

March 8, 1966

W. R. FOWLIE ETAL

3,238,920

FACSIMILE PRINTING MACHINE

Filed June 29, 1962

20 Sheets-Sheet 1

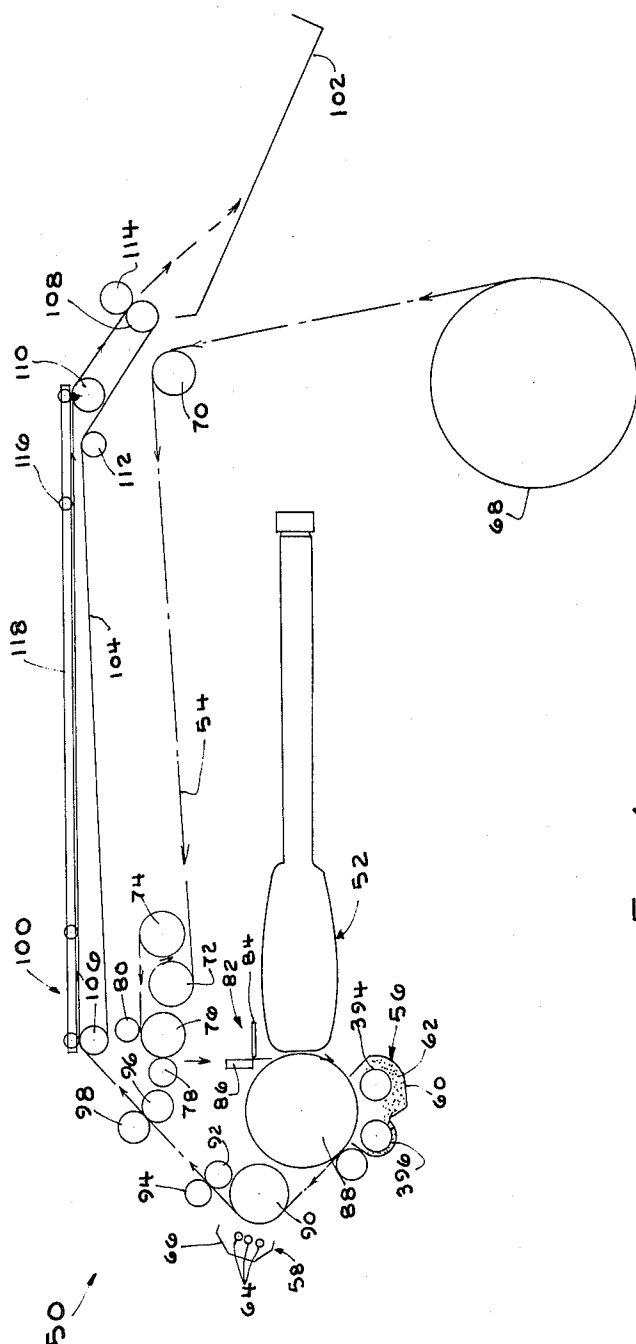


Fig. 1

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March 8, 1966

W. R. FOWLIE ETAL
