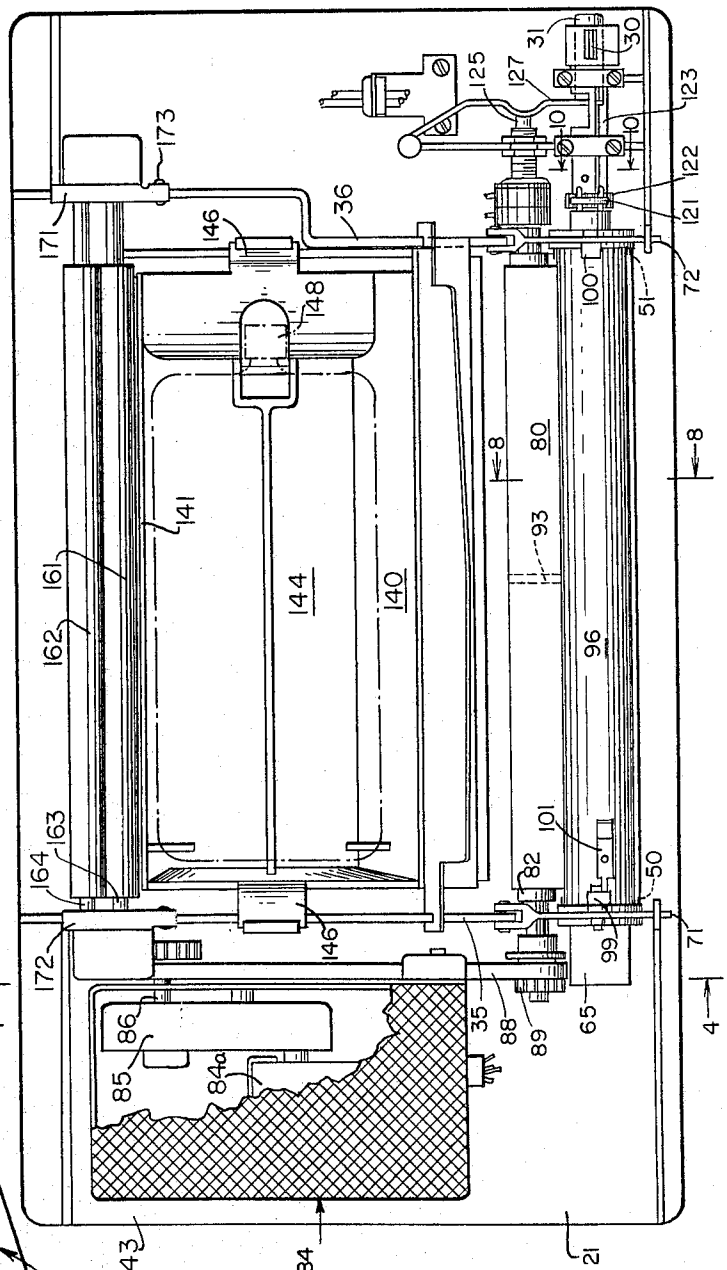


FIG. 2

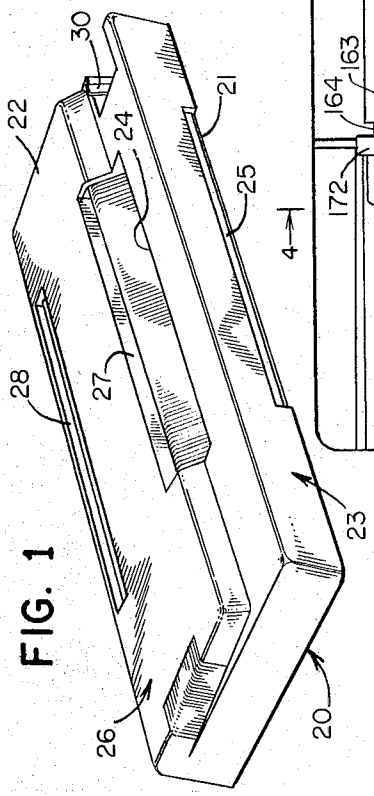


FIG. 1

Inventors
Burton D. Eisner,
Philip J. Burnstein.

