United States Patent

[11] 3,632,201

[72] Inventors **Daniel B. Granzow; Stanley A. Gawron, both of Arlington Heights; William P. Graff, Chicago, all of Ill.; Pervis A. Swain, Colorado Springs, Colo.**

[21] Appl. No. **5,235**
[22] Filed **Jan. 23, 1970**
[45] Patented **Jan. 4, 1972**
[73] Assignee **Addressograph-Multigraph Corporation Mount Prospect, Ill.**

Continuation of application Ser. No. 736,237, Mar. 11, 1968, which is a division of application Ser. No. 475,522, July 28, 1965, now Patent No. 3,397,628. This application Jan. 23, 1970, Ser. No. 5,235

[54] **GRAPHIC RECORDER**
2 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** ..... **355/3,** 250/49.5 ZC, 317/262 A
[51] **Int. Cl.** **G03g 15/02**
[50] **Field of Search** ..... 355/3; 317/262 A; 250/49.5 ZC; 346/74 ES

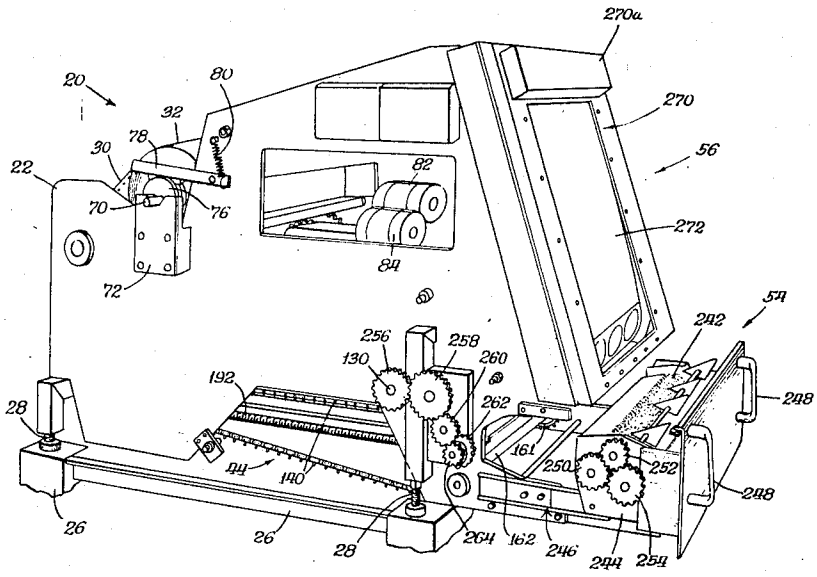
[56] **References Cited**

UNITED STATES PATENTS

2,932,742	4/1960	Ebert	317/262 A X
3,093,039	6/1963	Rheinfrank	355/16
3,133,193	5/1964	Guillotte et al.	317/262 A X
3,237,068	2/1966	Sowiak	250/49.5
3,303,401	2/1967	Naumann et al.	317/262 A
3,396,235	8/1968	Button et al.	355/3 X
3,062,956	11/1962	Codichini	250/49.5

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Robert P. Greiner
Attorney—Sol L. Goldstein

ABSTRACT: The copying machine includes both line and frame exposing means for a photoelectrostatic member and controls for conditioning the machine to operate in one of these two modes. A movable charging assembly is positioned in different locations in the two modes by the control, and other factors such as charging voltage, speed of movement of the member, and the continuous or intermittent nature of the charging operation are changed by the control in accordance with the copying mode for which the machine is conditioned.



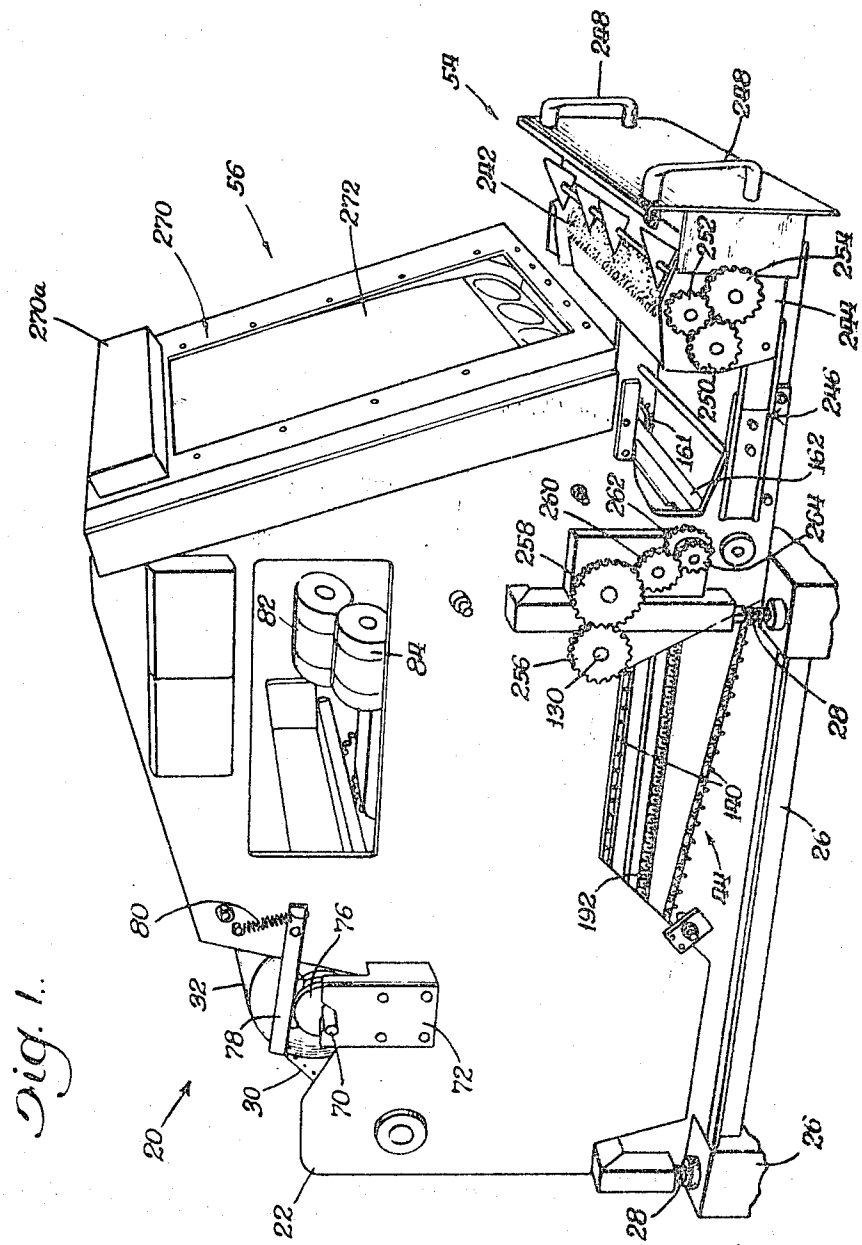
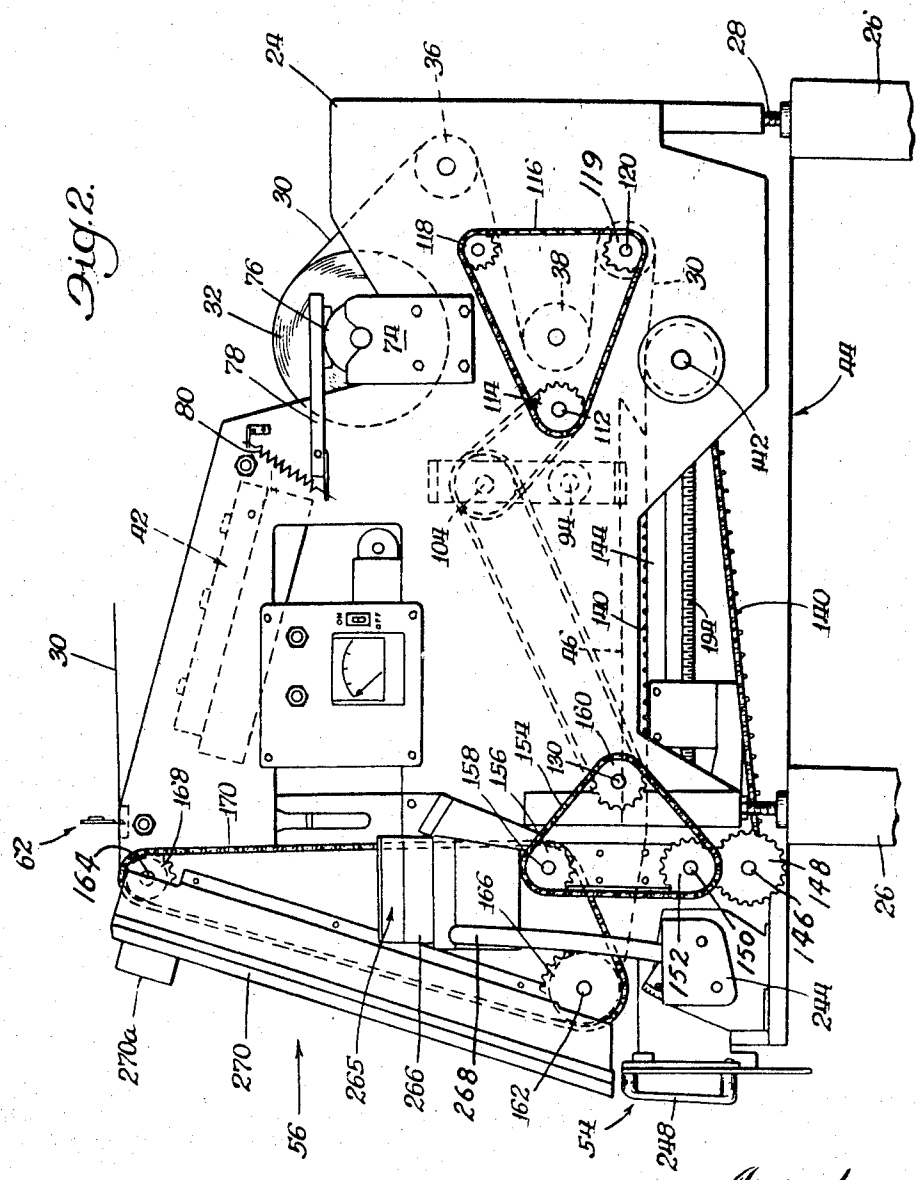


Fig. 1.

Inventors:
Daniel B. Granzow
Pervis A. Swain
Stanley A. Gawron
William P. Graff
Sol L. Goldstein
Attys.

Fig. 2.



