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Eichorn, deceased et al.

[11] **3,908,125**

[45] **Sept. 23, 1975**

[54] **REVERSE PATH IMAGING AND TRANSFIXING COPYING MACHINE**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[22] Filed: **Dec. 27, 1973**

[21] Appl. No.: **428,956**

[52] **U.S. Cl.** **250/316;** 250/319

[51] **Int. Cl.²** **B41M 5/00**

[58] **Field of Search** 250/316, 317, 318, 319

[56] **References Cited**

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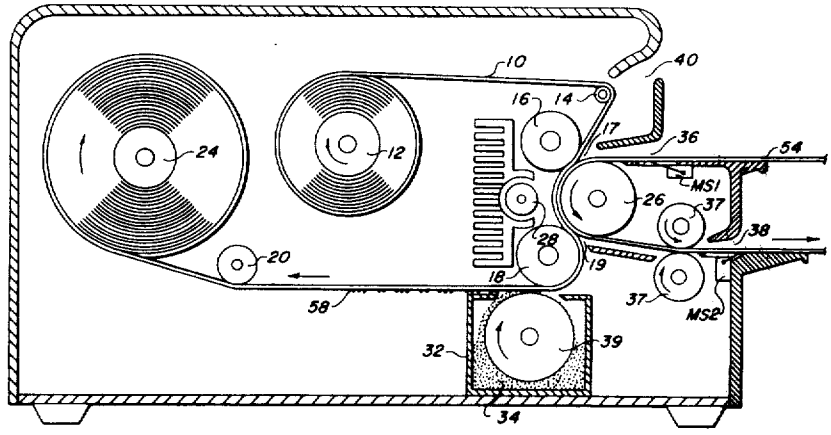
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Primary Examiner—Craig E. Church

[57] **ABSTRACT**

A copying machine is provided wherein a heat image is formed on a heat sensitive intermediate member at an imaging station by exposing the same and an original to a heat source. Then the intermediate is moved in one direction to a developing station wherein the image thereon is developed with toner particles and thereafter, the direction of movement of the intermediate is reversed back along the same path to the imaging station whereat a copy medium is brought into engagement with the developed image and heat is applied thereto by the same heat source and the developed image transferred to the copy medium. The heat sensitive intermediate member may be in the form of a continuous web or a cut sheet. Rather than transfer the developed image to a copy paper, the toner particles may be fixed or fused to the heat sensitive member.