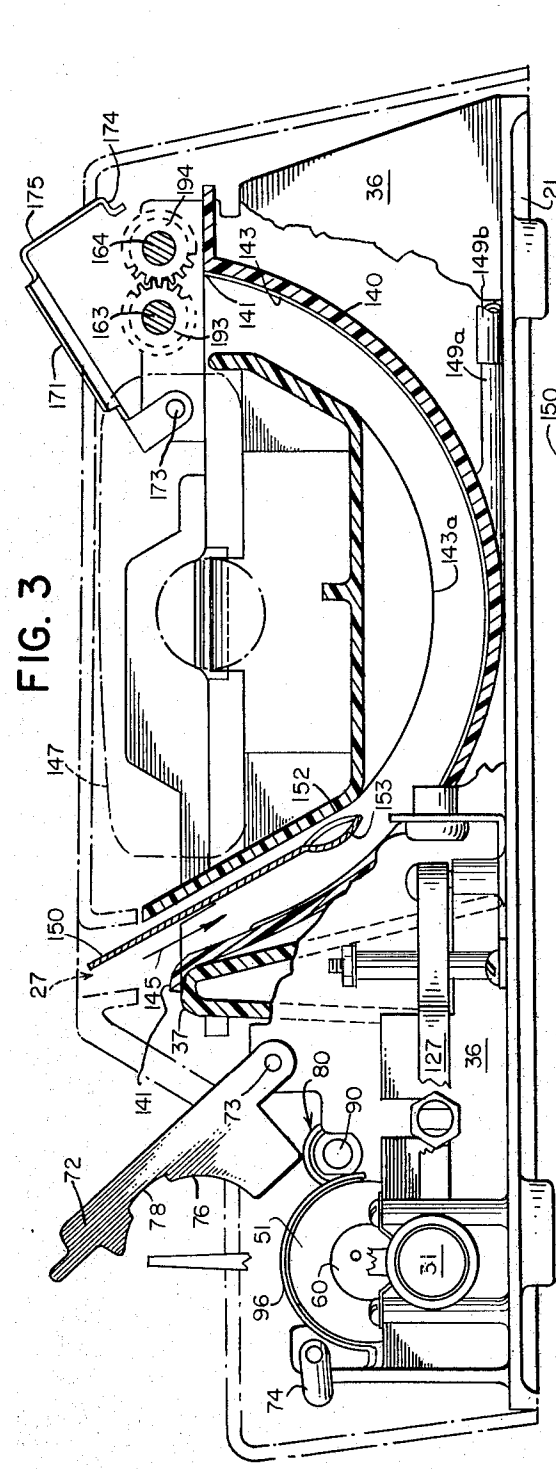
By
Wolfe, Hubbard, Voit & Osann

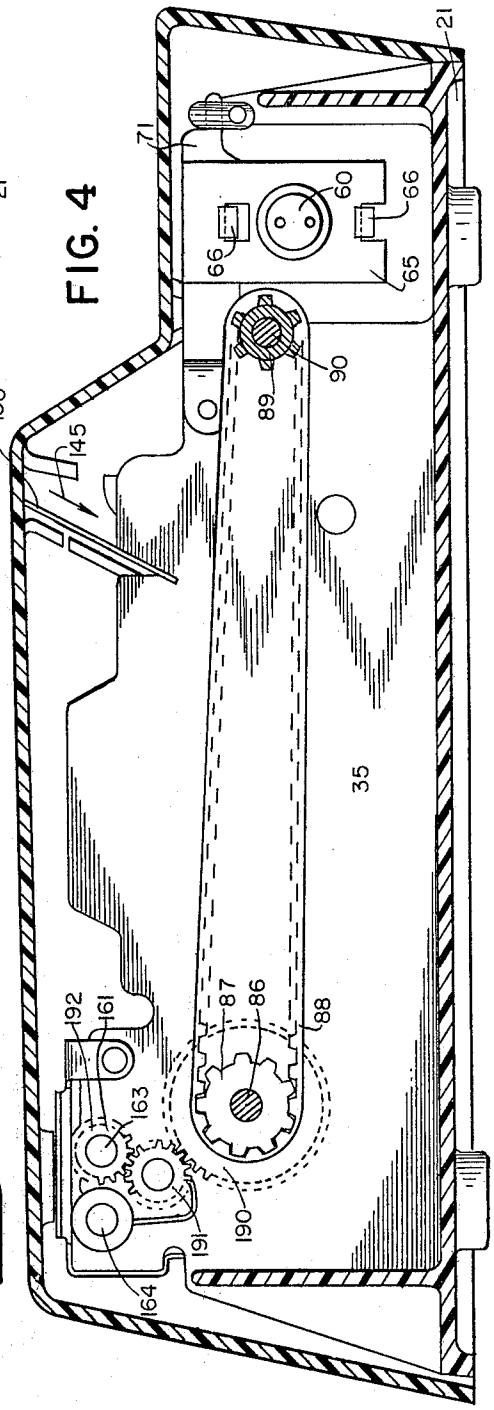
Attys.