Inventors:
Daniel B. Franzow
Perris H. Swain
Stanley H. Sawron
William P. Graff

Sol L. Goldstein Attys

Fig. 3

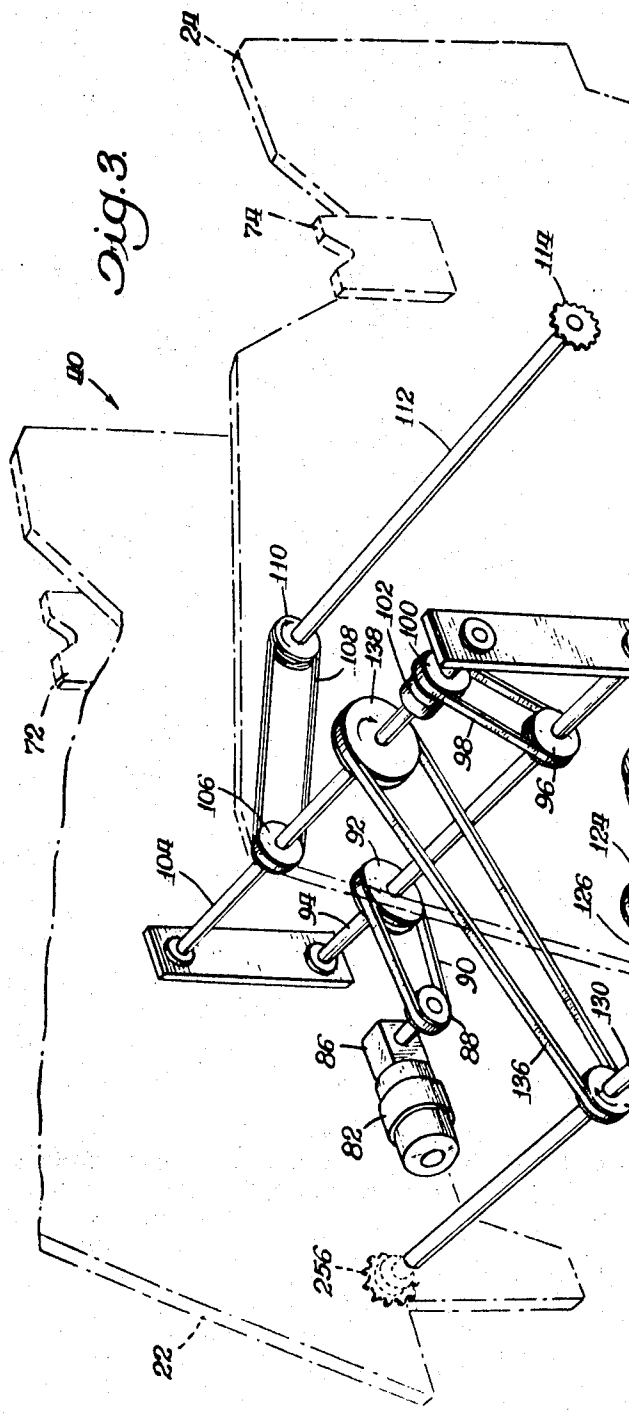
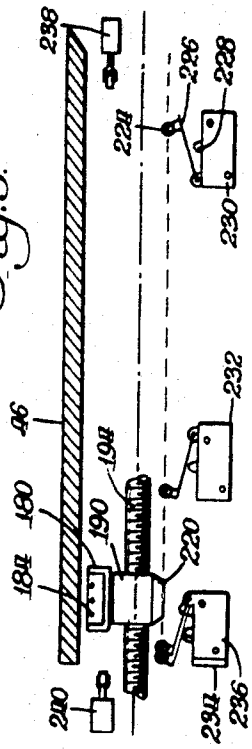


Fig. 5



Inventors:
Daniel B. Franzow
Pervis A. Swain
Stanley A. Hawron
William P. Graff
Sol L. Goldstein
Attys.

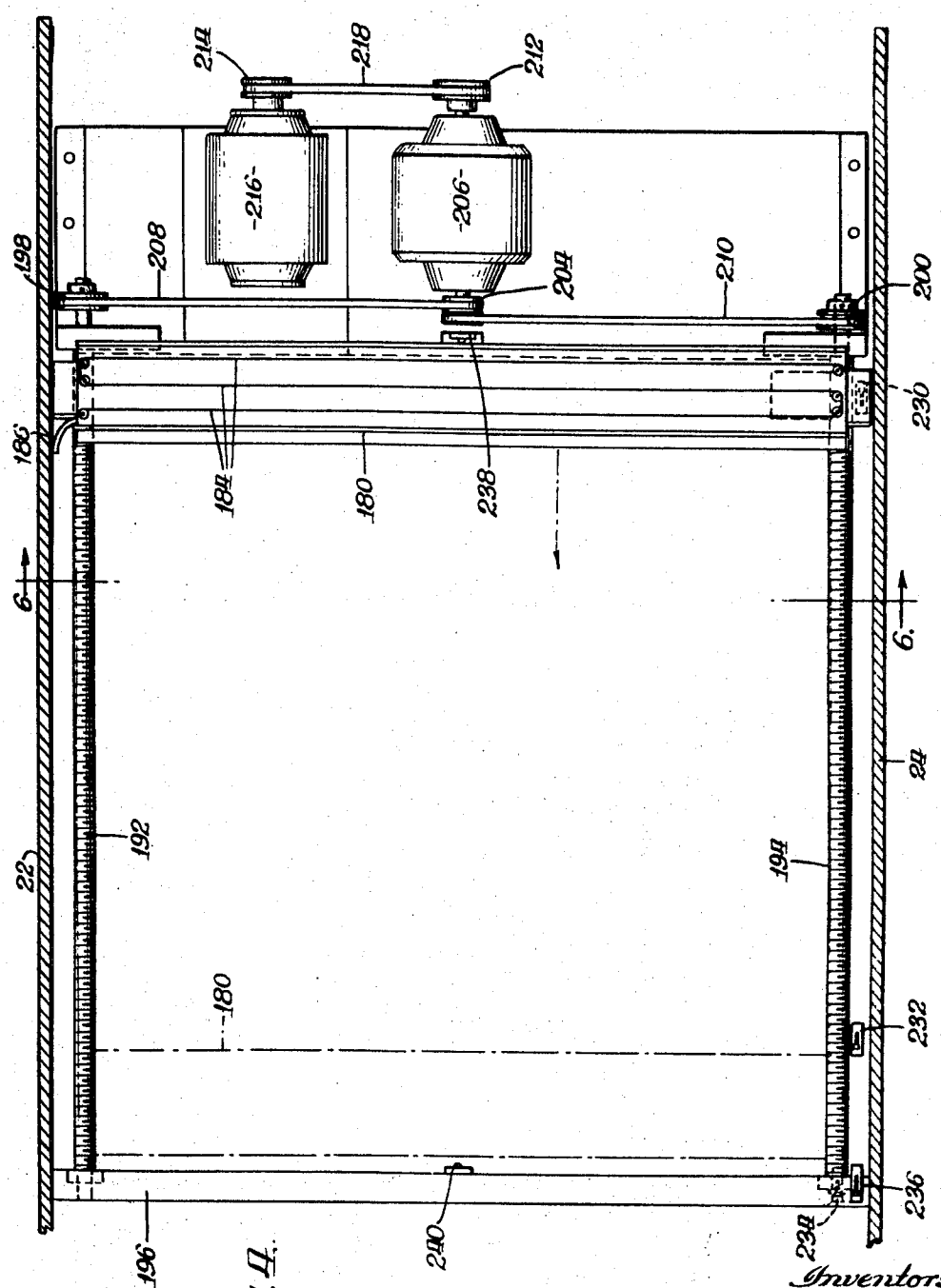


Fig. 4

Inventors:
Daniel B. Granzow
Pervis A. Swain
Stanley A. Fawron
William P. Graff
Sol L. Goldstein Attys.

Fig. 8.

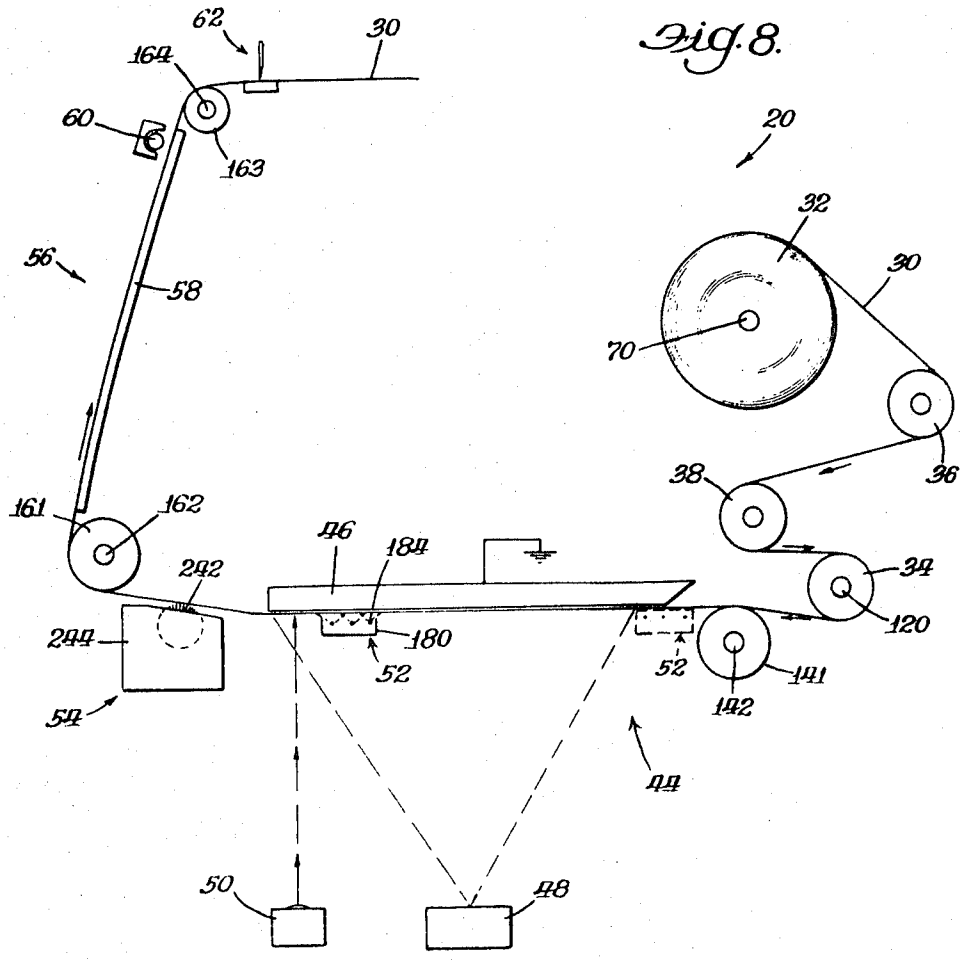


Fig. 6.