15 Claims, 14 Drawing Figures



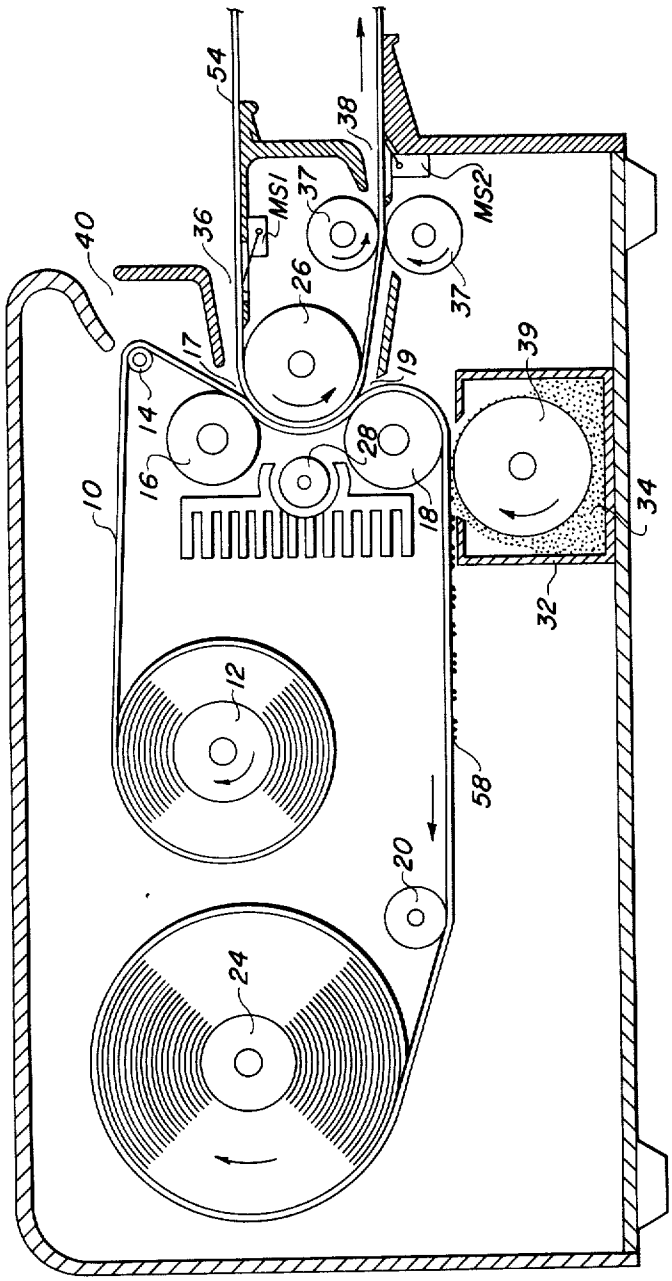


FIG. 1

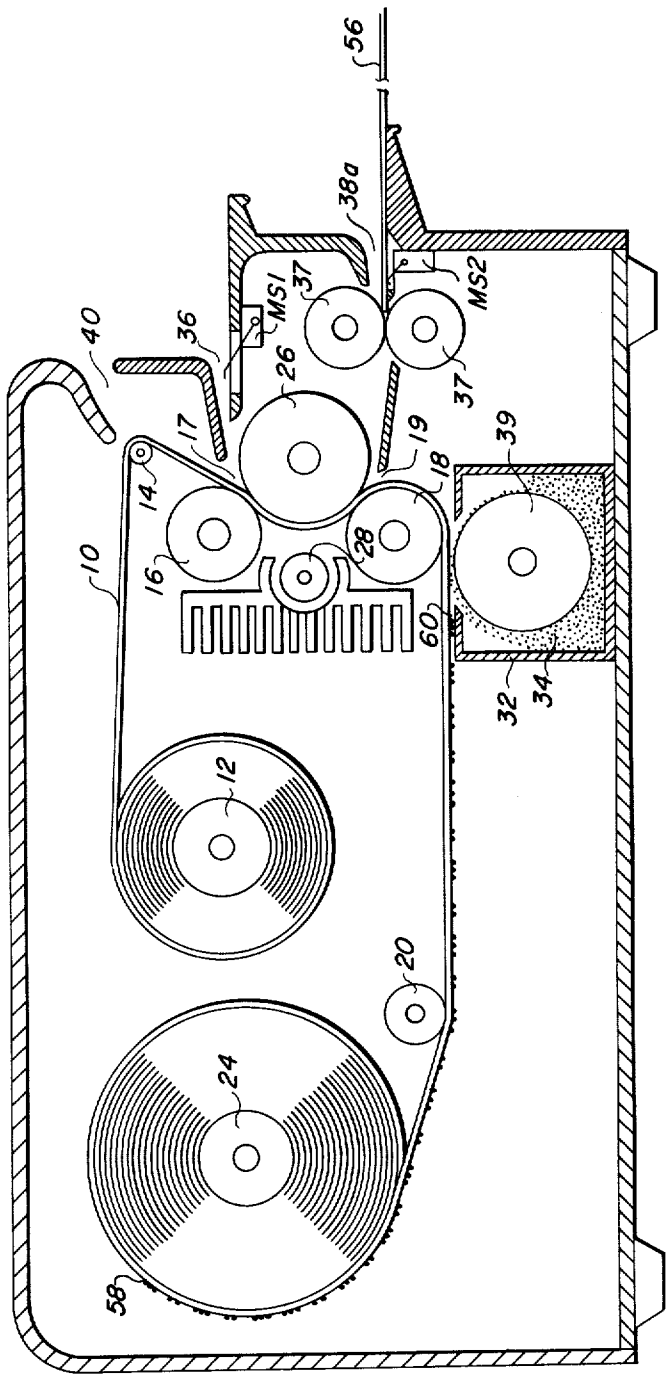

56
38a
MS1
37
MS2
40
36
26
37
17
19
39
14
18
10
16
28
60
32
34
12
20
24
58

FIG. 2

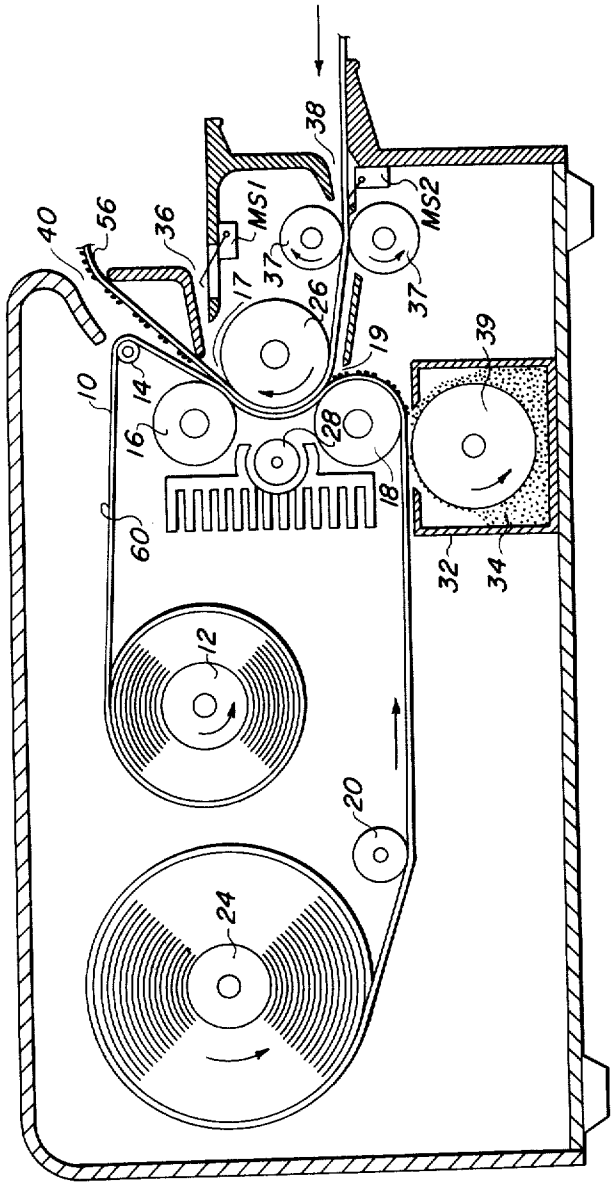


FIG. 3

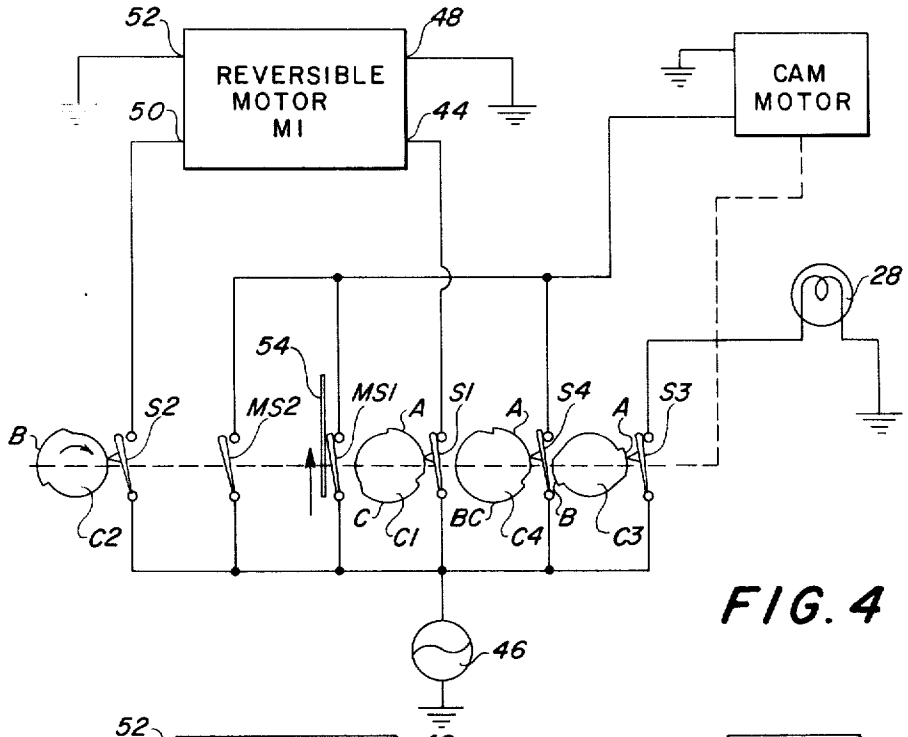

52
48
REVERSIBLE MOTOR MI
50
44
CAM MOTOR
28
54
MS2
MS1
S1
S4
S3
S2
A
B
C
C1
BC
C4
C2
C3
46

FIG. 4

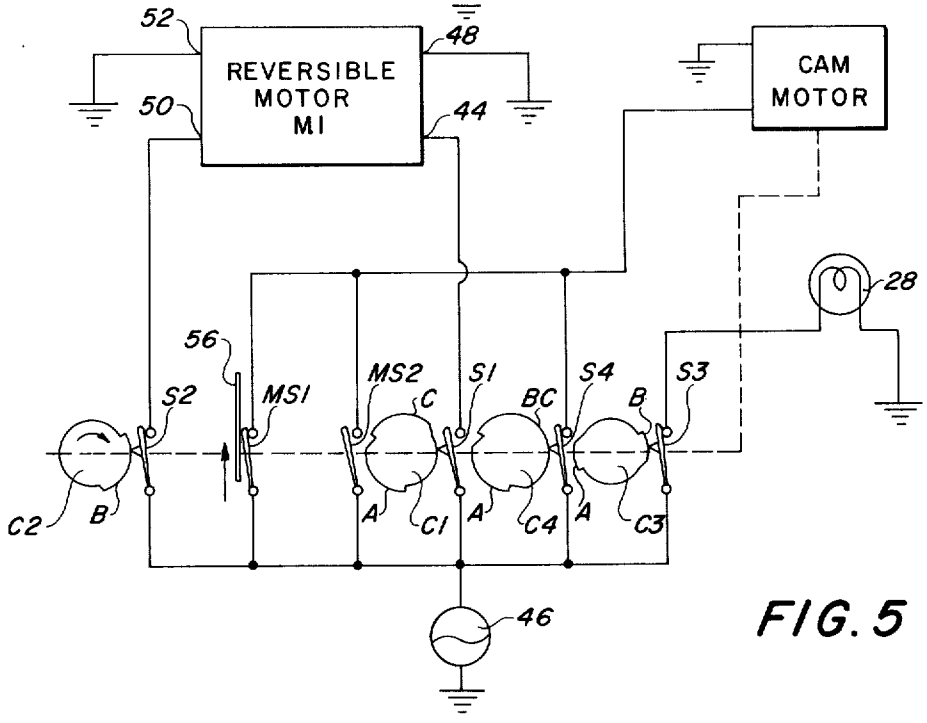

52
48
REVERSIBLE MOTOR MI
50
44
CAM MOTOR
28
56
MS2
MS1
S1
S4
S3
S2
C
BC
B
A
C1
C4
C3
C2
46

FIG. 5

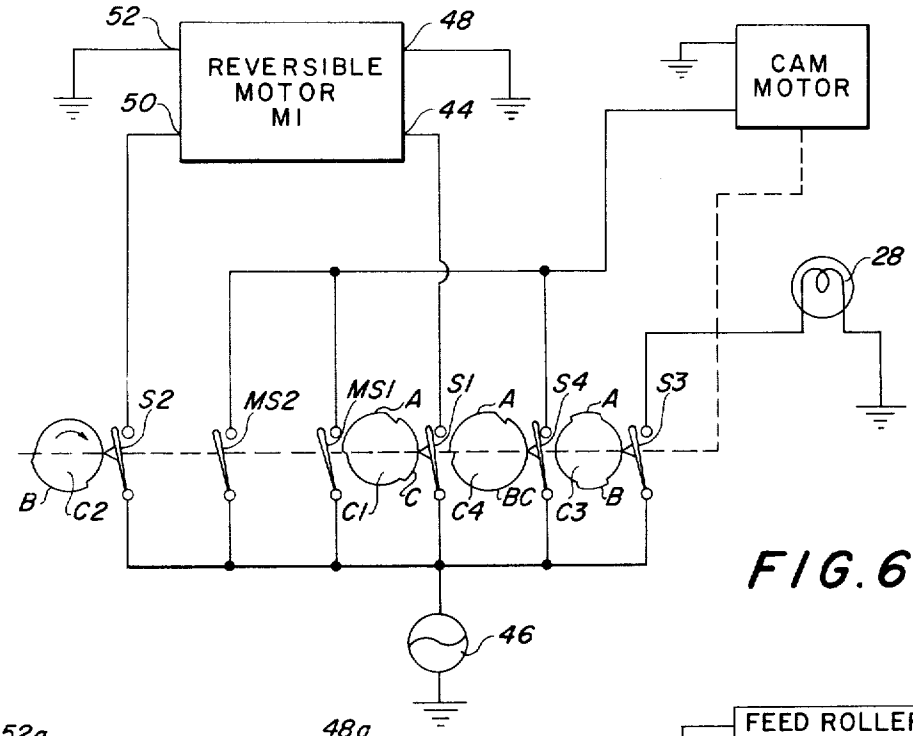

52
48
REVERSIBLE MOTOR MI
50
44
CAM MOTOR
28
S2
MS2
MSI
A