Dec. 13, 1966 B. D. EISNER ETAL 3,291,024

PHOTOCOPY MACHINE

Filed May 28, 1964 4 Sheets-Sheet 2





Inventors
Burton D. Eisner
Philip J. Burnstein

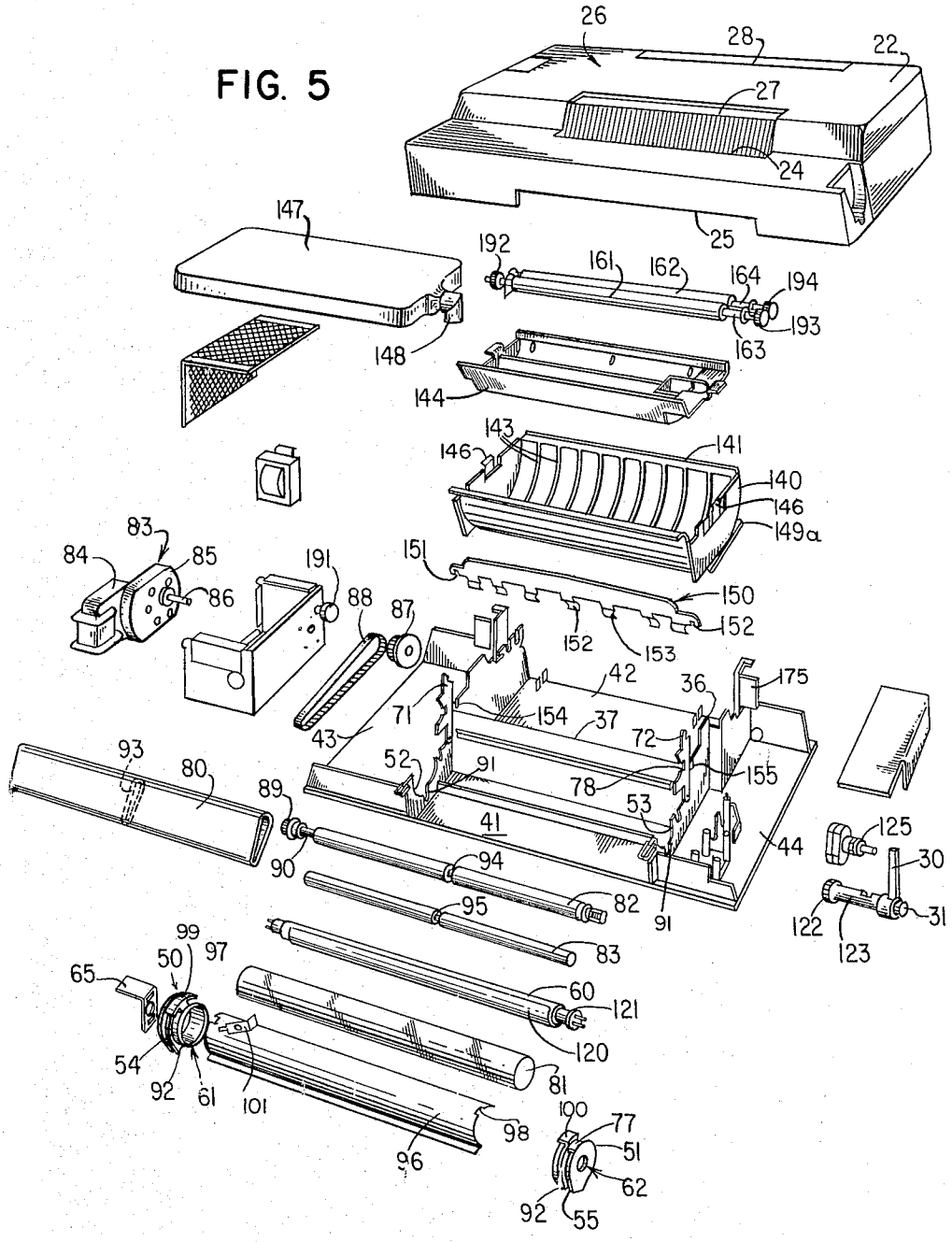
By
Wolfe, Hubbard, Voit & Osann
Attys.

Dec. 13, 1966 B. D. EISNER ETAL 3,291,024

PHOTOCOPY MACHINE

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FIG. 5



Inventors
Burton D. Eisner,
Philip J. Burnstein.

By
Wolfe, Hubbard, Voit & Osann
Attys.