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20 Sheets-Sheet 2

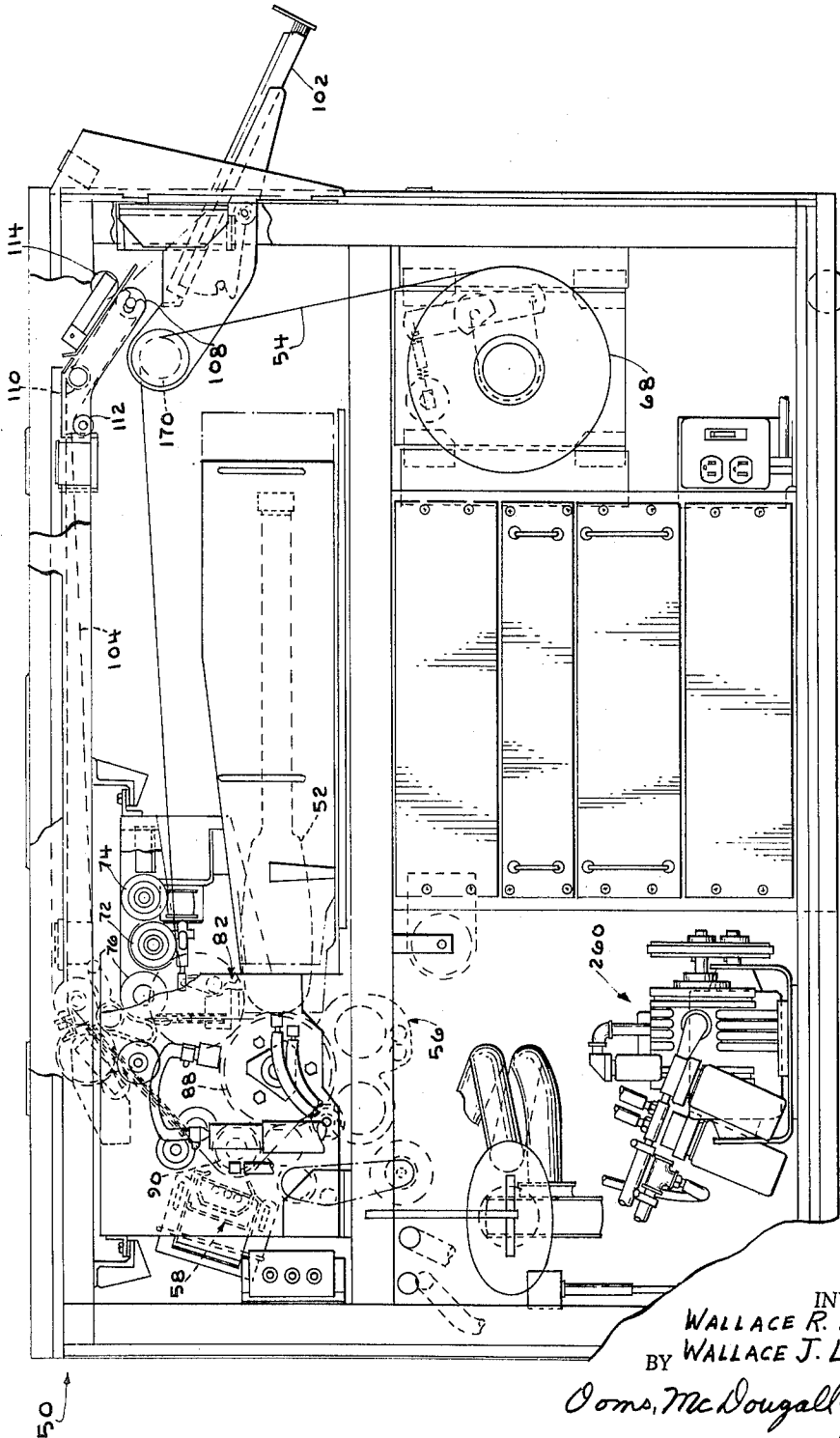


Fig. 2

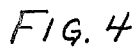
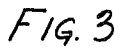
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FACSIMILE PRINTING MACHINE