SI
A
S4
A
S3
B
C2
C1
C
C4
BC
C3
B
46

FIG. 6

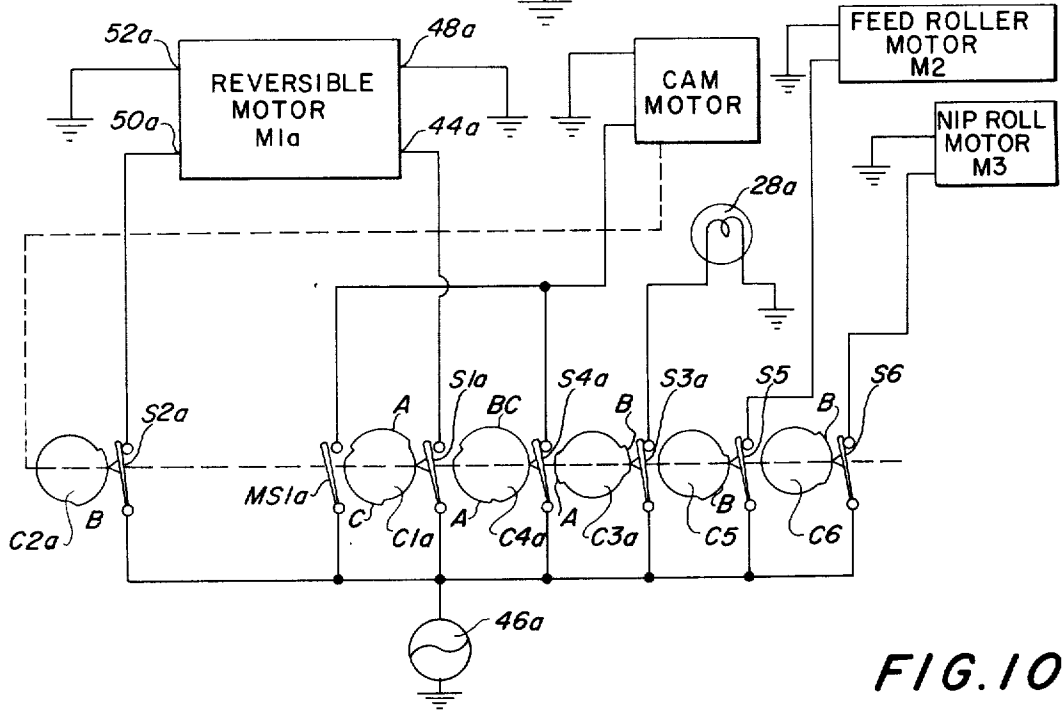

52a
48a
REVERSIBLE MOTOR Mla
50a
44a
CAM MOTOR
FEED ROLLER MOTOR M2
NIP ROLL MOTOR M3
28a
S2a
S1a
A
BC
S4a
B
S3a
S5
B
S6
B
MS1a
C
C1a
A
C4a
A
C3a
B
C5
C6
C2a
B
46a

FIG. 10

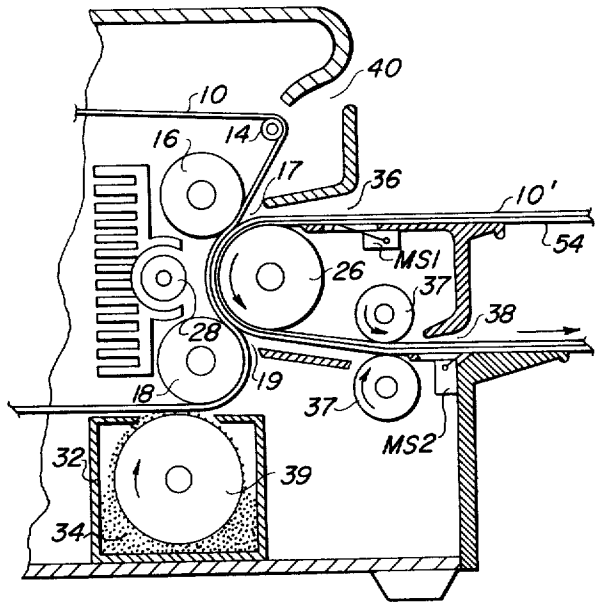

40
10
16
14
17
36
10'
54
MS1
26
37
38
28
19
18
37
MS2
32
39
34

FIG. 7

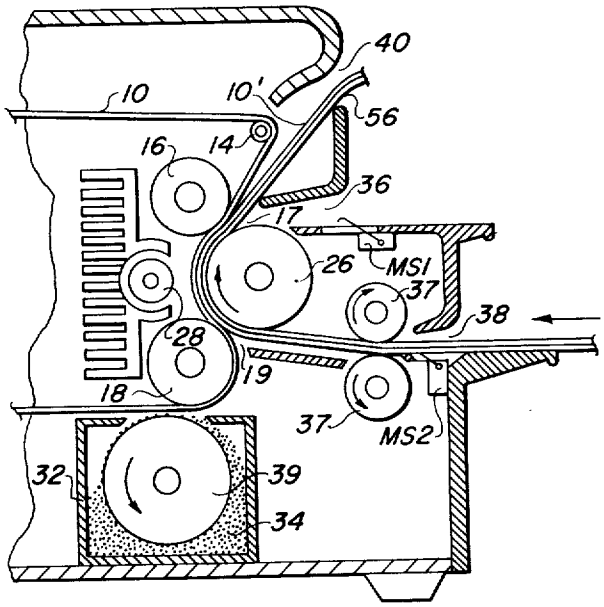

40
10
10'
56
16
14
36
17
26
MS1
37
38
28
19
18
37
MS2
32
39
34

FIG. 8

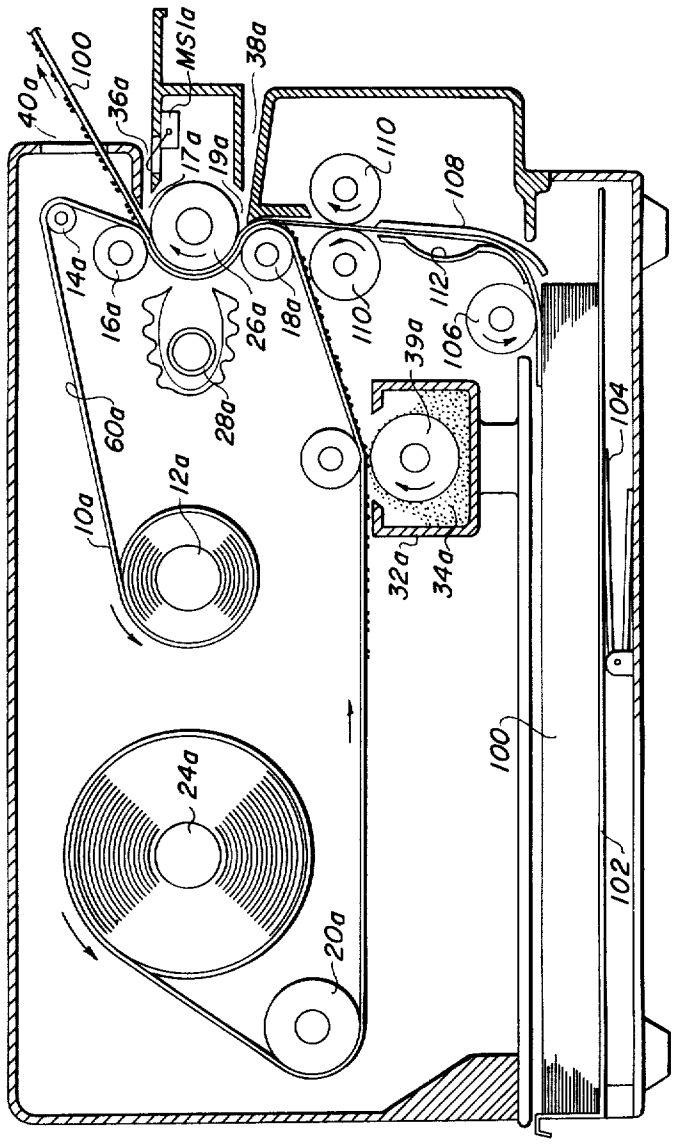

40a
100
36a
MS1a
38a
17a
19a
110
108
14a
16a
26a
18a
110
112
39a
106
28a
60a
12a
10a
104
32a
34a
100
24a
20a
102