Dec. 13, 1966 B. D. EISNER ETAL 3,291,024

PHOTOCOPY MACHINE

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FIG. 9

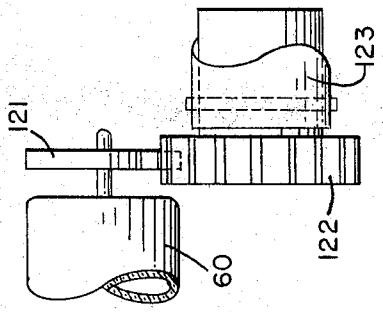


FIG. 11

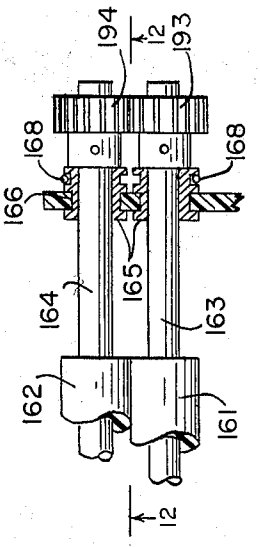


FIG. 10

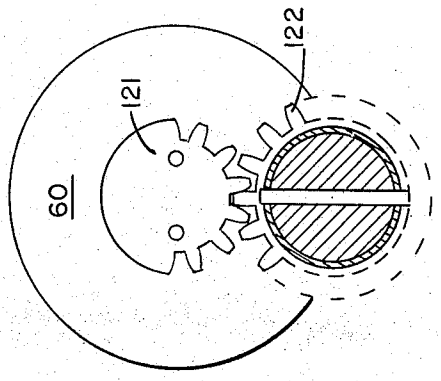


FIG. 12

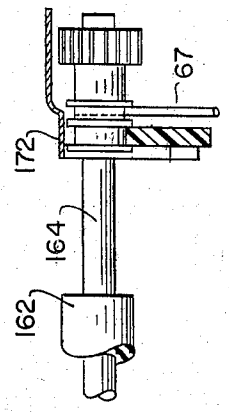


FIG. 7

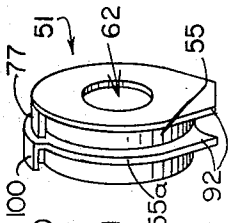


FIG. 6

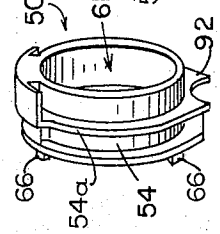
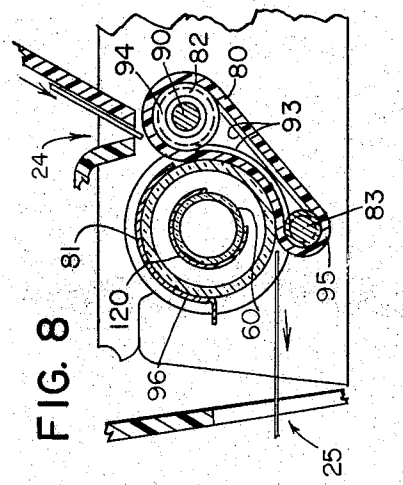


FIG. 8



Inventors
Burton D. Eisner,
Philip J. Burnstein

By Wolfe, Hubbard, Voit & Osann

Attys.

United States Patent Office 3,291,024 Patented Dec. 13, 1966

3,291,024

PHOTOCOPY MACHINE

Burton D. Eisner, Highland Park, and Philip J. Burnstein, Skokie, Ill., assignors to American Photocopy Equipment Company, Evanston, Ill., a corporation of Illinois

Filed May 28, 1964, Ser. No. 370,937
3 Claims. (Cl. 95—77.5)

The present invention relates generally to photocopy machines and, more particularly, to a machine for office use which is capable of making superior copies but which may be made and sold at a cost which is substantially less than that of comparable machines.

It is a primary object of the present invention to provide a photocopy machine which is capable of carrying out the diffusion-transfer-reversal process but which is extremely simple and compact, having a minimum number of simply formed parts and which is easily manufactured and easy to service. It is another object of the invention to provide such a machine which avoids the necessity for a resilient driving roller for the exposing cylinder of the machine, thereby avoiding the problem of maintaining the sponginess or resiliency of such a driving roller over extended operating periods at elevated temperatures. Conversely, it is an object to provide an improved belt driving system which is stable over extended operating periods and in which the belt remains perfectly centered during tensioning and relaxation thereof.

It is another object of the invention to provide a photocopy machine of the foregoing type which avoids the necessity of revolving the fluorescent lamp in the exposing means. A related object is to provide such a machine which includes an improved supporting structure which permits the lamp to be adjusted through an angle to vary the degree of exposure while also supporting the rotating exposing cylinder, the outside shield for the exposure unit, and an idler roll for the belt drive. Yet another object is to provide such supporting means which enables the fluorescent lamp and the outside shield to be separately removed for replacement or servicing without disassembling the entire exposure unit.

A further object of the invention is to provide an improved compact photocopy machine capable of carrying out the diffusion-transfer-reversal process and having a drainable developer tank. Another object is to provide such a machine having a one-piece base construction which permits the various parts to be simply dropped into place so the complete assembly and disassembly of the machine can be carried out quickly and efficiently. Still another object is to provide such a machine having a remote-controlled switch which permits the on-off button and the exposure control handle to be located at the same point for convenience of operation.

Other objects and advantages of the invention will become apparent upon reading the following description and appended claims and upon reference to the drawings, in which:

FIGURE 1 is a perspective view of an office copying machine embodying the features of the present invention;

FIG. 2 is a top plan view of the machine of FIGURE 1 with the housing removed and with a portion of the motor unit broken away to show the internal structure;

FIG. 3 is an end elevation view taken from the right-hand end of the machine as shown in FIG. 2, with a portion of the supporting partition 36 being broken away to show the internal structure of the developer tank;

FIG. 4 is a sectional end elevation view taken through the left-hand end of the machine along the line 4—4 in FIG. 2;

FIG. 5 is a perspective view showing the unitary base member and all the other parts of the machine in exploded positions;

FIG. 6 is a perspective of the left-hand bearing sleeve employed in the exposing unit of the machine;

FIG. 7 is a perspective of the right-hand bearing sleeve employed in the exposing assembly of the machine;

FIG. 8 is a fragmentary transverse section taken along the line 8—8 in FIG. 2 with cooperating portions of the housing added to show how the original and copy sheet are passed through the exposing unit of the machine;

FIG. 9 is an enlarged fragmentary elevation view showing the right-hand end of the fluorescent tube 60 and the exposure cantrol gears associated therewith;

FIG. 10 is an enlarged end elevation view of the fragment shown in FIG. 9;

FIG. 11 is a fragmentary section taken through one end of the expeller rollers and showing the bearings therefor; and

FIG. 12 is a section taken along the line 12—12 in FIG. 11 showing the spring clip and hold down arrangement used for the expeller rollers.