20 Sheets-Sheet 3



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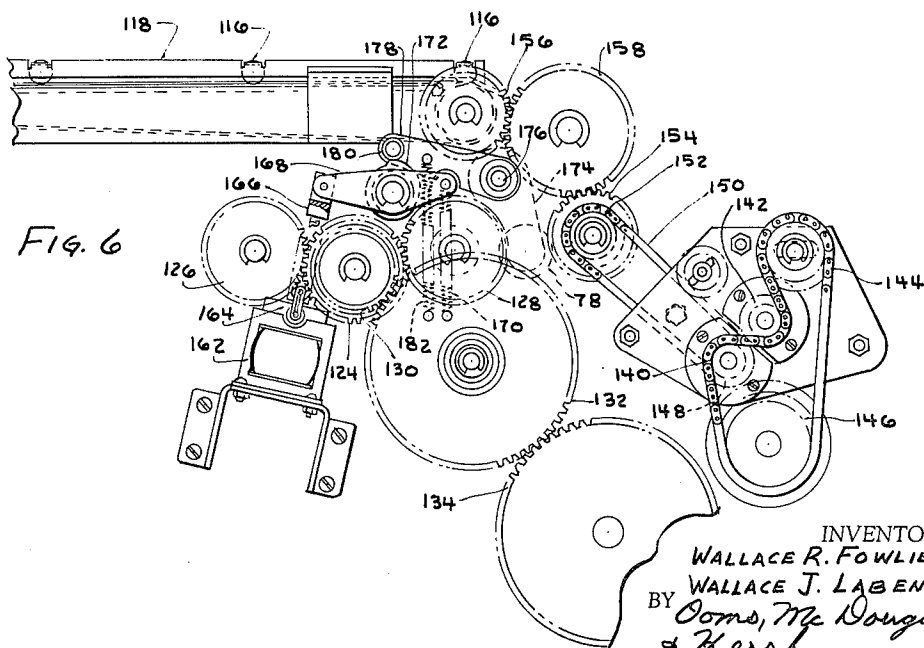
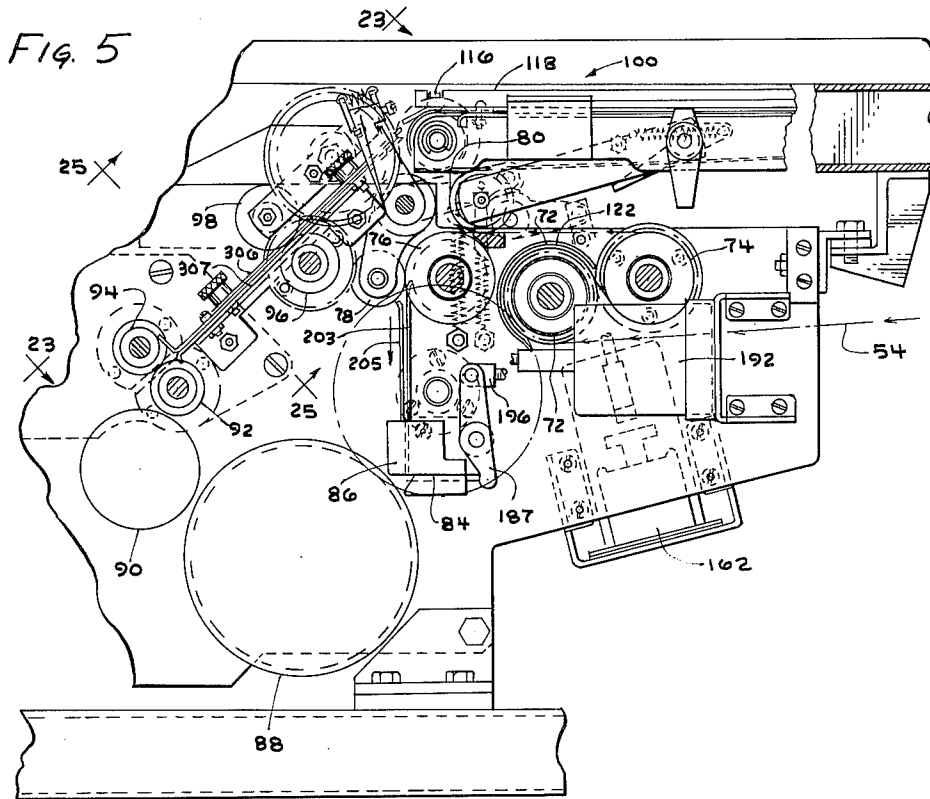
W. R. FOWLIE ET AL