FIG. 9

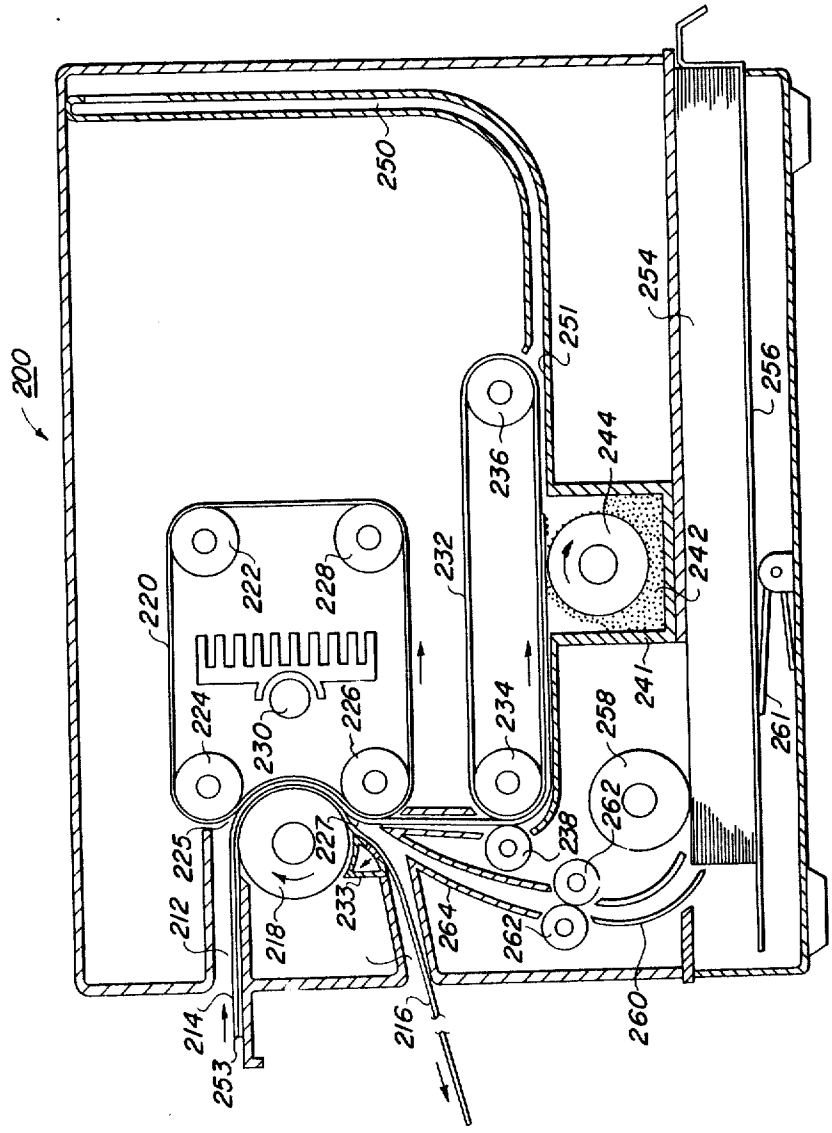

200
250
254
251
256
236
244
242
232
220
222
228
224
230
226
234
241
258
261
262
238
225
227
212
218
233
264
262
214
216
260
253

FIG. 11

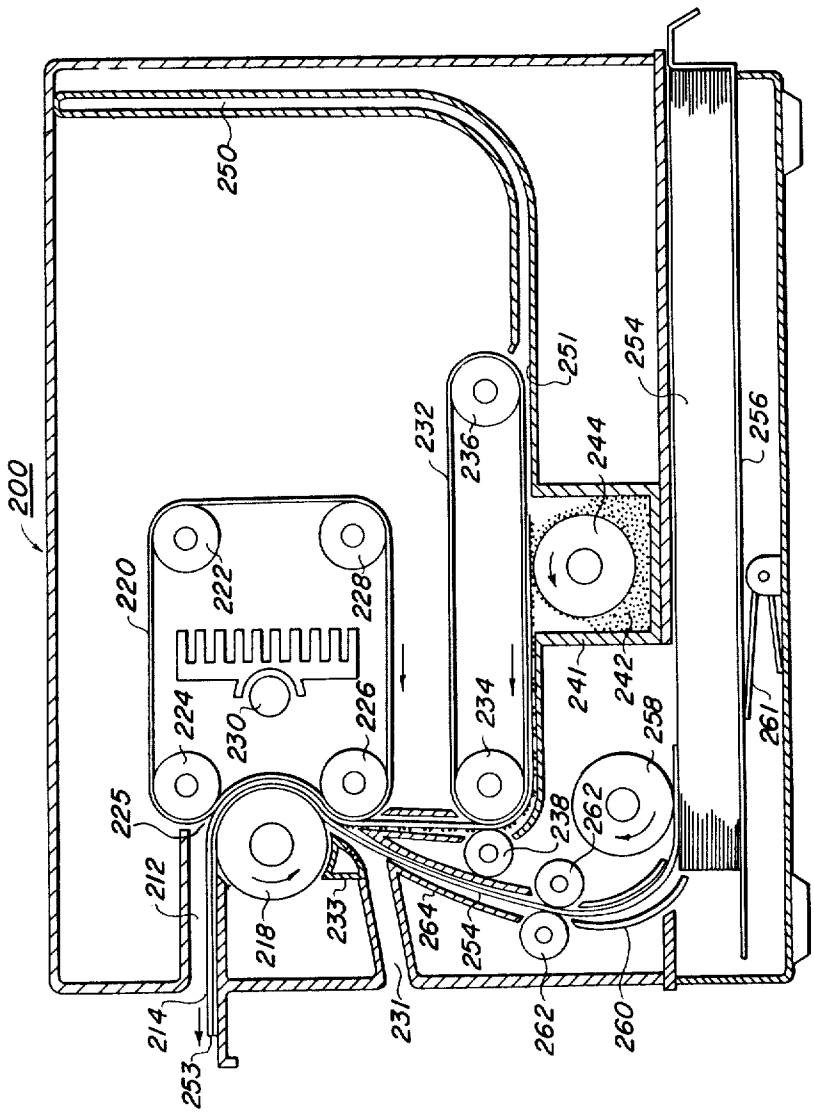

200
250
251
254
232
236
244
256
220
222
228
224
230
226
234
241
242
258
261
225
212
218
233
238
262
264
254
214
253
231
262
260

FIG. 12

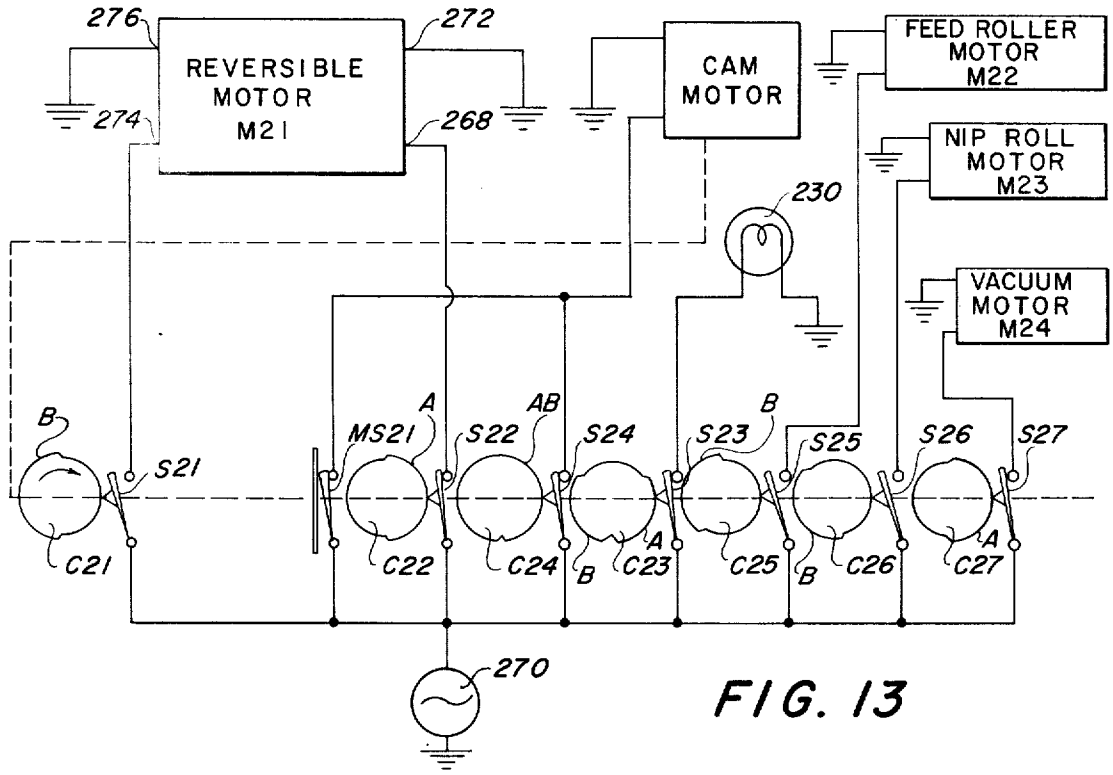

276
272
REVERSIBLE MOTOR M21
274
268
CAM MOTOR
FEED ROLLER MOTOR M22
NIP ROLL MOTOR M23
230
VACUUM MOTOR M24
B
S21
C21
A
MS21
C22
AB
S22
C24
S24
B
A
C23
B
S23
C25
S25
B
C26
S26
A
C27
S27
270