While the invention will be describel in connection with a preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment but, on the contrary, it is intended to cover the various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Turning now to the drawings, there is shown in FIG. 1 a photocopy machine 20 constructed in accordance with the present invention, having a one-piece base 21 and a housing 22. As will become apparent as the discussion proceeds, the front portion of the machine includes an exposing assembly 23 having an inlet slot 24 and an outlet slot 25. The rear portion of the machine comprises a developing assembly 26 having an inlet slot 27 and outlet slot 28. At the right-hand side of the machine is an exposure control handle 30, the machine being turned on and off by means of a button 31 (see FIGS. 2 and 5) at the base of the handle 30.

The operation of the various parts will be described in detail in the paragraphs which follow. It will be understood at the outset that the photocopy machine of this invention employs the well-known diffusion-transfer-reversal process. A copy sheet and the original to be copied are fed into the exposing assembly 23 through the slot 24, the two sheets subsequently exiting through the slot 25. The degree of exposure is controlled by the handle 30. Following the exposing operation, the copy sheet is separated from the original and placed face to face with a transfer sheet. These two sheets are then inserted into the slot 27 so that both sheets are wetted with developer fluid, following which the sheets are brought together face to face under pressure for ejection from the slot 28 as a pair. After allowing a short time for the development and transfer to be completed, the sheets are peeled apart, with one sheet being retained as a positive copy of the original.

Turning to the internal construction shown in FIGS. 2–5, the base 21 of the machine is of rectangular shape including a left-hand partition 35 and a right-hand partition 36 running from front to back within the machine and interconnected by a longitudinal partition 37. The partitions are preferably molded integral with the base 21, the left- and right-hand partitions being utilized to mount the various rotating elements. The partitions serve to define an exposure compartment 41 at the front of the machine, a development compartment 42 behind it, a motor compartment 43 at the left-hand end, and a control compartment 44 at the right-hand end.

In accordance with the present invention, the exposure

unit includes a pair of annular bearing members seated in the respective partitions **35** and **36**, a fluorescent tube transversely arranged with respect to the partitions and having its ends projecting through small center openings in the bearing members, an elongated transparent cylinder fitted over the fluorescent tube with the ends of the cylinder being journalled in the bearing members, and a flexible belt substantially as wide as the exposed portion of the transparent cylinder rotatably mounted between the partitions in bearing engagement with the outer surface of the cylinder. Thus, in the particular embodiment illustrated in the drawings, a pair of plastic bearing sleeves **50** and **51** are seated in notches **52** and **53** formed in the partitions **35** and **36**, respectively. In order to hold the bearing sleeves **50**, **51** firmly in place, they are provided with peripheral grooves **54**, **55** (see FIGS. 6 and 7) adapted to fit snugly down over the edges of the partitions **35**, **36** within the notches **52**, **53**.

The light source for the exposure unit is provided by a fluorescent lamp **60** arranged transversely with respect to the partitions **35**, **36** so that the ends of the lamp project through small center openings **61**, **62** in the bearings **50**, **51** for engagement with a pair of sockets (not shown) which are connected to the conventional A.C. supply line. The opening **62** in the right-hand bearing **51** has a diameter approximately the same as that of the reduced end portion of the lamp so as to provide a snug journal support for that end of the lamp. In order to permit the lamp **60** to be removed, for replacement or cleaning purposes for example, without disassembling the entire exposure unit, the opening **61** in the left-hand bearing sleeve **50** is made slightly larger than the largest diameter of the lamp so that the lamp may pass freely therethrough. The left-hand end of the lamp **60** extends through the opening **61** and is journalled in a releasable latch **65** which is mounted on two projecting catches **66** on the outside of the bearing member **50** (see FIG. 4). To remove the lamp, the operator detaches the sockets from the lamp, lifts the latch **65** slightly to disengage it from the catches **66**, and then pulls the latch away from the bearing sleeve **50** over the end of the lamp so that the lamp may be withdrawn through the opening **61**.

In order to lock the bearing members **50**, **51** in place in the partitions, a pair of clamps **71**, **72** are mounted on the respective partitions **35**, **36** (see FIGS. 3 and 5). Taking the right-hand clamp **72** by way of example, it will be noted in FIG. 3 that it is pivoted at **73** and held down by a small latch **74** pivoted on the front corner of the partition **36**. The clamp includes an arcuate cutout **76** which follows the contour of the bearing sleeve **51**, being received in the peripheral groove **55** formed in the bearing member. To key or lock the bearing sleeve **51** to the clamp **72**, the groove **55** is interrupted by a solid portion **77** which mates with a recess **78** in the arcuate cut out in the clamp. It will be apparent, then, that the bearing sleeves **50**, **51** and all the members held thereby may be released simply by releasing the latches and swinging the clamps **71**, **72** upwardly, as illustrated in FIG. 3.