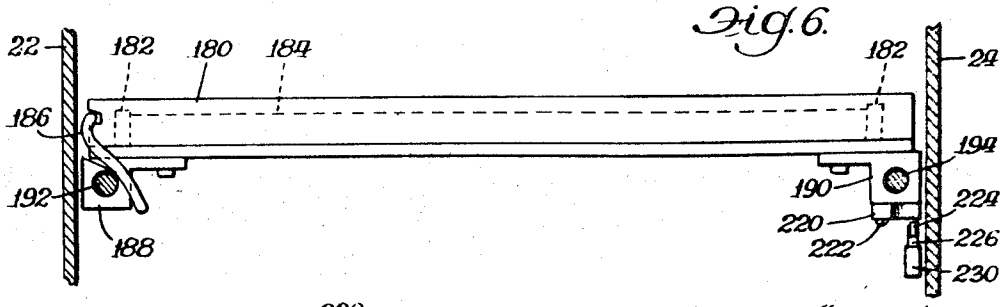
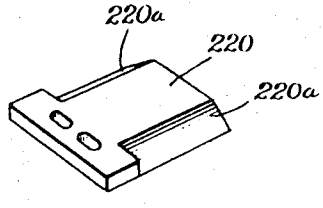


Fig. 7.



Inventors:
Daniel B. Granzow
Pervis A. Swain
Stanley A. Gawron
William P. Graff
Sol L. Goldstein Attys

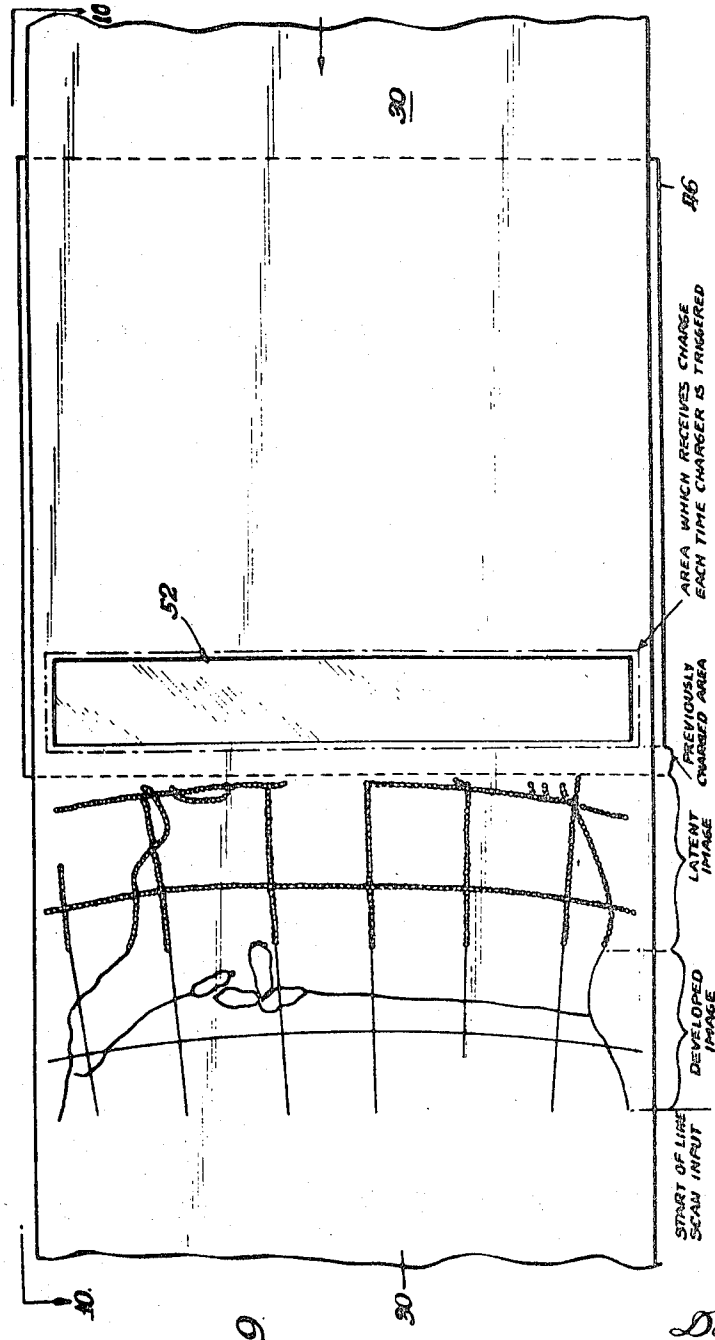
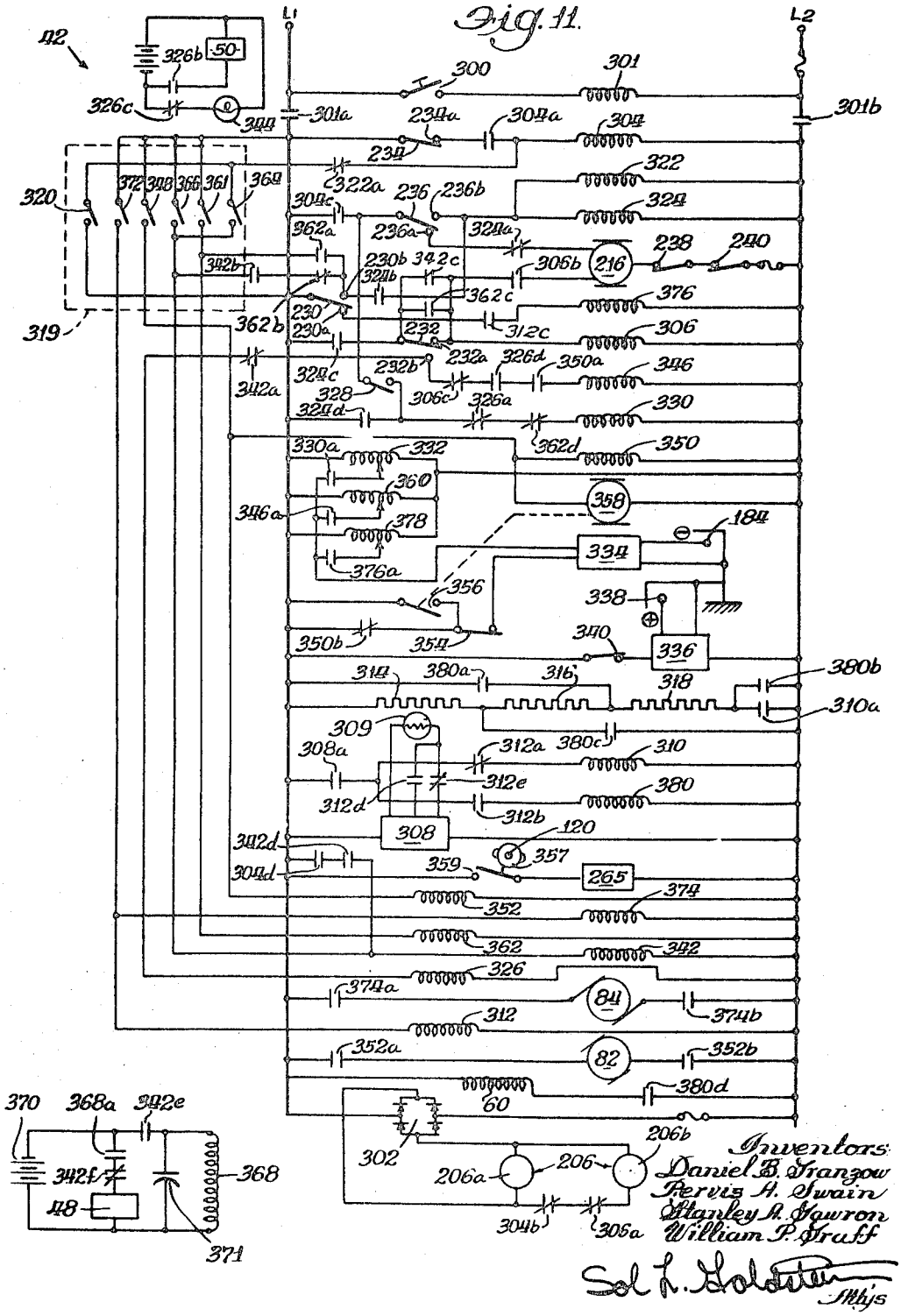


Fig. 9

Fig. 10

Inventors:
Daniel B. Granzow
Pervis A. Swain
Stanley A. Gawron
William P. Graff
Sol L. Goldstein Attys

Fig. 11.


L1
L2
112
326b
50
326c
300a
300
301
301a
301b
234a
304a
304
234
322
322a
236
236b
320
372
368
366
361
369
304c
322a
236a
324a
238
240
342b
230b
342c
306b
216
362a
324b
362c
376
362b
230
230a
232
312c
306
342a
324c
232b
232a
326d
350a
346
328
306c
326a
324d
330
362d
350
330a
332
360
358
346a
378
184
334
376a
356
338
350b
354
340
336
314
380a
316
318
380b
310a
309
308a
312a
380c
310
312e
312d
380
312b
308
120
342d
304d
359
357
265
374
352
362
342
326
374a
84
374b
312
352a
82
352b
380d
60
370
368a
342e
342f
368
118
371
302
206b
206a
206
304b
305a
Inventors
Daniel B. Franzow
Percis A. Swain
Stanley A. Fawron
William P. Graff
Sol L. Goldstein
Attys

GRAPHIC RECORDER

This is a continuation of Pat. application Ser. No. 736,237, filed Mar. 11, 1968, which is a division of Pat. application Ser. No. 475,522, filed July 28, 1965 now U.S. Pat. No. 3,397,628.

This invention relates to a copying apparatus of the type using photoelectrostatic material and, more particularly, to such a copying or recording apparatus that is selectively operable in a plurality of different modes.

Electrostatic or photoelectrostatic copying and recording apparatus and techniques are now used in a large variety of different applications in which their many desirable characteristics can be realized. The most common application is as a sheet or page copier in which a stationary or moving original controls the selective illumination of a photoelectrostatic member to provide a latent electrostatic image that is subsequently converted to visible form. Some of these machines expose a stationary photoelectrostatic member with a complete light image derived from the original, while others of these machines produce a latent electrostatic image using a scanning technique. The scanning technique generally used requires the simultaneous, selective exposure of an entire line area. Another type of line scanning used in some applications involves the use of a light beam which is scanned over successive increments of a line area and modulated in intensity during each scan to provide a serial intelligence input during the line scan. These different techniques all provide certain advantages which are useful in different applications, and it would be desirable to provide a single graphic copying or recording machine that is capable of being operated in more than one of these different modes.

Accordingly, one object of the present invention is to provide a new and improved graphic recorder or copying apparatus of the type using photoelectrostatic material.

Another object is to provide a new and improved graphic recorder which is capable of operation in a number of different modes.

Another object is to provide a graphic recorder or copying apparatus in which the photoelectrostatic material can be selectively illuminated using serially or concurrently presented intelligence or light input signals.

Another object is to provide a graphic recorder using a photoelectrostatic member in which a full frame on the member is selectively illuminated or in which incremental areas of successive line areas are scanned by a modulated point light beam.

A further object is to provide a graphic recorder of the type using a photoelectrostatic member including drive and charging assemblies which are selectively operable in different manners in dependence on whether the member is exposed by frame or beam scanning means.

A further object is to provide a copying machine including a movable assembly for charging a photoelectrostatic member and means for automatically adjusting the assembly to different positions in dependence on the mode of operation for which the machine is conditioned.