FIG. 13

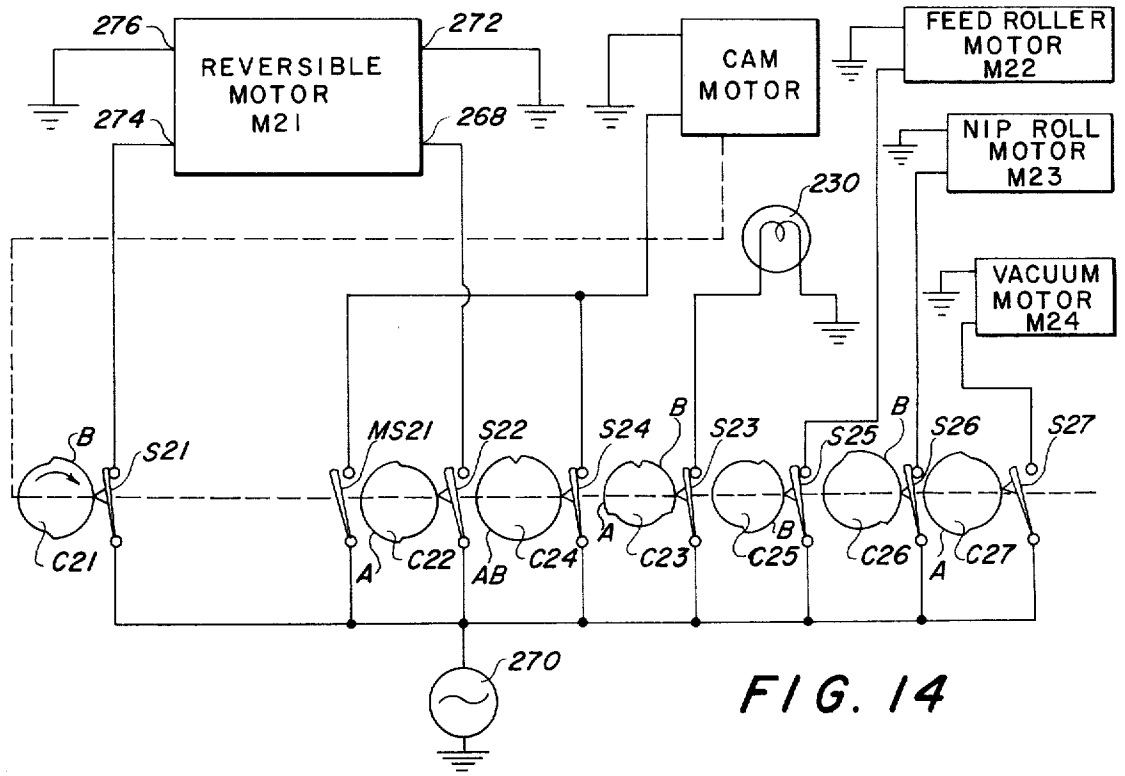

276
272
REVERSIBLE MOTOR M21
274
268
CAM MOTOR
FEED ROLLER MOTOR M22
NIP ROLL MOTOR M23
230
VACUUM MOTOR M24
B
S21
C21
MS21
A
C22
AB
S22
C24
S24
B
A
C23
B
S23
C25
S25
B
C26
S26
A
C27
S27
270

FIG. 14

REVERSE PATH IMAGING AND TRANSFIXING COPYING MACHINE

DESCRIPTION OF THE INVENTION

In many thermographic processes, a heat image is impressed upon a heat sensitive member at an imaging station and thereafter the image is developed with toner particles and either the toner particles are fused to the heat senstivie material or the toner particles are transfixed (transferred and fused) to a copy medium from the heat sensitive material at a fusing or transfer station downstream of the development station. Separate radiation sources are utilized for the heat imaging function and the fusing or transfer function. In some systems, the same radiation source is utilized for the imaging function as well as the fusing or transfer function at the separate stations.

In the process where two separate radiation sources are utilized, one downstream of the other, separate control mechanisms and transport mechanisms must be provided and must be synchronized so that the functions at each station are efficiently carried out. Obviously, this requires duplication of part and a more complicated system.

When the same radiation source is provided for both stations a web intermediate or heat sensitive material is wasted since a new portion of the web is exposed to the radiation source when the imaged portion of the web is being fused or transferred. Furthermore, one is slimited to the same radiation intensity for both functions or the machine must be larger so that the radiation source may be changed to a different intensity for either fusing or transfixing after imaging.

It is an object of this invention to provide an automated copying method which permits the use of an inexpensive, simple copying device in which there will be no or little waste of the heat sensitive web material and in which the device will be simple and compact.

It is a further object of this invention to provide an automated copying method which permits the use of an inexpensive simple copying device for utilizing heat sensitive material in cut sheet form.

It is proposed to accomplish the above object by using the same radiation source and station for imaging and either fusing or transfixing functions.

Other objects of this invention will become apparent from the following description with reference to the drawings wherein:

FIG. **1** is a general schematic view of one embodiment of a copying apparatus for effecting the concept of this invention while performing imaging and developing functions;

FIG. **2** is a view of the copying apparatus after an image on a web has been developed;

FIG. **3** is a partial view of the copying apparatus during transfer and fixing of a powder image from the web to a copy sheet;

FIG. **4** is a veiw of an electrical schematic of a system for operating the copying apparatus of FIG. **1** showing the operation thereof during the first phase of an operation cycle;

FIG. **5** is a view of the electrical schematic shown in FIG. **4** showing the operation thereof during the second phase of the operation cycle;

FIG. **6** is a view of the electrical schematic shown in FIG. **4** showing the operation thereof during the third phase of the operation cycle;

FIG. **7** is a veiw illustrating the use of the embodiment of FIG. **1** for making multicolored copies during an imaging step utilizing a separate heat sensitive sheet;

FIG. **8** is a view similar to FIG. **7** during transfer and fixing of a powder image from the separate heat sensitive sheet to a copy sheet;

FIG. **9** is a general schematic view of the copying apparatus shown in FIG. **1** only modified to include an automatic copy paper feed;

FIG. **10** is a view of an electrical schematic of a system for operating the copying apparatus of FIG. **7** showing the operation thereof during the second phase of the operation cycle;

FIG. **11** is a schematic view of another copying apparatus embodiment employing the same principles of this invention showing the imaging and developing step;

FIG. **12** is a view of the apparatus of FIG. **9** showing a developed image transfer step;

FIG. **13** is a view of an electrical schematic of a system for operating the copy apparatus of FIGS **9** and **10** showing the operation thereof during the first phase of an operation cycle; and

FIG. **14** is a view of the electrical schematic shown in FIG. **11** showing the operation thereof during the second phase of the operation cycle.

Referring to FIG. **1**, a web of heat sensitive material **10** is fed from a supply spool **12** around idler rolls **14**, 16, 18, and **20** to a take-up spool **24**. The web **10** comprises a support with a heat sensitive coating. For example, the support may be an organic film such as a polyester film, cellulose acetate or triacetate film coated with a delayed tack adhesive which is normally hard and non-tacky at toom temperature, but which, upon being activated by heat to a tacky condition and subsequently cooled to room temperature, thereafter remains tacky for considerable periods of time varying from at least 30 seconds to several days or more depending upon the particular composition involved. Such delayed tack coatings are well known and can be a mixture of discrete particles of resin such as indene resin or esterfied resin and discrete particles of crystalline plasticizer such as diphenyl phthalate or N-cyclohexyl paratoluene sulfonamide. The particles are bound together into the supporting film by a binder such as styrene-butadiene copolymer. Generally speaking, the crystalline plasticizer component of the mixture is in excess of the resin component.

The supply spool **12** and the take-up spool **24** are connected through a respective slip clutch (not shown) to a reversible motor M1 (see FIG. **5**). The clutch connection for the supply spool **12** is such that the spool will be positively driven in a counterclockwise direction and slips to allow the spool to rotate in a clockwise direction. The clutch connection for the take-up spool **24** is such that the spool will be positively driven in a clockwise direction and slips to allow the spool to rotate in a counterclockwise direction.

A rotatable cylinder **26** having a highly reflective surface and which is reversibly driven by the motot M1 is interposed between the idler rolls **16** and **18** and is so arranged that the web **10** is pressed against the idler rolls to form nips **17** and **19**. A radiation source such as an incandescent lamp **28** is located opposite the cylinder **26** and a reflector **30** is arranged to focus the rays of the lamp **28** onto the cylinder **26** between the idler rolls **16** and **18**.

A developing station is provided which comprises a developer housing **32** having a bed of ferromagnetic toner particles **34** therein. The toner particles **34** comprise thermoplastic particles pigmented with carbon black or other radiation absorbing dyes or pigments, and mixed with iron oxide particles.

A well known magnetic brush **39** is rotatably mounted to the side walls of the housing **32** and located to present toner particles to the web **10** as it passes thereby. The magnetic brush **39** is operably connected to the motor M1 to be reversibly driven thereby.

An original inlet slot **36** is provided which opens adjacent the nip **17** and an original outlet and copy inlet slot **38** is provided which opens adjacent the nip **19.** A copy outlet opening **40** is provided which is also adjacent the nip **17.** A micro-switch MS1 is provided in the original inlet opening **36** and a microswitch MS2 is located in the copy inlet slot **38** which, when actuated, serves to actuate a control mechanism **42.** A pair of nip rolls **37** are provided in the opening **38** and are driven in one direction by motor M1 to discharge an original from the copying apparatus and are driven in the opposite direction to pull a copy paper into the machine.