As the copy sheet and the original are fed into the exposing assembly through the slot **24**, they are gripped between a positively driven flexible belt **80** and a transparent glass cylinder **81** (see FIG. 8) which is fitted concentrically over the lamp **60** with the ends of the cylinder **81** being journalled in the bearing sleeves **50**, **51**. The sleeve **81** is restrained against axial displacement by the outside end walls of the bearing members which from the openings **61**, **62**. To insure free rotation of the sleeve **81**, the bearing members **50**, **51** are made of a material having a low coefficient of friction with respect to the glass sleeve **81**, such as the product sold under the trademark Teflon for example. As will be apparent from the ensuing discussion, the glass sleeve **81** is rotated solely by frictional engagement with the flexible belt **80** or the paper sheets being passed thereover.

In carrying out the present invention, the flexible belt **80**, which may be made of rubber for example, is trained around a drive roll **82** and an idler roll **83** so as to engage the paper sheets as they are fed into the machine and press them into tight engagement with the glass sleeve **81**. The belt advances the sheets past the exposure lamp, rotating the glass sleeve as they move, and discharges them through the outlet slot **25**.

For the purpose of rotating the flexible belt **80**, the drive roller **82** is powered by a motor **84** which is located at the left-hand side of the machine in the compartment **43**. This motor unit includes a motor **84***a* and a gear box **85** terminating in an output shaft **86**. For driving the roller **82**, the shaft **86** is connected to a cog pulley **87** (see FIG. 4) about which is trained a cog belt **88** which engages a driven cog pulley **89** mounted on the shaft **90** of the roller **82**. The idler roll at the lower end of the belt **80** is journalled in a pair of mating notches **91** (see FIG. 5) in the partitions **35** and **36**, and is held firmly therein by a pair of curved projections **92** on the bottom of each of the bearing members **50**, **51**.

In accordance with one aspect of the invention, the flexible belt has a width which is sufficient to accommodate the width of the original and copy sheet, and the belt is prevented from "walking" across its supporting rollers by a guide rib projecting inwardly from the middle portion of the belt in meshing engagement with a pair of peripheral grooves in the two supporting rollers. Thus, the belt **80** is provided with a continuous inwardly projecting guide rib **93** extending continuously around the entire belt, while the rollers **82** and **83** are provided with mating grooves **94** and **95**, respectively, to receive the guide rib (see FIG. 5). It is important that the rib **93** and the grooves **94**, **95** be located in the center of the belt assembly so that the rib and grooves remain in proper alignment with each other during stretching and relaxation of the belt **80**. For example, relaxation of the belt may be caused by a gradual loss of elasticity in the belt over extended periods of use, and a certain amount of periodic stretching and relaxation may be caused by temperature changes. It has been found that such variations in the belt are so substantial that ribs located near the edges of the belt simply cannot be maintained in proper alignment with mating roller grooves under actual operating conditions. By providing a single rib and groove arrangement in the center of the assembly, however, there is practically no transverse displacement of the rib, and proper alignment can be maintained indefinitely.

In order to shield the operator from the brilliant light of the exposure lamp, an elongated C-shaped shield **96** is mounted over the upper portion of the glass cylinder **81**. To lock the shield **96** in place, the ends of the shield are provided with small notches **97** and **98** which cooperate with a pair of generally T-shaped mounting elements **99** and **100** on the tops of the bearing sleeves **50**, **51**. The right-hand notch **98** is adapted to fit under the top portion of the T-shaped element **100**, while the left-hand notch **97** is large enough to fit down over the top of the T-shaped element **99**, with the left-hand end of the shield being held down against the bearing member **50** by a small swivel latch **101** rotatably mounted on the top of the shield. This latch **101** can be swiveled under the T-member **99** to lock the shield in position, and then swiveled out from under the T-member to permit the shield to be removed such as for cleaning of the glass cylinder.

For the purpose of concentrating a strip of light upon the original and copy sheet over the region of contact by the flexible belt, the fluorescent tube **60** is provided with a cylindrical shield **120** of C-shaped cross section which is permanently fixed to the outside surface of the tube (see FIGS. 5 and 8). This substantially limits exposure to the region where the original and copy sheet are pressed intimately together.

In accordance with one aspect of the invention, one end of the fluorescent tube is connected to an exposure control handle to permit the operator to vary the degree of exposure, and the starting button for the machine is remotely controlled by a button located at the base of the control handle so that the machine can be operated from a single control point. Thus, in the present embodiment a small insulating disc **121** having gear teeth on the lower edge thereof is fitted onto the pins at the right-hand end of the tube **60** so as to mesh with a gear wheel **122** connected to one end of a hollow control rod **123** (see FIGS. 9 and 10). The other end of the rod **123** is connected to the base of the exposure control handle **30**. Thus, it can be seen that movement of the handle **30** rotates the tube **60** slightly so as to adjust the position of the C-shaped shield **120**, thereby controlling the amount of light focused on the paper sheets.