A further object involves the provision of a copying machine capable of operation in several different modes which includes an assembly for charging a photoelectrostatic member and control means for automatically varying the operation of the charging assembly in accordance with the mode of operation for which the machine is conditioned.

Another object is to provide a graphic recorder operable in several different modes which includes both heating means and control means for automatically varying the operation of the heating means in accordance with the mode of operation for which the recorder is conditioned.

A further object is to provide a novel method of charging a photoelectrostatic member in which the member is intermittently charged.

A further object is to provide a novel method of making copies using a photoelectrostatic member in which the rate of relative movement between the photoelectrostatic member and an electrostatic charging assembly is on the order of 1 inch per minute and in which the charging assembly is intermittently energized.

In accordance with these and many other objects, an embodiment of the invention comprises a graphic recording or copying machine of the photoelectrostatic type including a supply roll of photoelectrostatic copying paper having a surface that is capable of retaining a uniform electrostatic charge which is selectively dissipated by incident illumination to provide a residual or latent electrostatic charge that can be subsequently developed by the application of a toner or electroscopic powder to provide a permanent visible image. A length of material from the supply roll is advanced by a feeding assembly actuated by a drive means to feed the copy material over a grounded platen at which the sheet is charged and selectively exposed or illuminated in accordance with the graphic material to be copied to provide the latent electrostatic image. The material bearing the latent image is then advanced to a developer station, such as one including a magnetic brush, at which a toner or electroscopic powder is applied to be selectively retained on the paper in accordance with the electrostatic charge image. The powder image is then passed through a fixing station, such as a means for applying heat, which places the powder image in permanent form, and the fixed image is then discharged from the machine and the copy is severed from the continuous length of copy material by suitable cutting means.

The machine is capable of operating in two different modes to provide either full frame copying or facsimile copying in which successive lines are scanned by a flying light spot. To condition the machine for facsimile copying, a movable corona charging carriage is moved from a home position adjacent the point at which the copy paper moves into proximity to the grounded platen to a position overlying the area swept by the flying spot. At this time, the corona charging means is energized, and the corona carriage is moved in a reverse direction a short distance to impart a uniform blanket of charge to the portion of the length of copy material normally occupying the area to be scanned by the flying spot. A control circuit then places the drive means in operation to advance the copy material at a relatively low speed on the order of 1 inch per minute and provides an enabling signal to the facsimile input means to render the facsimile system operative to supply an intensity modulated light beam on the order of 0.005–0.015 in diameter to scan across the copy sheet in a direction transverse to the direction of copy material movement. It has been determined that because of the relatively low speed of movement of the copy sheet during the facsimile copying and the proximity of the corona discharge wire to the area swept by the flying spot, it is not possible to use conventional charging techniques for imparting a uniform electrostatic charge to the sheet as it moves to the area swept by the flying spot. Accordingly, the control circuit in the present invention includes means for pulsing the corona wire in the charging unit so that the corona charging unit is only intermittently energized.

In this manner, a long continuous or a number of different graphic originals can be recorded on the continuously moving copy sheet in accordance with the intelligence signals serially supplied to the facsimile scanning unit. When the facsimile operation is terminated, the corona discharge assembly is deenergized, the copy material drive means is placed in an inoperative state, and the corona carriage is returned to its home position adjacent the point at which the copy sheet enters the platen area.

When the machine is to be conditioned for use with full frame graphic recording, the control circuit automatically places the corona carriage drive mechanism in operation so that this carriage sweeps over the full length of the copy material overlying the platen and then returns to its normal position adjacent the point at which the copy material enters the platen area. During this return movement, the corona wire is continuously energized so that a uniform electrostatic charge is applied to the entire area of the copy material overlying the platen. Since this material had been advanced beyond the charging assembly, it is necessary to apply a charge to this material before the first frame exposing opera-

tion can take place. When the corona carriage returns to its normal home position, it is disposed out of the image area exposed by the full frame exposing means. At this time, the control circuit supplies an enabling signal indicating that the first frame exposing operation can take place.

The frame exposing means now applies a light image corresponding to the graphic original to be copied to virtually the entire area of the copy material overlying the platen to instantaneously develop a corresponding latent electrostatic image. The control circuit then advances the exposed image past the developer station at a relatively high rate of speed while reenergizing the charging assembly to impart a uniform electrostatic charge to the new surface of the copy material moving into the exposing station. In addition, the control circuit energizes additional heating means, such as a bank of infrared lamps, to provide an additional heat source to ensure fixing of the powder image. This additional heat is desirable because of the greatly increased speed at which the copy sheet is moved during the frame exposing operation. When the next frame area is moved into the exposing station, the operation of the drive means is arrested to await the next exposure operation. If at any time, a prolonged period of time elapses between the completion of an exposure operation and the consequent charging of the next segment of sheet and the time at which the next exposure operation is to take place, there is a chance that the charge on the copy material in the exposing station will become depleted. Loss of the copy or any excessive use of the copy material is prevented by operating the control circuit to cause the corona carriage to scan the entire area of the sheet in the copy station and to return to its normal home position outside of the exposure area. During this scanning operation, the corona wire is energized so that the length of copy material from which the charge may have become dissipated is recharged in preparation for the exposure operation.

Many other objects and advantages of the present invention will become apparent from considering the following detailed description in conjunction with the drawings in which:

FIG. 1 is a perspective view of one side of a graphic recorder or copying apparatus embodying the present invention shown with the developer unit in an open position;

FIG. 2 is an elevational view of an opposite side of the recording machine with the developer unit closed;

FIG. 3 is a fragmentary perspective view of a two-speed drive system for feeding copy material through the machine shown in FIG. 1;

FIG. 4 is a bottom elevational view of a movable corona carriage and drive means therefor;

FIG. 5 is a schematic view illustrating the relative positions of a group of switches for controlling the movable corona carriage;

FIG. 6 is a fragmentary sectional view taken generally along line 6—6 in FIG. 4;

FIG. 7 is an enlarged perspective view of a control cam carried on the movable corona carriage for selectively actuating the switches shown in FIG. 5;

FIG. 8 is a schematic view of the graphic recorder;

FIG. 9 is a schematic plan view illustrating the generation of a facsimile recording using the apparatus embodying the present invention;

FIG. 10 is a schematic view illustrating the relative positions of certain components of the apparatus used in the production of the facsimile recording shown in FIG. 9; and

FIG. 11 is a schematic circuit diagram of a circuit for controlling the operation of the graphic recorder.

Referring now more specifically to FIGS. 1, 2, and 8 of the drawings, therein is illustrated a graphic recorder which is indicated generally as 20 and which embodies the present invention. The recorder 20 includes a supporting structure having, among other things, a pair of side supporting walls 22 and 24 between which are mounted substantially all of the components of the recorder 20 except the optical systems. The frame including the sidewalls 22 and 24 is supported on a lower frame structure 26 by a plurality of adjustable leveling feet 28. The frame and line scanning or facsimile optical systems can be disposed within the structure 26 beneath the frame including the sidewalls 22 and 24. The entire machine 20 is disposed within a housing (not shown) and is adapted to be mounted on the floor or other supporting structure such as a desk or table.

In its general arrangement, the graphic recorder 20 is adapted to produce copies on a length of photoelectrostatic copy material 30 (FIG. 8) fed from a supply roll 32 thereof. The copy material 30 can be of any well-known type, such as one including a flexible paper or insulating backing to which a layer of resinous material containing zinc oxide is applied. The copy material 30 preferably is provided with sprocket openings adjacent its opposite, outer edges and is advanced to a master sprocket drive roller 34 over a pair of idler or tension rollers 36 and 38. The master sprocket drive roller 34 is driven by a drive control system indicated generally as 40 (FIG. 3) at a slow rate of speed during facsimile recording and at a substantially higher speed during full frame recording. The drive system 40 is automatically conditioned for operation at different speeds in accordance with the mode of operation for which the machine 20 is conditioned by a control circuit indicated generally as 42 (FIG. 11).

The copy sheet is fed from the master sprocket drive roller 34 to an exposure station indicated generally as 44 (FIG. 8) by a sprocket chain drive assembly driven in synchronism with the master sprocket drive roller 34 by the drive assembly 40 so that the sheet is advanced to a position underlying a grounded platen 46 with the treated surface of the copy sheet faced downwardly toward a frame exposing means or optical system 48 and a line scanning assembly or optical system 50.

To provide means for imparting a uniform electrostatic charge to the treated surface of the copy material 30, a corona charging assembly indicated generally as 52 is provided. When the machine 20 is to be conditioned for facsimile recording, the control circuit 42 advances a movable carriage for the assembly 52 from a normal home position shown in dashed outline in FIG. 8 to a position interposed between the platen 46 and the scanning light source 50. The carriage is then moved in an opposite direction to the facsimile position shown in solid line in FIG. 8 during which the corona wire in the assembly 52 is energized to impart a uniform electrostatic charge to the adjacent surface of the copy material 30. When the carriage for the assembly 52 is stopped at the position shown in solid line in FIG. 8, this carriage is disposed adjacent but not interposed in the path of the scanning movement of the light beam from the assembly 50.

The control circuit 42 conditions the machine 20 for operation in the facsimile mode so that the transversely scanning light spot provided by the assembly 50 selectively discharges the copy material, line by line, to produce a latent electrostatic image. The copy material 30 is advanced by the drive assembly 40 at a very low speed on the order of 1 inch per minute when the machine 20 is operated in a facsimile mode. Because of the proximity of the charging assembly 52 to the scanning point and because of the slow speed at which the copy material 30 is advanced, the control circuit 42 includes means for automatically selecting the potential applied to the corona wire in the assembly 52 in accordance with the selection of the facsimile mode and also includes means for intermittently energizing the corona wire. When the machine 20 is returned to its normal condition at the end of the facsimile recording, the carriage for the assembly 52 is restored to the home position shown in dashed outline in FIG. 8.

When the graphic recorder 20 is to be prepared for full frame recording, the control circuit 42 moves the carriage 25 from the position shown in dashed outline in FIG. 8 to a position adjacent the left end of the platen 46. At the end of this movement, the control circuit 42 energizes the corona wire in the assembly 52 and moves the carriage back to the normal position shown in dashed outline in FIG. 8. During this movement, the length of copy material 30 previously advanced to a position underlying the platen 46 is provided with a uniform

electrostatic charge. When the carriage **52** returns to its home position, the machine **20** is conditioned for full frame recording, and the assembly **48** exposes the previously charged surface in the area indicated by dashed line in FIG. **8** to provide a latent electrostatic image of the complete graphic original to be recorded. The control circuit **42** controls the drive assembly **40** to advance the copy material **30** at a high speed during the full frame recording, and the charging assembly **52** is also controlled by the circuit **42** to impart a uniform charge to the copy material subsequently moved past the assembly **52** toward the exposure station **44**.