The reversible motor M1 has a forward input terminal **44** connected to a power source **46,** a forward input terminal **48** connected to ground, a reverse input terminal **50** connected to the power source **46** and a reverse input terminal **52** connected to ground. Cam operated switches S1 and S2 are located to control the communicaton of the power source with the forward input terminal **44** and the reverse input terminal **50,** respectively. The lamp **28** is connected to the power source **46** and a cam operated switch **53** controls the communication therebetween. A cam motor is connected to the power source **46** and a cam operated switch S4 controls the communication therebetween. Microswitches MS1 and MS2 also control the communication between the power source **46** and the cam motor. The cam motor drives a shaft in one direction which has a plurality of cams C1, C2, C3 and C4 fixedly secured thereto which are arranged to actuate switches S1, S2, S3 and S4, respectively, during one complete revolution through phases A, B and C of one cycle of machine operation. Cam C1 has cam surfaces A and C which close switch S1 during rotation of the cams through A and C phases. Cam C2 has a cam surface B which closes switch S2 during rotation of the cams through the B phase. Cam C3 has cam surfaces A and B which close switch S3 during rotation of the cams through the A and B phases. Cam C4 has cam surfaces A and BC which close switch S4 during the A, B and C phases.

The operation of the apparatus is as follows:

Referring to FIGS. **1** and **4,** an original sheet **54** having an image thereon is fed into the inlet slot **36** actuating the microswitch MS1 which connects the cam motor with the power source **46** and sets the cam bank into clockwise rotation. As soon as the cam bank begins rotation, the cam surface A of cam C1 closes switch S1 to actuate motor M1 in the forward direction to rotate the web take-up spool **24,** the cylinder **26,** the magnetic brush **39** and the nip rolls **37** in the direction indicated by the arrows in FIG. **1.** At the same time, the cam surface A of cam C4 closes the switch S4 to lock in communication of the cam motor to the power source **46.** Also at the same time, the cam surface A of cam C3 closes the switch S3 to energize the lamp **28.** The leading edge of the original sheet **54** is fed into the nip **17** and is moved with the web **10** past the lamp and then the original separates from the web and is directed through the outlet opening **38.** The switch MS2 located in the outlet opening is a one way switch and is not actuated by the original as it travels therepast. As the web **10** and the original **54** pass the lamp **28** and around the cylinder **26,** the sandwich is in tight engagement with the cylinder **26** assuring efficient heat transfer between the image and the heat senstive layer whereby the radiant rays are absorbed by the image forming a heated image which is transferred to the heat sensitive web **10** to form a tacky image corresponding to the image on the original sheet. The web is transported past the magnetic brush **39** which presents toner particles to the web and develops the tacky image thereon. The cam surface A on cam C3 is designed to allow the switch S3 to open approximately after the imaging function has been completed thereby de-energizing the lamp **28.** The cam surface A of cam C1 is designed to allow switch S1 to open and stop the drive motor M1 and thereby the take-up shaft **24,** the cylinder **26,** the nip rolls **37,** and the magnetic brush **39** when a sufficient length of the web **10** corresponding to the length of the sheet to be copied passes at least the magnetic brush **39** with a portion of the leading edge of the developed image being wrapped on the take-up roll **24** as a single layer only to avoid any smudging of the developed image. To illustrate this, reference is made to FIG. **2** where the leading edge of the developed image is indicated by reference numeral **58** and the trailing edge indicated by reference numeral **60.** The cam surface A of cam C4 is designed to allow switch S4 to open immediately after switch S1 is open to stop the cam motor. At this point, the cam bank has turned approximately one-third of a revolution.

Referring now to FIGS. **3** and **5,** the operator inserts a copy sheet **56** into the copy slot **38** which actuates switch MS2 which connects the cam motor to the power source **46** and thereby starts the cam bank rotating again. As soon as the cam bank starts rotating, the cam surface B of cam C2 closes switch S2 to energize motor M1 in the reverse direction thereby rotating the supply shaft **12,** the cylinder **26,** the nip rolls **37,** and the magnetic brush **39** in the direction as shown by the arrows in FIG. **3.** At the same time, the cam surface BC of cam C4 closes switch S4 to lock in communication between the power source **46** and the cam motor. Cam surface B of C3 is so located to close switch S3 to energize the lamp **28** at approximately the time just prior to the leading edge of the copy sheet **56** entering the nip **19.** The web **10** starts its reverse movement with the former trailing edge **60** now being the leading edge. As the leading edge **60** of the image moves toward the nip **19,** the copy sheet **56** is moved toward the nip **19** by the nip rolls **37** and so timed that the leading edge of the copy sheet **56** will align with the leading edge **60** of the image just prior to entering the nip **19.** The aligned copy sheet and the image on the heat senstive web are forwarded past the lamp **28** whereby the rays therefrom heat the toner particles whereby a substantial portion thereof are transfixed (transfer and become fixed) to the copy sheet to provide a reproduction of the original image. This transfer occurs due to the pressure between the web **10** and the copy sheet **56** effected as they travel around the cylinder **26** and effected at the nip **17** combined with a corresponding proper temperature. As the copy sheet **56** emerges from the nip **17,** the

sheet separates from the web **10** and is directed out of the machine through the slot **40.** The cam surface B of cam C3 is so designed to allow switch S3 to cut off communication between the lamp **28** and the power source **46** immediately after the trailing edge of the copy sheet **56** emerges from the mip **17.** The cam surface B of cam C2 is so designed to allow switch S2 to open to cut off communication between the power source and the motor M1 at the same time that the lamp **28** is turned off to stop rotation of the supply shaft **12,** the cylinder **26,** the nip rolls **37** and the magnetic brush **39.** At this point of the operation, the cam shaft has rotated approximately two-thirds of a revolution.

Referring to FIG. **6,** the cam surface BC of cam C4 is so designed to maintain switch S4 closed and thereby keep the cam motor turning the cam bank which results in cam surface C of cam C1 closing switch S1 to communicate motor M1 to the power source **46** to drive the motor in the forward direction which drives the web take-up shaft **24,** the cylinder **26,** the nip rolls **37** and the magnetic brush **39** in the direction as shown in FIG. **1.** The cam surface C of cam C1 is so designed to maintain the switch S1 closed and therefore the motor M1 driving in a forward direction until the edge **60** of the used portion of the web is transported to just beyond the nip **17** whereby a fresh portion of the web is in position to be used when a new copy is to be made. The cam BC of cam C4 so so designed to keep the switch S4 closed and thereby the cam bank rotating until just after the switch S1 is opened. At this point, a full cycle of operation of the copying apparatus has been completed and the cam bank has rotated one complete revolution.

Rather than insert a copy sheet into the original outlet slot, a separate copy inlet slot with microswitch MS2 therein could be provided. Also, a safety switch may be employed in series with microswitch MS2 in the reverse direction in case the copy sheet is inserted prior to the motor M1 being stopped after phase A. In this case, a cam can close the safety switch to energize the motor M1 in the reverse direction after motor M1 has stopped at the completion of phase A.

Referring to FIGS. **7** and **8,** the copying apparatus may be used in another manner illustrated. It may be desired to make a multicolored copy of the original **54.** In this instance, the original **54** and a heat sensitive sheet **10'** are fed into the inlet slot **17** as a sandwich actuating the microswitch MS1 which starts the machine operation as previously described. The sandwich is fed past the rays from lamp **28** imparting a heat image on the sheet **10'.** The sandwich is discharged out of the slot **38** and the sheets separated by the operator. The operator then dusts by hand toner particles over the developed image in any manner he wishes and in any color pattern. The operator then takes the developed sheet **10'** and a copy sheet **56'** and introduces the same as a sandwich into the slot **38** which actuates microswitch MS2 which reverses the copying apparatus in the manner described above. The sandwich is fed past the lamp rays of lamp **28** whereby the toner particles are transferred to the copy sheet **56'.** The sandwich is then discharged through the slot **40** and the sheets are separated by the operator. A special control can be provided to be set by the operator which will prevent the machine from operating during rotation of the cam bank through the third phase. since the web **10** does not become tacky, the toner particles **34** presented by magnetic brush **39** do not stick thereto. Therefore the web **10** is in position to be used again in the normal manner without any waste being effected during this copying process. Rather than transfer the toner to a copy sheet, the toner could be fused to the sheet **10'** by passing that sheet alone into the slot **38** and out of the slot **40.**

Referring to FIG. **9,** there is illustrated a modification of the copying apparatus of FIG. **1** wherein the copying apparatus has been provided with a paper tray for automatic paper feed. All elements which operate in the same manner as the described in the previous embodiment are illustrated with the same reference numeral only with an "*a*" affixed thereto. A stack of copy sheets **100** is located on a paper tray **102.** The stack of sheets are urged by a torsion spring **104** against a paper feed roll **106.** The paper feed roll **106** drives the uppermost sheet of the stack along a guide **108** to a pair of nip rolls **110** which receive the leading edge of the copy sheet therein. A motor M2 is operably connected to the paper feed roll **106** for driving the same and a motor M3 is operably connected to the nip rolls **110** for driving the same.