For the purpose of starting the fluorescent tube **60**, a starting pushbutton **125** is provided which completes the circuit of the tube filaments to bring them to operating temperature. Upon release of the pushbutton, a gaseous discharge takes place within the tube and the filament circuit, being no longer needed, is broken. The starting pushbutton **125** is mounted rearwardly of the control rod **123** for remote control by the external button **31** via an actuating arm **127** (see FIG. 2). The external button **31** is positioned at the base of the exposure control handle **30** on its axis of rotation so that the button **31** remains stationary as the handle **30** is rotated. It will be appreciated that this arrangement is convenient for the operator since all operations can be controlled from a single location.

Turning to the developing compartment **42**, a developing trough **140** having a rounded bottom wall, as shown in FIG. 3, is provided between the two partitions **35** and **36**. The forward edge **141** of the trough is aligned with the inlet slot **27** and is provided with a forwardly extending lip which rests on top of the longitudinal partition **37**. In the arcuate bottom wall of the trough, there are provided a plurality of guide ribs **143** which cooperate with a plurality of complemental ribs **143***a* on the bottom of a rectangular tray **144** which forms the top of the trough. These complemental ribs define a passageway **145**, shown in FIG. 3, which is followed by the copy sheet and the transfer sheet, insuring that the sheets pass under the level of the developer fluid in the trough. The tray **144** is supported by a pair of end lugs **146** which rest on the end walls of the trough **140**, and the tray is easily removable for cleaning purposes. To replenish the developer fluid in the trough, an auxiliary bottle **147** may be placed within the tray **144** and provided with a barometric feeding arrangement **148** insuring that additional fluid is added as the level drops within the trough.

In accordance with one aspect of the invention, the developing trough is provided with a drain spout molded into the curved bottom of the trough at its lowermost point to permit draining of spent developer fluid from the trough. Thus, as shown in FIGS. 3 and 5, the developing trough **140** is provided with a rearwardly extending drain spout **149***a* which opens into the lowermost point of the bottom of the trough adjacent its right-hand end wall. A flexible hose **149***b* is fitted over the end of the spout **149***a* to carry the spent developer liquid to an appropriate sink or disposable container. When the hose **149***b* is not in use, it is simply folded for storage inside the machine beneath the rear portion of the trough **140**.

To separate the copy sheet and the transfer sheet as they enter the developer trough, a sheet separator is provided having means for supporting the same on the partitions **35**, **36** in a position of central alignment with the inlet slot **27**, with the lower portion of the separator extending downwardly into the trough. To understand the present construction, reference is made to FIGS. 3 and 5 where it will be noted that the separator consists of a single metal plate terminating at its lower end in a plurality of downwardly projecting tongues which are curved in opposite directions. Thus, the separator **150** is provided with a plurality of downwardly extending tongues **152** and **153**, with the alternate tongues **152** being curved toward the back of the machine and the intervening tongues **153** being curved toward the front of the machine. The top portion of the separator **150** extends upwardly through the receiving slot **27** so that the two sheets may be inserted face-to-face on opposite sides thereof, the two sheets being spread apart by the oppositely curved tongues **152**, **153** as they are advanced downwardly for the entry of developing fluid between them. For the purpose of supporting the separator on the partitions **35**, **36**, the separator **150** is provided with laterally extending ears **151**, **152** which are received in registering notches **154**, **155** formed in the partitions. Thus, in assembling the unit, the trough is placed in position and the separator is simply dropped into place with the ears thereon registering in the notches in the partition members. After the housing is secured in position, the laterally extending ears **151**, **152** prevent withdrawal of the separator through the receiving slot **27**.

For the purpose of drawing the two sheets through the developing trough and for "squeegeeing" them together under substantial pressure, a pair of expeller rollers **161**, **162** are provided having shafts **163**, **164** arranged at the rearward edge of the trough. To support the rollers **161**, **162** centered on the partitions **35**, **36**, bushings **165** made of antifriction material are used as shown in detail in FIG. 11. A typical bushing **165** includes an annular groove **166** for registering with suitable notches formed in the upper edge of the partitions. For the purpose of providing pressure between the expeller rollers **161**, **162**, a spring clip **167** is used having hooks **168** received in notches formed on the bushings. The bushings **165** are preferably formed of plastic material having a low friction coefficient as, for example, used in the antifriction bearing sleeves **50**, **51**.

To maintain the bushings **165** seated in the partitions **35**, **36**, spring clips **171**, **172** are used. Taking the spring clip **171** by way of example, it is of inverted, U-shaped construction, being pivoted at **173** and having a detent **174** (see FIG. 3) which engages a suitable notch along the rear edge of the associated partition. And in order to lift the clips against the force of the detent, each clip is provided with a finger hold **175**.

To drive the expeller rollers, **161**, **162**, the output shaft **86** of the motor unit includes a drive gear **190**. In mesh with the gear **190** is an idler gear **191** which, in turn, drives a driven gear **192** located on the shaft of the expeller rollers **161**. At the opposite end of the expeller rollers are coupled by a pair of gears **193**, **194** so that driving power is fed positively from one row to the other thereby insuring that both rollers rotate at precisely the same speed.