The latent electrostatic image developed at the exposing station **44** by either the line scanning means **50** or the frame exposing means **48** is advanced by the drive means **40** to a developing station indicated generally as **54** (FIG. **8**) which can comprise any suitable developing means. In the illustrated machine **20**, the developing station **54** comprises a magnetic brush developer in which a toner or developer mix containing magnetic carrier particles and electroscopic powder is formed into brushlike filaments or "whiskers" to selectively deposit the electroscopic powder on the latent image for selective retention on the surface of the copy material **20** to place the image in visible form.

The developed image is advanced from the developer station **54** to a fixing or fusing station indicated generally as **56** comprising a heated platen **58** over which the back or uncoated surface of the copy material **30** is advanced to apply heat and fuse the retained toner material or electroscopic powder to place the image in permanent form. During the slow movement of the copy material **30** used during facsimile recording, a relatively small amount of heat can be provided by the heated platen **58**. During the high-speed advance used during full frame exposure, the platen **58** provides a greater quantity of heat which is supplemented by the heat provided by a bank or assembly of infrared lamps **60**. The fixed image is discharged adjacent the top of the graphic recorder **20**, and successive copies are separated from the continuous length of copy material **30** by suitable severing means, such as a knife assembly indicated generally as **62**.

The supply roll **32** of copy material **30** is rotatably mounted on the supporting frame by a shaft **70** (FIGS. **1** and **2**) whose opposite ends are received within V-shaped grooves in a pair of trunnion supports **72** and **74** secured to the side frame walls **22** and **24**, respectively. The shaft **70** carries a pair of braking discs **76** adjacent its opposite ends interposed between the roll **32** and the trunnion supports **72**, **74**. These braking discs are engaged by frictional elements carried on a pair of brake levers **78** which are pivotally mounted on the sidewalls **22** and **24** and resiliently biased into engagement with the peripheries of the discs **76** by a pair of tension springs **80** connected between the levers **78** and the sidewalls **22**, **24**. When the roll **32** is installed in the machine **20**, the free end thereof is threaded around the tensioning rollers **36** and **38**, which can be spring biased to apply a light tension to the copy material **30**, and the perforations on the edges of the web **30** are moved into engagement with pins on the sprocket wheels **34**.

The sprocket wheels **34** are driven by the controllable drive assembly **40** (FIG. **3**) which is mounted between the sidewalls **22** and **24** in a position generally overlying the platen **46**. The drive assembly **40** includes a slow speed drive motor **82** (FIG. **3**) which is used during the facsimile mode and a fast speed motor **84** which is used during full frame exposure. The drive motor **82** can, for instance, provide an output speed of 0.62 revolutions per minute, while the fast speed motor **84** can provide an output of 57 revolutions per minute. The low-speed motor **82** is coupled through a gearbox **86** to a pulley **88** which is connected by flexible drive belt **90** to a pulley **92** secured to a shaft **94** that is rotatably mounted between the sidewalls **22** and **24**. The shaft **94** carries a second pulley **96** which is coupled by a drive belt **98** to a pulley **100** which is coupled by a one-way clutch **102** of conventional design to a shaft **104** that is also rotatably mounted between the sidewalls **22** and **24**. A second pulley **106** secured to the shaft **104** and a flexible drive belt **108** couple the shaft **104** to a pulley **110** that is secured to a shaft **112** that is rotatably mounted between the sidewalls **22** and **24**. One end of the shaft **113** is secured to a sprocket gear **114**.

The teeth on the sprocket gear **114** mesh with a sprocket chain **116** (FIG. **2**) which passes around an idler gear **118** and a sprocket gear **119** secured to a shaft **120** which is rotatably mounted between the sidewalls **22** and **24**. The master register sprockets **34** are secured to the shaft **120**. The sprocket gear **114** is driven in a clockwise direction (FIG. **2**) so that the shaft **120** is rotated in a clockwise direction to feed the length of copy material **30** toward the exposure station **44**.

The sprocket gear **114** can also be driven by the high-speed motor **84** (FIG. **3**). The output shaft of the motor **84** is connected through a gearbox **122** to drive a pulley **124** in a clockwise direction. The pulley **124** is coupled by a belt **126** to a pulley **128** which is coupled to a shaft **130** through a conventional one-way clutch unit **132**. The shaft **130**, which is rotatably mounted between the walls **22** and **24** of the frame, is secured to a pulley **134** which is coupled by a drive belt **136** to a pulley **138** secured to the shaft **104**. When the motor **84** is energized and the motor **82** is not energized, the shaft **104** is rotated by the motor **84** through the pulley **138** to rotate the sprocket gear **114** in a clockwise direction.

To advance the copy material **30** through the exposure station **44**, a sprocket chain drive is utilized. This drive includes a pair of spaced and parallel sprocket chains **140** (FIG. **2**) aligned with the side apertures or sprocket openings in the copy material **30** fed by the master register sprocket **34**. The right-hand ends of the two chains **140** pass around a pair of idler sprocket gears **141** (FIG. **8**) carried on a shaft **142**. The upper flights of the two chains **140** are received within the channels formed in two edge supporting members **144** (FIG. **2**) which support the opposite edges of the copy material **30**. The supporting members **144** are spaced slightly below the grounded platen **46**. At their forward or left-hand ends (FIG. **2**), the sprocket chains **140** pass around two idler gears (not shown) that are generally in alignment with and somewhat below the supporting member **144** and around a pair of sprocket gears secured to a shaft **146** which is rotatably mounted between the sidewalls **22** and **24**.

To provide means for rotating the two sprocket gears on the shaft **146**, a gear **148** (FIG. **2**) is secured to the shaft **146**. This gear meshes with a gear (not shown) which is secured to a shaft **150** that is rotatably mounted on the sidewall **24**. A sprocket gear **152** is secured to the shaft **150** and is coupled to a drive chain **154** which passes around a first gear **156** secured to a shaft **158** that is rotatably mounted on the wall **24** and a second gear **160** that is secured to one end of the shaft **130** (FIG. **3**). The shaft **130** is driven in a clockwise direction (FIGS. **2** and **3**) by the high-speed motor **84** through the belt **126** or the low-speed motor **82** through the belts **90** and **136**. The one-way clutch **132** prevents rotation of the pulley **128** when the shaft **130** is driven by the low-speed motor **82**. When the shaft **130** and the gear **160** are driven in a clockwise direction, the gear **148** is driven in a counterclockwise direction so that the upper flights of the two chain loops **140** move from right to left (FIG. **2**) to advance the copy sheets through the exposure station **44**.

The drive assembly **40** also includes means for feeding the developed copy material **30** through the fusing or fixing station **56** to a point at which it is ejected from the recorder **20**. This feeding means includes a pair of lower sprocket wheels **161** (FIG. **1**) secured to a shaft **162** (FIGS. **1** and **2**) which is rotatably mounted between the sidewalls **22** and **24** of the frame and a pair of similar upper sprocket wheels **163**, (FIG. **8**), secured to a shaft **164** (FIG. **2**) which is also rotatably mounted between the sidewalls of the frame. A sprocket gear **166** is secured to the shaft **162**, and a sprocket gear **168** is secured to the shaft **164**. A sprocket chain **170** passes around the gears **166** and **168** and also around an additional sprocket gear (not shown) which is secured to the shaft **158**. Thus, when the chain **154** is advanced by rotation of the gear **160**,

the chain 170 is advanced to rotate the sprocket gears 166 and 168 in a clockwise direction (FIG. 2) and to rotate the connected sprocket wheels in the same direction. Thus, the copy material 30 is fed upwardly through the fusing station 56 toward the top of the recorder 20.

The charging assembly 52 (FIGS. 4–8) applies a uniform electrostatic charge to the coated surface of the copy material 30 and is automatically adjusted to different positions under the control of the control circuit 42 in dependence on the mode of operation for which the graphic recorder 20 is conditioned. Not only is the charging assembly 52 moved to different positions but also includes means for supplying different potentials of different durations to corona wire means in the assembly 52 in dependence on the mode of operation of the recorder 20. The charging assembly 52 includes an upwardly open housing 180 extending generally transverse to the direction of movement of the copy material 30. A plurality of spaced dielectric supporting elements or posts 182 are disposed within the housing 180 to support a continuous corona discharge wire 184 in a spaced position from the closed end of the housing 180 and insulated therefrom. One end of the corona wire 184 is connected to a power supply over a flexible cable 186.

To provide means for adjustably supporting the housing or carriage 180 in and for moving this carriage to a plurality of different positions, a pair of internally threaded blocks 188 and 190 (FIG. 6) are secured to the opposite ends of the carriage or housing 180 and threadedly receive a pair of lead screws 192 and 194 (FIGS. 4 and 6) which are journaled at one end in a transverse supporting member 196 (FIG. 4) of the housing. At the other end, the shafts or lead screws 192 and 194 are also rotatably journaled on the supporting frame and are each provided with one of a pair of pulleys 198 and 200. The pulley 198 is coupled to an output pulley 204 on an electrically controlled brake-clutch unit 206 of conventional design by a drive belt 208. Similarly, the pulley 200 is coupled to the pulley 204 by a drive belt 210. An input pulley 212 to the brake-clutch unit 206 is coupled to a pulley 214 secured to the output shaft of an electric drive motor 216 by a drive belt 218.

The drive motor 216 can be operated in either direction and provides means for rotating the lead screws 192 and 194 in opposite directions. When the clutch-brake unit 206 is operated to its braking condition, the output pulley 204 is positively locked against movement to instantaneously arrest movement of the lead screws 192 and 194. When the unit 206 is operated to its alternate or clutching condition, rotation imparted to the input pulley 212 by the drive motor 216 is transmitted to the output pulley 204 to rotate the lead screws 192 and 194 in the desired direction. In FIG. 4 of the drawings, the corona carriage or housing 180 is shown in its normal position. In the dashed line condition shown in FIG. 4, the corona assembly 52 occupies the alternate extreme position spaced in the forward direction of movement of the copy material 30.

The electrical actuation of the clutch-brake unit 206 and the drive motor 216 to effect scanning movement of the carriage 180 as well as the positioning thereof is controlled by the control circuit 42. To accomplish this automatic positioning of the carriage 180, the control circuit 42 includes a plurality of switches disposed adjacent the path of movement of the carriage 180 for detecting the position thereof. A first group of these switches are selectively actuated by a cam member 220 (FIGS. 6 and 7) which is secured to the bottom wall of the threaded block 190 by a plurality of machine screws 222. The cam member 220 includes a pair of inclined slopes 220*a* for engaging one or more rollers 224 rotatably mounted between the bifurcated ends of an operator arm 226 (FIGS. 5 and 6) which is pivotally mounted on the housing for the control switches in a position overlying an operator stem 228.

A first group of control switches are mounted on the supporting frame for the machine 20 underlying but disposed in the path of movement of the cam 220. These switches include a switch 230 (FIGS. 4 and 5) which is operated when the carriage 180 is in the normal home position illustrated in dashed outline in FIG. 8. A switch 232 is operated when the carriage 180 is in the facsimile or line scanning position shown in solid outline in FIG. 8, and a pair of switches 234 and 236 are sequentially operated when the carriage 180 reaches its extreme left-hand position shown in dashed outline in FIG. 4. In addition, the charging assembly 52 includes a safety switch 238 that is operated if the carriage 180 moves too far to the right (FIG. 8) beyond its home position and a second safety switch 240 that is operated if the carriage 180 moves too far beyond its extreme left-hand position (FIG. 8). The switches 238 and 240 are operated by engagement with the housing 180 rather than by engagement with the actuating cam 220.