Referring to FIG. **10,** an electrical diagram for operating this modified machine is disclosed. All elements which operate in the same manner as in the previous embodiment are designated by the same reference numerals only with an "*a*" affixed thereto. A cam operated switch S5 is arranged to control communication between the motor M2 and the power source **46***a* and a cam operated switch S6 is arranged to control communication between the motor M3 and the power source **46***a*. Cams C5 and C6 are arranged to actuate the switches S5 and S6 respectively. Cam surface B on cam C5 is so designed to close the switch S5 to communicate motor M2 to the power source **46***a* at the same time that cam C2*a* closes switch S2 to cause reversing of the motor M1*a*. The actuation of the feed roll a**06** by the motor M2 drives the uppermost sheet of the stack **100** along the guide **108** to the nip rolls **110.** A storage recesss **112** is provided in the guide **108** to allow the sheet to buckle until the nip rolls **110** are actuated. The cam surface B on cam C6 so designed to close switch S6 to actuate the motor M3 and thereby the nip rolls **110** at the proper time so that the leading edge of the copy sheet will align with the leading edge **56***a* of the developed image just prior to entering the nip **19***a*. The cam surface B of the cam C5 is designed to allow the switch S5 to open and cut off communication between the motor M2 and the power supply **46***a* immediately after the feed roll **106** has discharged the uppermost copy sheet from the stack of copy papers **100.** The cam surface B of cam C6 is so designed to allow switch S6 to open to cut off communication between the power source **46***a* and the motor M3 and thereby stop nip rolls **110** after the trailing edge of the copy sheet is discharged through the nip rolls.

Rather than transfer the developed image to a copy paper, the developed image may be fused onto the heat sensitive webs **10** and **10***a* or the heat sensitive sheet **10'.** This may be desired when a series of copies are needed in a specified sequence. In this case, the copy paper is eliminated and the toner particles are fused to the heat sensitive webs **10** and **10***a* or the heat sensitive sheet **10'** when they are exposed to the lamp **28** or **28***a* when moving therepast in the reverse direction as shown in either FIGS. **3, 8,** or **9.** In this respect, the sur-

face of the cylinders **26**, **26***a* which will be contacted during the fixing or fusing step by the toner particles must comprise a material to which melted toner particles will not stick. Alternatively, a release sheet could be substituted for the copy sheet **56** in FIGS. **3** and **8** or a stack of release sheets could be placed on the paper tray **102** in FIG. **9** and fed past the lamps **28** or **28***a* in contact with the developed image. In this instance, the release sheet will be of a material to which the toner particles will not stick.

Referring to FIG. **11**, the same principle utilized for the previous embodiments is applied for making copies when utilizing heat sensitive members in cut sheet form. In this embodiment, a copying apparatus **200** has a guide slot **212** for receiving a sandwich of a heat sensitive sheet **214** and an original sheet **216** with an image thereon. A cylinder **218** having a highly reflective surface is rotatably mounted on the frame of the machine and a transparent belt **220** rotates around three idler rolls **222**, **224**, **228**, and a drive roll **226**. The cylinder **218** and the drive roll **226** are driven by a reversible motor **M21**. The rolls **224** and **226** are arranged that the belt **220** is pressed against the cylinder **218** to form nips **225** and **227**, respectively. A microswitch MS21 is located in the slot **212** and is electrically connected to the reversible motor M21 for starting the same and is arranged to be actuated upon insertion of sheets into the slot. Upon rotation of the cylinder **218**, the belt **220** will be rotated therewith and pressed against the surface of the cylinder. An incandescent lamp **230** is arranged opposite the cylinder **218** to apply radiant rays to the region of the cylinder **218** which is opposite the lamp. Upon insertion of the original sheets **216** and the heat sensitive member **214** as a sandwich into the slot **212** and into engagement with the nip **227**, the sandwich will be pulled past the lamp **230**. A slot **231** is provided through which the original sheet **216** emerges after being separated from sheet **14**. A sheet separator **233** is located at the entrance of the slot **231** and is under vacuum during a period necessary to attract the original thereto thereby separating the same from the heat sensitive sheet **214**. A motor **M24** is provided for effecting the vacuum at sheet separator **233**.

A conveyor mechanism, which comprises a belt **232** arranged around a drive roll **234** and an idler roll **236**, is located to coact with a roll **238** wich forms a pressure nip therebetween to grip the leading edge **239** of the heat sensitive sheet **214** to drive the same along a guide member **240** to a developer station which comprises a housing **241** having ferromagnetic toner particles **242** therein. The drive roll **234** is driven by the motor **M21**. A well known magnetic brush **244** is mounted on the housing **241** to have a portion rotatable in the toner bed **242** and a portion arranged to engage the heat sensitive sheet **214** to present toner thereto to develop the image thereon. The magnetic brush **244** is also connected to the reversible motor **M21** which drives the cylinder **218** and the drive roll **234**.

A storage slot **250** is provided to receive the leading edge **239** of the heat sensitive sheet **214** after the same has passed the development station. The idler roll **236** is arranged relative to the surfade **251** of the slot **250** that the belt **232** is spaced from the surface **251** less than the thickness of the sheet **214** to grip the heat sensitive sheet **14** therebetween to move the same. A supply of copy paper **254** is arranged on a paper tray **256** and a feed roll **258** is arranged to engage the uppermost one of the stack of copy papers **254** to drive the same away from the stack along a guide member **260** to a pair of nip rolls **262**. A torsion spring **261** biases the paper tray **256** toward the feed roll **258** and thereby brings the stack of copy paper into engagement with the feed roll. A motor **M22** is provided for driving the feed roll **258** and a motor **M23** is provided for driving the nip rolls **262**.

Referring to FIG. **13**, there is shown an electrical control diagram for operating the apparatus of the embodiment of FIGS. **11** and **12**. The reversible motor **M21** has a forward input terminal **268** connected to a power source **270**, a forward input terminal **272** connected to ground, a reverse input terminal **274** connected to the power source **270** and a reverse input terminal **276** connected to ground. Cam operated switches **S21** and **S22** are located to control the communication of the power source with the reverse input terminal **274** and the forward input terminal **268**, respectively. The lamp **230** is connected to the power source **270** and a cam operated switch **S23** controls the communication therebetween and a cam motor is connected to the power source **270** and a cam operated switch **S24** controls the communication therebetween. The motors **M22**, **M23**, and **M24** are connected to the power source **270** and cam operated switches **S25**, **S26**, and **S27** control the communication therebetween, respectively. The cam motor drives a shaft in one direction which has a plurality of cams **C21**, **C22**, **C23**, **C24**, **C25**, **C26**, and **C27** fixedly secured thereto which are arranged to actuate switches **S21**, **S22**, **S23**, **S24**, **S25**, **S26**, and **S27**, respectively, during one complete revolution through phases A and B of one cycle of machine operation. Microswitch MS21 also controls communication of the power source **270** to the cam motor.

Cam **C22** and **C27** each has a cam surface A which closes switches **S22** and **S27**, respectively, during rotation of the cam bank through the A phase of the cycle. Cams **C21**, **C25** and **C26** each has a cam surface B which closes switches **S21**, **S25**, and **S26**, respectively during rotation of the cam bank through the B phase of the cycle. Cam **C23** has cam surfaces A and B which close switch **S23** during rotation of the cam bank through the A and B phases of the cycle. Cam **C24** has cam surface AB which closes switch **S24** during rotation of the cam bank through the A and B phases of the cycle.

The operation of the apparatus is as follows: referring to FIGS. **11** and **13**, a heat sensitive sheet **214** and an original sheet **216**, having an image thereon to be copied, are placed together to form a sandwich and inserted into the slot **212** to actuate the microswitch MS21 which connects the cam motor with the power source **270** and sets the cam bank into clockwise rotation. As soon as the cam bank begins rotation, the cam surface A of cam **C22** closes switch **S22** to actuate motor **M21** in the forward direction to rotate the cylinder **218**, belt **232**, and the magnetic brush **244** in the direction indicated by the arrows in FIG. **11**. At the same time, the cam surface A of cam **C24** closes switch **S24** to lock in communication of the cam motor to the power source **270**. Also at the same time, the cam surface A of cam **C23** closes the switch **S23** to energize the lamp **230** and the cam surface A of cam **C27** closes the switch **S27** to energize the motor **M24** and effect a vacuum at separator **233**. The sandwich is fed between the cylinder **218** and the belt **220** past the incandescent

lamp **230** and is exposed to the rays of the lamp **230**. The intensity of the lamp and the speed at which the sandwich passes thereby is such as to cause sufficient heat to effect a tacky image on the heat sensitive member corresponding to the image on the original sheet **216**. As the leading edge of the sandwich emerges from between the belt **220** and the cylinder **218**, the original is separated from the heat sensitive sheet **214** by vacuum separator **233** and is discharged from the copying apparatus through the slot **231**. The heat sensitive sheet **214** continues to the development station whereby the magnetic brush **244** dusts toner particles **242** onto the tacky image and then passes into the storage slot **250**. The cam surface A of cam C22 is designed that the trailing edge **253** of the heat sensitive sheet **214** will have passed the magnetic brush **244** prior to allowing switch S22 to open and stop motor M21. The cam surface A on cam C23 is designed to allow switch S23 to open and thereby de-energize the lamp **230** after the sandwich has been discharged through the nip **227**. The cam surface A on cam C27 is designed to allow switch S27 to open to stop the vacuum motor M24 at about the same time that the motor M21 is stopped. The cam surface AB on cam C24 is designed to keep ths switch S24 closed to keep the cam motor actuated and thereby the cam bank turning after the switch S22 is opened. At this point, the cam bank has turned approximately one-half of a revolution.