It will be apparent to one skilled in the art that various minor changes may be made in the construction without departing from the invention. For example, it is conceivable that other tubular light sources may be used so that the term "fluorescent" should be read in a generic sense.

It can be seen that this invention provides a diffusion-transfer-reversal photocopy machine which is extremely simple and compact, having a minimum number of simply formed parts which are easily manufactured and easy to service. With the improved belt driving system provided in the exposing unit of the machine, there is no problem of maintaining the resiliency or spongeness of a driving roller over extended operating periods, and the belt remains perfectly centered during the period tensioning and relaxation encountered under actual operating conditions. Moreover, the fluorescent lamp in the exposure unit remains stationary except for minor adjustments to vary the degree of exposure, and the fluorescent

tube and its protective shield can be separately removed for replacement or servicing without disassembling the entire exposure unit. It is also a simple matter to remove any of the other elements of the exposure unit. Furthermore, the drainable developer tank provided by this invention eliminates the need for removing the tank from the machine every time it is desired to remove spent liquid therefrom. Finally, the remote controlled switch permits the on-off button and the exposure control handle to be located at the same point so that the operator can turn the machine on, control the degree of exposure, and turn the machine off without ever moving its hand.

What is claimed is:

1. In a photocopy machine for office use, means for exposing an original and a copy sheet comprising in combination, a supporting frame, a fluorescent tube, an elongated transparent cylinder fitted over the fluorescent tube and mounted for rotation about its axis, a continuous flexible drive belt sufficiently wide to accommodate the width of the original and copy sheet trained about a pair of shafts journalled in the outer side of said frame so that said belt is in bearing engagement with said transparent cylinder, said belt being provided with an inwardly extending central rib and said shafts being provided with complementally formed and located grooves which receive said rib so as to prevent transverse displacement of said belt during rotation of the same, means for admitting an original and copy sheet between the transparent cylinder and the flexible belt for exposing the same to the light of the fluorescent tube, and a light shield provided around a portion of said fluorescent tube for concentrating the light on a predetermined zone of the original and copy sheet in the area of engagement by said flexible belt.

2. In a photocopy machine for office use, the combination comprising a base having a pair of upstanding space partitions, a fluorescent tube transversely arranged with respect to said partitions, an elongated transparent cylinder fitted over the fluorescent tube and mounted for rotation about its axis, a continuous flexible drive belt sufficiently wide to accommodate the width of the original and copy sheet trained about a pair of shafts journalled in said partitions so that the outerside of said belt is in bearing engagement with said transparent cylinder, said belt being provided with a guide rib extending inwardly from the middle of the belt and said shafts being provided with complementally formed and located grooves which receive said guide rib so as to maintain the flexible drive belt in its centered position during periodic tensioning and relaxation of said belt, means for admitting an original and copy sheet between the transparent cylinder and the flexible belt for exposing the same to the light of the fluorescent tube, a developing trough mounted on said partitions rearwardly of said drive belt with the bottom wall of the developing tank sloping downwardly through a drain spout for draining spent developing fluid from the trough, a flexible hose having an end adapted for connection to said drain spout for conducting the spent liquid away from the trough, and means for conducting the exposed copy sheet and the transfer sheet through said developing trough so that both sheets are wetted with developer fluid.

3. In a photocopy machine for office use, the combination comprising a frame having a base and a pair of upstanding partitions, an exposure assembly including a pair of anti-friction bearing sleeves seated in the respective partitions and means for securing said bearing sleeves in their seated positions, a fluorescent tube transversely arranged with respect to said partitions and having its ends projecting through small center openings in said sleeves so as to permit rotation of said tube, a light shield secured to the outside of said fluorescent tube for concentrating the light therefrom in a predetermined zone, an exposure control handle mechanically connected to one end of said tube for turning the tube and its shield about their axis for adjusting the degree of exposure, switch means for starting said tube mounted off to one side of said control handle, pushbutton means mounted at the base of said control handle on its axis of rotation and connected to said switch means through an actuating arm, an elongated transparent cylinder mounted over the fluorescent tube and journalled in said bearing sleeves for rotation about its axis, a continuous flexible drive belt sufficiently wide to accommodate the width of the original and copy sheet trained around a drive roller and an idle roller journalled in the outer side of said partitions so that said belt is in bearing engagement with said transparent cylinder, said belt being provided with a guide rib extending inwardly from the middle of the belt and said rollers being provided with complementally formed and located grooves which receive said guide rib so as to maintain the flexible belt in centered position during tensioning and relaxation of the same, said idler roller being held in its seated position in said partitions by the lower portions of said bearing sleeves, driving means connected to said drive roller for rotating said belt around said rollers whereby the transparent cylinder is rotated about its axis, and means for admitting an original and copy sheet between the transparent cylinder and the flexible belt for exposing the same to the light of the fluorescent tubes.

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JULIA E. COINER, *Primary Examiner.*