The developer station 54 receives the latent electrostatic image provided at the exposure station 44 and, by the selective deposition of electroscopic powder, converts the electrostatic image into a visible image. As indicated above, the developer station 54 can comprise any conventional construction and is illustrated in FIGS. 1 and 2 as comprising a magnetic brush 242 formed by a rotating drum disposed within the influence of a magnetic field to form a toner mixture consisting of electroscopic powder and magnetic particles into fine filaments which are wiped against the surface of the copy material 30 containing the image to permit the selective deposition of the electroscopic toner powder. This magnetic brush developer unit can be of the construction shown and described in detail in U.S. Pat. No. 3,003,462.

A receptacle 244 containing the magnetic brush assembly is formed as a drawer unit mounted on the frame of the machine 20 by a telescoping slide assembly 246 (FIG. 1) and having a pair of front handles 248 for moving the developer station 54 into and out of an assembled relation with the remainder of the graphic recorder 20. Three gears 250, 252, and 254 provide means for driving the components of the magnetic brush assembly and are selectively moved into and out of driving engagement with the drive assembly 40 to provide means for operating the developer assembly 54 in synchronism with the movement of the copy material 30 through the graphic recorder 20.

More specifically, a gear 256 secured to the opposite end of the shaft 130 (FIG. 3) from the gear 160 is rotated in a counterclockwise direction (FIG. 1) by the drive system 40. The gear 256 is effective through a plurality of meshed gears 258, 260, and 262 to rotate a gear 264 in a clockwise direction (FIG. 1). The gear 264 meshes with the gear 260 when the drawer containing the developer station 54 is moved to the closed position shown in FIG. 2 of the drawings. Thus, the drive system 40 operates the developer station 54 at a rate commensurate with the speed at which the copy material 30 is advanced through the graphic recorder 20.

The developer station 54 also includes an assembly 265 (FIG. 2) for automatically adding electroscopic powder to the developer mix in the receptacle 244 in proportion to the number of linear feet of copy material that is advanced through the recorder 20. This assembly includes a receptacle 266 containing a supply of electroscopic powder which can be selectively vibrated at spaced time intervals to feed electroscopic powder through a tube 268 to be discharged into the housing 244. The construction of the toner dispensing assembly 265 can be, for instance, that shown and described in detail in the U.S. Pat. No. 3,224,649, issued Dec. 21, 1965, assigned to the same assignee as the present application.

The fusing or fixing station 56 includes the heat conducting backing member or platen 58 (FIG. 8) in which are embedded or to which are affixed a plurality of electrical resistance heating elements. The backing member 58 is disposed within a housing or cabinet indicated generally as 70 (FIG. 1) having a transparent outer wall or window 272. As the copy sheet 30 containing the toner image passes over the backing plate 58, the heat applied by this backing member to the copy material 30 fuses the toner particles and places the image in a permanent condition. The window 272 permits the fixed image to be viewed prior to its ejection from the machine. The housing

270 includes an additional housing portion 270*a* in which are disposed the infrared lamps 60 (FIG. 8). When the machine 20 is operated in the facsimile mode with the low-speed advance of the copy material 30, the control circuit 42 energizes only the heating elements affixed to the backing member 58 to provide a relatively low level of heat. However, when the graphic recorder 20 is in its full frame mode, the heating elements are energized by the control circuit 42 to provide a higher level of heat, and this heat is supplemented by the energization of the infrared lamps 60.

The operation of the graphic recorder 20 is described below in conjunction with the description of the operation of the control circuit 42 in both the facsimile and the frame recording modes. Assuming that the corona carriage 180 is in the normal home position shown in dashed line in FIG. 8 and in solid line in FIG. 4, the switch 230 is operated to a condition in which a pair of contacts 230*a* are closed and a pair of contacts 230*b* are opened. The machine is placed in operation by closing a switch 300 to energize the operating winding of a relay 301 to close two pairs of normally open contacts 301*a* and 301*b*. The closure of the contacts 301*a* and 301*b* connects an alternating current input potential source to the control circuit 42 to provide power for controlling the various functions to be performed by the machine. The input potential also energizes a full-wave rectifier bridge 302 to provide a source of direct current power for controlling the brake-clutch control unit 206 for the carriage drive motor 216. Two windings 206*a* and 206*b* in the control unit 206 are energized over a circuit including two pairs of normally closed contacts 304*b* and 306*a* on two control relays 304 and 306. When both of the windings 206*a* and 206*b* in the control unit 206 are energized, the drive unit for the carriage 180 is braked to prevent movement thereof.

In addition, when the control circuit 42 is initially energized, a temperature control unit 308 including a temperature responsive sensing element 309 normally connected to the unit 308 by a pair of normally closed contacts 312*e* on a relay 312 is rendered effective to sense the temperature of the backing plate or platen 58. Since this unit is not heated, the sensing unit 309 indicates to the control unit 308 that the plate 58 is below temperature, and a pair of normally open contacts 308*a* are closed by the unit 308. This completes an obvious operating circuit for a low heat control relay 310 over a circuit including a pair of normally closed contacts 312*a* on the heat control relay 312. The operation of the low heat control relay 310 closed a pair of normally open contacts 310*a* to connect three resistance elements 314, 316, and 318 in series across the input potential. The series connection of the three resistance elements across the line provides a low heat level which is maintained by the temperature controller 308. When the sensing unit 309 determines that the backing member 58 is at the desired temperature, the contacts 308*a* are opened to release the relay 310 and open the contacts 310*a*. This cycling continues under the control of the sensing element 309 to ensure that the temperature is maintained at the desired level.

The control circuit 42 is adapted to be controlled by an external control circuit 319 which manually or automatically programs the graphic recorder 20 to its facsimile or full frame mode in dependence on incoming information and, for instance, the availability of different types of equipment and input signal sources. In FIG. 11 of the drawings, the external control circuit 319 is shown schematically as a plurality of manually actuated switches, although these switches can be controlled conduction devices or other control components. To prepare the recorder 20 for operation in the facsimile mode, a switch 320 is momentarily closed to forward a signal over a pair of normally closed contacts 322*a* on a relay 322 to energize the relay 304. In operating, the relay 304 closes three normally open pairs of contacts 304*a*, 304*c*, and 304*d* and opens the normally closed contacts 304*b*. The opening of the contacts 304*b* terminates the energization of the winding 206*b* in the control unit 206 so that the brake is released from the drive system actuated by the carriage drive motor 216 and this motor is free to advance the lead screws 192 and 194. The closure of the contacts 304*d* performs no useful function at this time. The closure of the contacts 304*a* completes a holding circuit for the relay 304 extending through a pair of normally closed contacts 234*a* on the switch 234. This holding circuit maintains the relay 304 operated after the termination of the momentary signal provided by the switch 320 and holds this relay operated until the carriage 180 has completed its forward movement.

The closure of the contacts 304*c* completes an energizing circuit for forward drive winding on the corona carriage drive motor 216 which extends through a pair of normally closed contacts 236*a* on the switch 236, a pair of normally closed contacts 324*a* on a relay 324, and the two normally closed limit switches 238 and 240. When energized, the drive motor 216 operates in a forward direction to advance the corona carriage 180 from right to left (FIGS. 4 and 8). As the carriage or housing 180 leaves the home position, the switch 230 is released to open a pair of contacts 230*a* and to close a pair of contacts 230*b*. During this forward movement, the switch 232 is operated and released without effect on the circuit 42 as the assembly 52 passes the facsimile position.

It is possible to energize the corona wire 184 during this forward path of movement of the assembly 52. More specifically, if a normally open switch 328 is closed prior to placing the control circuit 42 in operation, the closure of the contacts 304*c* also completes a circuit for energizing a relay 330 over a circuit including the closed switch 328, a pair of normally closed contacts 326*a* on a relay 326, and a pair of normally closed contacts 362*d* on a relay 362. The operation of the relay 330 closes a pair of normally open contacts 330*a* so that the output potential from a tap on a transformer 332 is supplied to the input of a high voltage supply 334 which is connected to the corona wire 184. In this manner, a uniform negative electrostatic charge will be imparted to the portion of the copy material 30 overlying the grounded platen 46 during the forward movement of the carriage 180. Generally, however, the switch 328 is not closed. A power supply 336 for a corona discharge wire 338 providing bias in the developer station 54 is normally continuously energized from the input potential source over a circuit including a normally closed switch 340. The switch 340 can be opened to facilitate servicing the power supply unit 336.

The control circuit 42 remains in this condition in which the drive motor 216 is advancing the carriage 180 over the stationary copy material 30 disposed on the platen 46. When the carriage 180 reaches its extreme left-hand position (FIGS. 4 and 8), the cam member 220 engages the operator linkage for the switch 236 and operates this switch to open the normally closed contacts 236*a* and to close a pair of normally open contacts 236*b*. The opening of the contacts 236*a* interrupts the above-described energizing circuit for the forward winding of the drive motor 216 so that this motor is no longer energized. The concurrent closure of the contacts 236*b* completes an operating circuit for the relay 322 so that this relay is operated to open the normally closed contacts 322*a*. This opens the connection between the control relay 304 and the switch 320 to prevent reoperation of the relay 304.

The closure of the contacts 236*b* also completes an energizing circuit for the relay 324 so that this relay opens the contacts 324*a* to interrupt the forward energizing circuit for the drive motor 216 at a second point. The operation of the relay 324 also closes three pairs of normally open contacts 324*b*, 324*c*, and 324*d*. The closure of the contacts 324*d* completes the above-described circuit extending through the closed contacts 326*a* and 362*d* for energizing the control relay 330 to close the normally open contacts 330*a*. The closure of the contacts 330*a* forwards the potential derived from the transformer 332 to the input of the power supply so that the corona wire 184 is now energized at the potential desired for charging the copy material 30. Thus, the power supply 334 is energized independent of the position of the switch 328 when the corona carriage 180 reaches its left-hand position. The closure of the

contacts 324*b* completes a holding circuit for the relays 322 and 324 extending through the closed contacts 230*b* on the switch 230.