Referring now to FIGS. **12** and **14**, continued rotation of the cam bank effects closing of the switch S21 by the cam surface B on cam C21 thereby starting motor M21 in the reverse direction thereby causing reversal of rotation of the belt **232**, the magnetic brush **244**, and the cylinder **218**. At the same time, the cam surface B of cam C25 closes switch S25 to actuate the motor m22 and thereby start rotation of the paper feed roll **258**. Upon reversal of the belt **232**, the heat sensitive sheet **214** is removed out of the storage area **250** with the former trailing edge **253** now being the leading edge. The sheet **214** is passed through the developer station wherein magnetic brush **244** presents particles to the image to develop the image with more toner particles if necessary. At this point, the leading edge of a copy paper **154** has been moved to the nip rolls **262** and the cam surface B of cam C26 closes switch S26 to energize the motor M23 and thereby rotate the nip rolls **262** in the direction as shown in FIG. **12** to drive the copy sheet **254** to arrive just prior to the nip **227** at the same time as former trailing edge **253**, but now the leading edge, of the heat sensitive sheet **214** arrives thereat so the two sheets will be aligned. Cam surface B of cam C23 closes switch S23 to energize the lamp **230** just prior to the time that the leading edges of the copy sheet **254** and the heat sensitive sheet **214** enter the nip **227**. The two sheets enter the nip **227** between the cylinder **218** and the belt **220** as an aligned sandwich and are exposed to the incandescent lamp **230** for a sufficient time to melt the toner particles whereby a substantial portion thereof will transfer to the copy sheet **254** to provide a reproduction of the original image. The heat and the slight pressure between the sheets caused by the pressure between the belt **220** and cylinder **218** effects transfer and the fixing of the toner particles to the copy sheet **254**. Then the sandwich is passed out of the copying apparatus through the slot **212** whereby an operator takes the sandwich and separates the sheets to obtain the copy of the image on the original. The cam surfaces B of cams C21, C23, and C26 are designed to allow the switches S21, S23, and S26 to open and thereby shut off their respective motors after the sandwich is discharged through slot **212**. The cam surface B on cam C25 is arranged to allow switch S25 to shut off motor M22 and thereby stop rotation of the paper feed roll **258** after the feed roll has discharged the uppermost copy sheet from the stack of copy papers **254**. The cam surface AB of cam C24 is designed to allow switch S24 to open after all other switches are open to thereby stop the cam motor and the rotation of the cam bank to complete the cycle of operation.

Rather than using a paper tray, this embodiment could be modified by eliminating the paper tray **256** and its associated parts and a copy sheet could be inserted into original outlet slot **231** or a new copy inlet could be provided. The slot would have nip rolls arranged similar to nip rolls **37** of the embodiment of FIG. **1**. In this instance, a microswitch could be located to be actuated by the copy sheet. The control circuit would be modified whereby the cam motor is inactivated after the first phase and then is activated upon closing the microswitch by the copy sheet.

Rather than transfer the developed image to a copy sheet, the developed image may be fixed to the heat sensitive sheet **214** with the heat sensitive sheet being the copy itself. In this respect, the surface of the cylinder **218** which will be contacted by the toner particles during the fixing or fusing step must comprise a material to which melted toner particles will not stick. Alternatively, a stack of release sheets could be placed on the paper tray **256** and fed past the lamp **230** in contact with the developed image. In this respect, the release sheet will be of a material to which the toner particles will not stick.

From the above, it can be seen that compact and simple copying apparatus has been invented. furthermore, since the imaging and developing function of the components of the embodiments described is separate from the image transfer or fusing function, the intensity of the lamps **28, 28***a*, and **230** and the speed at which the webs **10**, and **10***a* and sheet **214** travel in reverse can be changed from the intensity and speed for the imaging and developing function depending upon for what results a particular apparatus machine is designed.

The connection of the motors to their respective elements which they drive have not been shown as these are all well known and well within the grasp of one having ordinary skill in the art.

What is claimed is:

1. A thermographic copier comprising the combination of a radiant source for supplying radiant energy to a first station via a predetermined path, a development station spaced from said first station, reversible transport means for advancing a heat sensitive member through said first station in one direction to thermally impart an image thereto and for continuing movement of said heat sensitive member in said one direction through said development station to develop said image and for then moving said heat sensitive member back in the opposite direction through said first station to produce a substantially permanent copy of said image, a copy supply tray, means for moving a copy member out of said tray and into contact with said heat sensitive member at a location between said development station and said first station when said heat sensitive mem-

ber is moving in said opposite direction, and means for selectively energizing said radiant source in preparation for the passage of said heat sensitive member through said first station is said one and said opposite directions.

2. The copier of claim **1** further comprising means for discharging the copy member and the heat sensitive member from the copier after they have passed through said first station in said opposite direction.

3. A thermographic copier comprising the combination of a radiant source for supplying a heating station with radiant energy, reversible drive means for conveying an image bearing subject and a heat sensitive member through said heating station in one direction so that said image is thermally imparted to said member and for conveying at least the heat sensitive back through said heating station in the opposite direction, a storage area, a development station located between said heating station and said storage area, and means located between said development station and said heating station for separating the subject and heat sensitive member after they pass said heating station in said one direction; said drive means including means for continuing the movement of said heat sensitive member in said one direction after separation from said subject so that said heat sensitive member is conveyed past said development station for development of said thermally imparted image and into said storage area, and means for subsequently conveying said heat sensitive member in the opposite direction back through said development station and said heating station to fuse the developed image.

4. A copier as recited in claim **3** wherein the developed image is transfixed onto a a copy paper as said heat sensitive member moves through said heating station in said opposite direction.

5. A thermographic copier comprising the combination of a source for supplying radiant energy to a heating station via a predetermined path, a development station spaced from said heating station, a heat sensitive web extending through said heating and development stations, reversible drive means for selectively moving said web in one direction and in the opposite direction, control means for actuating said drive means to sequentially move a portion of said web through said heating station and said development station in said one direction and to then move said portion of said web back through said heating station in the opposite direction, and means for energizing said radiant source while said portion of said web is passing through said heating station in either of said directions.

6. The copier of claim **5** wherein said drive means includes means for presenting an unused portion of said web for each successive copying cycle.

7. The copier of claim **5** further comprising means for bringing a member bearing an original image into contact with said portion of said web, said reversible drive means including means for moving the image bearing member and said portion of said web through said heating station in said one direction, and means located between said development station and said heating station for separating the image bearing member from said web before moving said portion of said web through said development station.

8. The copier of claim **7** further comprising means for bringing a copy member into contact with said portion of said web after said web has completed movement in said one direction, said drive means including means for moving the copy member and said portion of said web through said heating station in said opposite direction.

9. The copier of claim **8** further comprising means responsive to motion of a copy member toward said web for reversing said drive means to move said web portion in said opposite direction.

10. The copier of claim **7** further comprising an inlet opening for feeding said image bearing member into contact with said web at a location upstream of said heating station, an outlet opening, and means located between said development station and said heating station for separating said image bearing member from said web during movement of said web in said one direction and for feeding said image bearing member out of said copier via said outlet opening.

11. The copier of claim **10** further comprising a copy member supply tray, and means for moving a copy member out of said tray and into contact with said web portion at a location between said development station and said heating station when said web portion is moving in said opposite direction.

12. The copier of claim **10** wherein said outlet opening also serves to feed a copy member toward said web

13. The copier of claim **12** further comprising means responsive to the feed of a copy member through said outlet opening for reversing said drive means to move said web portion in said opposite direction.

14. A thermographic copier comprising the combination of a radiant source for imaging and fusing at a common heating station, a development station spaced from said heating station, a heat sensitive web extending through said heating station and said development station, reversible drive means for moving said web first in one direction and then in the opposite direction, means for bringing a first sandwich containing a member with an original image thereon and a heat sensitive member into contact with said web to move with said web through said heating station in said one direction, means located between said development station and said heating station for separating the first sandwich from said web after they pass said heating station while traveling in said one direction, means for bringing a second sandwich containing a copy member and a heat sensitive member bearing a developed image into contact with said web at location between said development station and said heating station to move with said web through said heating station in said opposite direction, means for separating the second sandwich from said web and for discharging said second sandwich from the copier and means for energizing said radiant source when said web moves in each of said directions, whereby imaging takes place as said web moves in said one direction and fusing takes place as said web moves in the opposite direction.

15. The copier of claim **14** further comprising means responsive to the appearance of said second sandwich in the copier for reversing said drive means to move said web and said second sandwich in said opposite direction.

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