The closure of the contacts 324*c* completes a circuit extending through a pair of normally closed contacts 232*a* on the switch 232 for operating the control relay 306. The operation of the relay 306 opens the normally closed contacts 306*a* and an additional pair of normally closed contacts 306*c* and closed a pair of normally open contacts 306*b*. The opening of the contacts 306*a* interrupts an additional point in the energizing circuit for the solenoid 206*b* to maintain the brake in the control unit 206 in a released condition. The closure of the contacts 306*b* completes an energizing circuit for the reverse winding of the drive motor 216 extending through the closed contacts 324*c* and 232*a*. This energization of the reverse drive winding of the motor 216 provides dynamic braking to retard the movement of the corona carriage 180 which continues to the left (FIGS. 4 and 8) under the effects of inertia even following the termination of the energization of the forward drive winding on the motor 216. During this movement, the cam 220 engages the operator for the switch 234 so that this switch is operated to open the normally closed contacts 234*a*. In doing so, the holding circuit for the relay 304 is interrupted, and this relay releases to close the contacts 304*b* and to open the contacts 304*a*, 304*c*, and 304*d*. The opening of the contacts 304*d* does not perform any useful function at this time. The closure of the contacts 304*b* does not energize the winding 206*b* because of the prior opening of the contacts 306*a*. The opening of the contacts 304*c* interrupts the above-described operating circuit for the relays 322 and 324, but these relays remain operated over the holding circuit including the closed contacts 342*b*.

The drive motor 216, after dynamically braking movement to the left of the carriage 180, operates the lead screws 192 and 194 to move the carriage 180 toward the right from the extreme left-hand position to the position shown in solid line in FIG. 8 of the drawings. As the carriage 180 moves to the right, the portion of the copy material 30 over which the carriage moves is provided with a uniform electrostatic charge to prepare this copy material for receiving the facsimile image. This movement also releases the switch 234 to close the contacts 234*a* and releases the switch 236 to close the contacts 236*a* and open the contacts 236*b*. These contact operations do not change the present operations controlled by the circuit 42.

When the carriage 180 moves into the facsimile position disposed adjacent but spaced from the area scanned by the assembly 50, the cam 220 actuates the switch 232 to open the contacts 232*a* and to close a pair of normally open contacts 232*b*. The opening of the contacts 232*a* interrupts the circuit for energizing the reverse direction winding of the motor 216 so that this motor is no longer energized. The opening of the contacts 236*a* also interrupts the operating circuit for the relay 306 so that this relay releases to restore the contacts controlled thereby to their normal condition. The opening of the contacts 306*b* interrupts an additional point in the energizing circuit for the reverse winding of the motor 216. The closure of the contacts 306*a* energizes the solenoid or winding 206*b* in the control unit 206 so that brakes are applied to the drive system to arrest the lead screws 192 and 194 in a position in which the corona carriage 180 is properly disposed relative to the area exposed by the facsimile scanning unit 150. The closure of the contacts 306*c* does not perform any useful function at this time.

The closure of the contacts 232*b* completes an operating circuit including the closed contacts 324*c* and a pair of normally closed contacts 342*a* on a relay 342 for energizing and operating the relay 326. The operation of the relay 326 opens the contacts 326*a* and an additional pair of normally closed contacts 326*c*, and closes two pairs of normally open contacts 326*b* and 326*d*. The opening of the contacts 326*a* interrupts the energizing circuit for the relay 330 so that the contacts 330*a* are opened to disconnect the transformer 332 from the input of the high voltage supply unit 334. Thus, the corona wire 184 is no longer energized. The opening of the contacts 326*c* terminates the illumination of a lamp 344 to provide a visible indication that the graphic recorder 20 has been prepared for a facsimile operation. The corresponding closure of the contacts 326*b* forwards a recorder ready signal to the facsimile scanning unit 50 to indicate that facsimile recording can be initiated. The closure of the contacts 326*d* prepares a portion of an operating circuit for the control relay 346.

The graphic recorder 20 and the control circuit 42 remain in this condition until a demand signal is received indicating that facsimile signals are present for reproduction. At this time, the external control circuit 319 applies a continuous demand signal represented by the closure of a switch 348. The closure of the contacts 348 completes an operating circuit for a pair of relays 350 and 352. The operation of the relay 352 closes two pairs of normally open contacts 352*a* and 352*b* to connect the slow speed drive motor 82 across the input potential source. This energizes the motor 82 and is effective through the drive system 40 shown in FIGS. 1–3 of the drawings to advance the copy material 30 through the graphic recorder 20 at a low speed on the order of 1 inch per minute. The energization of the slow speed drive motor 82 also is effective to actuate the magnetic brush assembly at the developer station 54.

The operation of the relay 350 closes a pair of normally open contacts 350*a* and opens a pair of normally closed contacts 350*b*. The opening of the contacts 350*b* interrupts a circuit extending through a normally closed switch 354 to the power supply circuit 334. The circuitry of the power supply 334 is such that the opening of the circuit including the contacts 350*b* renders the power supply 334 incapable of energizing the corona wire 184. The application of a potential to the corona wire 184 is now transferred to a pair of cam driven contacts 356 which are actuated by a timing cam driven by a motor 358.

The closure of the contacts 350*a* completes an operating circuit over the closed contacts 324*c*, 232*b*, 306*c*, and 326*d* for operating a relay 346. The operation of the relay 346 closes a pair of normally open contacts 346*a* to connect an adjustable tap on a transformer 360 to the input of the high voltage potential source 334. Thus, the transformer 360 now supplies the power supply circuit 334 with a potential in a range suitable for charging the copy material 30 during facsimile recording, and the control or operability of the power supply circuit 334 to supply potential to the corona wire 184 is transferred to the cam controlled contacts 356.

The closure of the switch 348 in facsimile recording not only controls the operation of the relays 350, 352, and 346 in the manner described above, but also completes an energizing circuit for the drive motor 358 so that the contacts 356 are periodically opened and closed. In one control circuit 42 constructed in accordance with the present invention, the contacts 356 are closed four times each minute and remain closed for a period of 0.5 seconds. This means that the power supply circuit 334 supplies a high potential (around 4,000 volts) to the corona wire 184 in a magnitude determined by the setting of the transformer 360 for a period of 0.5 seconds four times during each 1-minute interval. This intermittent charging is desirable with the slow speed (1.2 inches per minute) at which the copy material is moved past the corona wire 184. Although the reason for the desirability of the pulsed charging of the copy material is not completely understood, it appears that there is an interaction between the zinc oxide coating on the copy material 30 and light emanating from the corona discharge wire 184 that produces a form of spontaneous discharge of the copy material 30 and a resultant inability to store an adequate latent image. It also appears that with continuous charging, there is an interaction or "crosstalk" between the portion of the copy material 30 selectively discharged by the means 50 and the charged area at the developer station 54 that negates the charged level of the latent image and causes print reversal. All of these phenomena

which were detected with customary continuous charge application are removed using the pulsed charging technique.

FIGS. 9 and 10 of the drawings schematically illustrate the operation of the graphic recorder 20 during the facsimile mode. As described above, the corona wire charging assembly 52 charges the portion of the copy material 30 underlying the platen 46 and disposed between extreme left-hand position of movement of the carriage 180 and the illustrated facsimile position of the carriage 180. When the recorder 20 is placed in operation by the closure of the switch 348 in the manner described above, the slow drive motor 82 is placed in operation to advance the copy material 30, and the facsimile recording or optical means scans an intensity modulated light beam providing a light dot of 0.005–0.015 inch diameter transversely across the copy sheet 30 to expose a line segment. During this interval, the corona wire 184 in the charging assembly 52 is pulsed to charge additional areas of the copy material as it moves to the light scanning area.

In a representative example of a facsimile recording, the light beam provided by the assembly 50 can be modulated to provide a weather map which is developed line by line. As illustrated in FIG. 9, the scanning by the beam from the unit 50 develops a latent electrostatic image corresponding to the information which is to be recorded which is advanced beyond the scanning area toward the magnetic brush 242 at the developer station 54. The selectively exposed lower surface of the copy material 30 bearing the latent electrostatic image is contacted by the electroscopic powder in the magnetic brush 242 to convert the latent electrostatic image into a loose powder or developed image. The developed image then passes through the fusing or fixing assembly 56 in which the toner material is fused to provide a permanent image. This operation continues for so long as facsimile signals are received by the assembly 50 or for so long as the facsimile demand represented by the closed switch 348 persists. When the facsimile input information is no longer available, the demand signal terminates, as represented by the opening of the switch 348, and the relays 346, 350, and 352 are released to restore the control circuit 42 in the graphic recorder 20 to a condition in which it is conditioned for facsimile reproduction, but in which the drive assembly 40 and the corona discharging assembly 52 are not activated. However, whenever the facsimile demand signal is returned, the closure of the contacts 348 again places the recorder 20 in operation.

During the facsimile or frame recording, a cam 357 on the drive shaft 120 periodically closes a switch 359 to connect a dispensing drive means in the toner feed assembly 265 across the potential source. Since the shaft 120 is driven in direct proportion to the linear length of copy material consumed by the machine 20, the periodic closing of the contacts 359 to energize the toner dispensing control 265 causes an amount of toner to be fed from the assembly 265 to the magnetic brush 244 that is proportionate to or dependent on the linear length of copy material 30 developed by the graphic recorder 20.

When the graphic recorder 20 is returned to a normal condition by cancelling the conditioning for facsimile recording, the control unit 319 provides a momentary facsimile cancel signal by momentarily closing a switch 361. The closure of the switch 361 completes an operating circuit for the relay 362 which closes two pairs of normally open contacts 362*a* and 362*c* and opens the closed contacts 362*d* and a pair of normally closed contacts 362*b*. The opening of the contacts 362*d* prevents the operation of the relay 330 and the energization of the corona wire 184 during movement of the carriage 180 to its home position. The closure of the contacts 362*a* completes a holding circuit for the relay 362 extending to the closed contacts 230*b* on the home switch 230. The closure of the contacts 362*c* provides a shunt around the facsimile switch 232 and completes an operating circuit for the relay 306 extending through the closed contacts 324*c*. The operation of the relay 306 again opens the contacts 306*a* and 306*c* and closes the contacts 306*b*.

The opening of the contacts 306*c* interrupts an additional point in the energizing circuit for the relay 346. The opening of the contacts 306*a* terminates the energization of the solenoid 206*b* in the brake-clutch control unit 206 so that brake is removed from the drive to the lead screws 192 and 194. The closure of the contacts 306*b* completes the energizing circuit for the return or reverse winding of the carriage drive motor 216 so that the carriage or housing 180 is now moved to the right (FIGS. 4 and 8) from the facsimile position shown in solid outline in FIG. 8 toward the normal home position shown in solid line in FIG. 4.

As the carriage or housing 180 moves away from the facsimile position toward the home position, the facsimile switch 232 is released to open the contacts 232*b* and to close the contacts 232*a*. The closure of the contacts 232*a* completes an additional operating circuit for the relay 306. The opening of the contacts 232*b* interrupts an additional point in the operating circuit for the relay 346 and also interrupts the holding circuit for the relay 326 so that the contacts 326*b* and 326*d* are opened and the contacts 326*a* and 326*c* are closed. The opening of the contacts 326*d* interrupts an additional point in the operating circuit for the relay 346. The opening of the contacts 326*b* removes the facsimile ready signal from the control unit 50. The closure of the contacts 326*c* illuminates the lamp 344 to indicate that the machine is not conditioned for facsimile operation. The closure of the contacts 326*a* prepares an operating circuit for the relay 330 which is interrupted at the open contacts 362*d*.

When the carriage 180 returns to its normal home position, the cam 220 engages the operator for the switch 230 and actuates this switch to open the contacts 230*b* and to close the contacts 230*a*. The opening of the contacts 230*b* interrupts the holding circuit for the relays 322, 324, and 362 so that these relays release to restore their contacts to their normal conditions. The release of these relays terminates the energization of the carriage drive motor 216 and completes the energizing circuit for the winding 206*b* in the clutch-brake control unit 206 so that the carriage 180 is braked in its home position. Thus, all of the control relays are restored to their normal conditions, and the machine 20 is in a condition in which the control circuit 42 can be controlled by the external control unit 319 to place the machine 20 in a condition for facsimile recording or full frame recording.

When full frame recording is to be performed by the graphic recorder or copying apparatus 20, the external control unit provides a conditioning signal to the control circuit 42 by momentarily closing two switches 364 and 366. When both of the switches 364 and 366 are closed, an operating circuit for the relay 304 is completed extending through the closed contacts 322*a*. The operation of the relay 304 closes the contacts 304*a* to complete a holding circuit to maintain the relay 304 operated when the switch 364 is opened. The operation of the relay 304 performs substantially the same function as set forth above when this relay is operated to prepare the graphic recorder 20 for facsimile operation. Thus, the opening of the contacts 304*b* terminates the energization of the winding 206*b* to release the brake, the closure of the contacts 304*d* prepares a portion of a holding circuit for the relay 342, and the closure of the contacts 304*c* completes the circuit for energizing the forward winding of the motor 216. Thus, the drive motor 216 now rotates the lead screws 192 and 194 to advance the carriage 180 of the corona charging assembly 52 in a forward direction from right to left in FIGS. 4 and 8.

The closure of the switch 366 completes an operating circuit for the relay 342 so that this relay operates to open the normally closed contacts 342*a* and an additional pair of closed contacts 342*f* and to close a plurality of pairs of contacts 342*b*, 342*c*, 342*d*, and 342*e*. The closure of the contacts 342*d* in combination with the prior closure of the contacts 304*d* completes a holding circuit for the relay 342 to maintain this relay operated when the switch 366 is opened. The closure of the contacts 342*b* prepares an additional holding circuit for the relay 342 which is interrupted at the open contacts 230*b*.

The opening of the contacts **342***a* interrupts an additional point in the above-described operating circuit for the relay **326** to prevent operation of this relay when the facsimile switch **232** is operated. The closure of the contacts **342***c* provides a shunt across the contacts **232***a* of the switch **232**.

The opening of the contacts **342***f* interrupts a point in a circuit for supplying a conditioning signal to the full frame recording assembly **48**, and the closure of the contacts **342***a* completes an operating circuit for a relay **368** extending to a potential source or battery **370**. The operation of the relay **368** closes a pair of normally open contacts **368***a*. The closure of the contacts **342***e* also initiates the charging of a capacitor **371**.

As the carriage or housing **180** is moved away from home position toward the left-hand position, the home switch **230** is operated to open the contacts **230***a* and to close the contacts **230***b*. The closure of the contacts **230***b* completes the above-described holding circuit extending over the contacts **362***b* and **342***b* for maintaining the relay **342** in an operated condition.

The circuit **42** remains in this condition as the carriage **180** moves to the extreme left-hand position. During this movement, the switch **232** momentarily opens the contacts **232***a* and closes the contacts **232***b*, but this contact actuation does not provide any useful function. When the carriage **180** reaches its extreme left-hand position, the switches **234** and **236** are again operated to perform the functions described above of interrupting the energization of the forward winding of the drive motor **216**, of providing dynamic braking for the motor **216**, and of energizing the reverse winding of the motor **216** so that the lead screws **192** and **194** are now rotated in a direction to return the carriage **180** to its extreme right-hand or home position. Incident to this operation, the relays **306**, **322**, **324**, and **330** are operated, and the relay **304** is released. The relay **330** again closes the contacts **330***a* so that the voltage derived from the transformer **332** is again applied to the input of the power supply circuit **334** to energize the corona discharge wire **187** during the reverse movement of the carriage **180**. This imparts a uniform electrostatic charge to the entire length of the copy material **30** underlying the grounded platen **46**. The switches **234** and **236** are released as the carriage **180** moves toward the home position. During this reverse movement, the operation of the facsimile switch **232** does not produce the operations described above by which the carriage **180** is stopped in the facsimile position because the contacts **232***a* are shunted by the closed contacts **342***c* and because the open contacts **342***a* disconnect the facsimile control relay **326** from the switch **232**.

When the carriage **180** returns to its home position after charging the full extent of the copy material **30** overlying the platen **46**, the switch **230** is operated by the cam **220** to open the contacts **230***b* and to close the contacts **230***a*. The opening of the contacts **230***b* interrupts the holding circuit for the relays **322** and **324** so that these relays release. In addition, the opening of the contacts **230***b* interrupts the holding circuit for the relay **342** so that this relay releases. The release of these relays also interrupts the holding circuit for the relay **306** so that this relay releases. Thus, all of the control relays in the circuit **42**, with the exception of the input relay **301**, are now released. The carriage **180** is in its normal home position moved beyond the field of exposure of the full frame exposing assembly **48** (see FIG. **8**), and the portion of the copy sheet **30** to receive the full frame exposure has been uniformly charged with the desired electrostatic field. Since it is possible for the charging carriage **180** to make a complete passover the full area of the copy material **30** underlying the platen **46**, this surface can be charged and subsequently exposed. This avoids the waste of copy material **30** inherent in advancing a full frame length of this copy material past a charging assembly which is maintained in a fixed home position.

In addition, when the relay **342** is released, the closure of the contacts **342***f* completes a circuit for supplying a short duration signal to the assembly **48** to indicate that the graphic recorder **20** is in condition for full frame recording. The opening of the contacts **342***e* when the relay **342** releases interrupts the operating circuit for the relay **368**, but this relay is rendered slow to release by the capacitor **371** which discharges through the winding of the relay **368** to maintain this relay operated for a predetermined period of time. At the end of this time delay, the relay **368** releases to open the contacts **368***a* and remove the conditioning signal from the recording unit **48**.

With the assembly **48** now in condition for operation, the external control unit **319** applies a signal to the assembly **48** so that a light image corresponding to the graphic original to be recorded is directed on the charged surface of the copy material **30** disposed adjacent the platen **46** so as to selectively discharge the uniform electrostatic image and provide a latent electrostatic image corresponding to the original to be recorded. The area covered by the full frame exposure includes the area blocked by the charging assembly **52** when this assembly is in its facsimile position. However, the entire surface of the copy sheet **30** can be utilized because of the movement of the charging assembly **52** to its home position prior to operation of the recorder **20** in its full frame mode. If, for some reason, the copy material **30** is not exposed within a given period of time following the application of the uniform electrostatic charge in the manner described above, the switches **364** and **366** can again be momentarily operated to cause the reapplication of a charge.

Following the development of a latent electrostatic image, the external control unit **319** forwards a signal to the circuit **42** of a duration sufficient to move the exposed portion of the copy sheet **30** beyond the platen **46** and to initiate the process of developing and fusing the previously exposed portion of the copy material **30**. This signal is represented by the closure of a switch **372** which completes an operating circuit for the relay **312** and a high-speed motor control relay **374**. The operation of the relay **374** closes two pairs of normally open contacts **374***a* and **374***b* to connect the high-speed drive motor **84** across the input potential source. This places the drive assembly **40** in operation to advance the copy material **30** at high speed through the machine **20** and to operate the magnetic brush assembly at an increased rate of speed. The operation of the relay **312** closes three pairs of normally open contacts **312***b*, **312***c*, and **312***d* and opens the contacts **312***a* and **312***e*. The closure of the contacts **312***c* operates a relay **376** to close a pair of normally open contacts **376***a* so that a transformer **378** is connected to the input of the power supply **334** to supply a potential of around 6,500 volts to the corona discharge wire **184** when the copy material **20** is moved at high speeds relative to the corona charging assembly **52**. Thus, as the previously exposed section of the copy material **30** is moved beyond the platen **46**, the material moving onto the platen is supplied with a uniform electrostatic charge by the assembly **52**.

The operation of the relay **312** also conditions the fixing assembly **56** for a higher temperature operation to provide sufficient heat to fuse the electroscopic particles in the visible image as the copy material **30** moves at higher speed through the fixing unit **56**. More specifically, the opening of the contacts **312***a* interrupts the intermittently completed operating circuit for the relay **310** so that the contacts **310***a* remain open. The closure of the contacts **312***b* prepares an operating circuit for a high heat relay **380** extending to the contacts **308***a* controlled by the temperature controller **308**. Since the assembly **56** has been operating at low temperature, the opening of the normally closed contacts **312***e* and the closure of the normally open contacts **312***d* converts the temperature controller **308** and the sensor **309** to regulate the temperature of the platen **58** to a higher level. Accordingly, the sensor **309** controls the control unit **308** to immediately close the contacts **308***a* because of the lower temperature of the platen **58**. The closure of the contacts **308***a* completes an operating circuit for the relay **380** so that this relay operates to close four normally open pairs of contacts **380***a*, **380***b*, **380***c*, and **380***d*.

The closure of the contacts **380***a* and **380***b* places the heating element **318** directly across the line and thus increases the current flow therethrough. The closure of the contacts **380***c* connects the heating element **314** directly across the input potential source, and the closure of the contacts **380***a* and **380***c* connect the heating element **316** directly across the potential source. Thus, the heat provided by the three resistance elements **314**, **316**, and **318** is substantially increased. The closure of the contacts **380***d* energizes the infrared lamps **60** to provide supplemental heat directed on the image bearing surface rather than the opposite surface of the copy material **30** as it passes through the fixing assembly **56**.

As indicated above, the switch **372** remains closed to maintain the above-described circuit conditions until sufficient copy material has been advanced to move the previously exposed portion of this material beyond the frame exposing area. At such time, the switch **372** is momentarily opened, and the assembly **48** exposes the next frame area on the material **30**. The switch **372** is then reclosed to produce the same operations described above. This intermittent operation continues until such time as all desired full frame printing has been completed. The control circuit **42** can be operated to condition the graphic recorder **20** for facsimile recording at any desired time by sequential operation of the switches **320** and **348** in the manner described above.

Although the present invention has been described with reference to a single illustrative embodiment thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this invention.

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

1. A graphic recording machine operable in a facsimile mode for making a record on a photoelectrostatic member, comprising:

an exposure station where the member is imaged to provide said record,

means immediately adjacent said station for charging the member, said charging means including a corona discharge device spaced from said member,

means for moving the member past the charging means and into said station at a predetermined, substantially slow rate on the order of about 1 inch per minute, and

control means for repeatedly turning the charging means on and off at a rate in accordance with which said charging means is on only for substantially minute periods per unit time, as the member moves past said charging means so that the member is uniformly charged.

2. The machine defined by claim **1** wherein said member is exposed to an intensity modulated scanning light beam upon arrival at said station.

* * * * *