3,238,920

FACSIMILE PRINTING MACHINE

Filed June 29, 1962

20 Sheets-Sheet 4



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3,238,920

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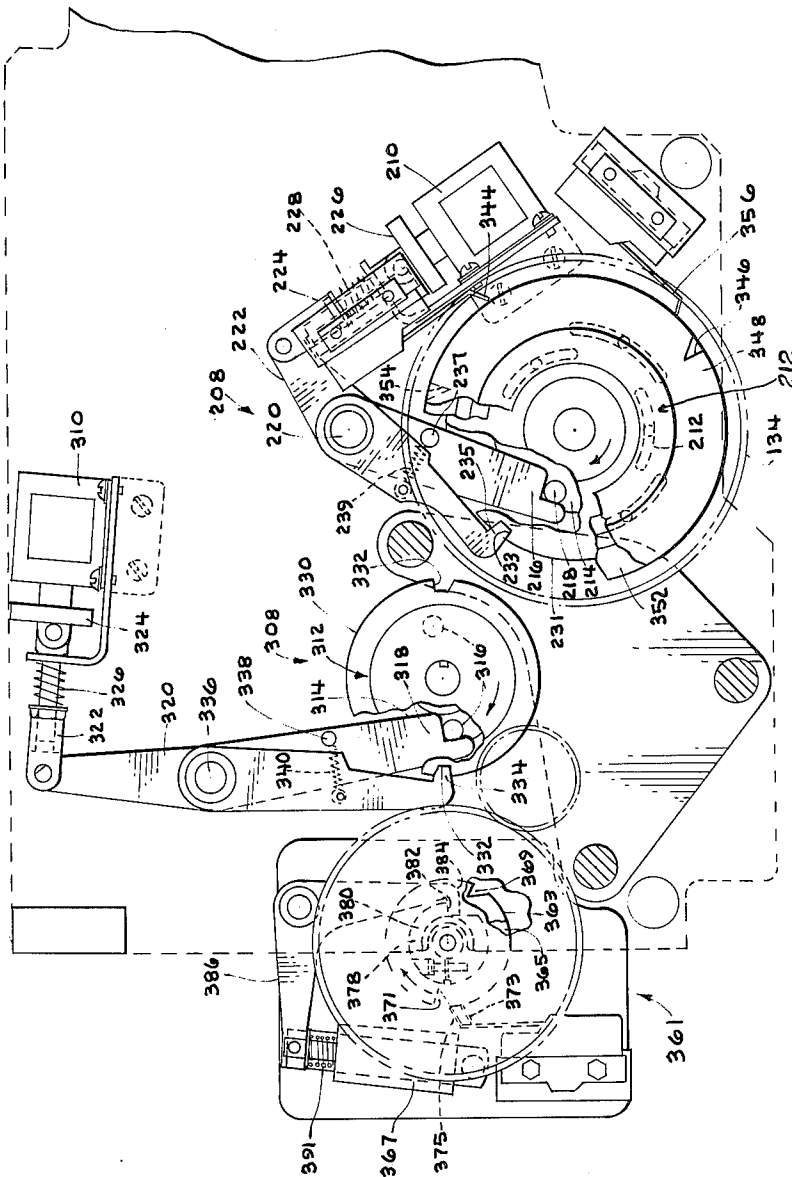


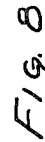
Fig. 7

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W. R. FOWLIE ETAL
FACSIMILE PRINTING MACHINE

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FACSIMILE PRINTING MACHINE

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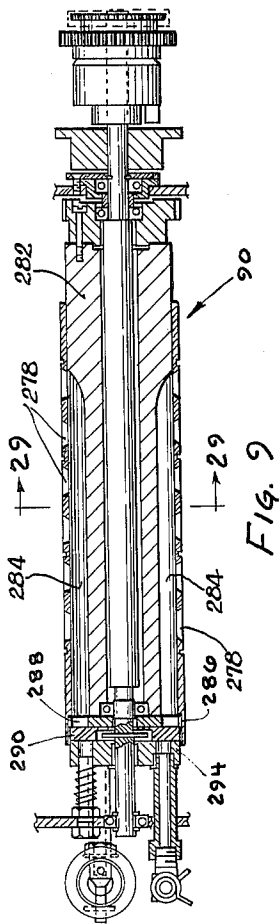


Fig. 9

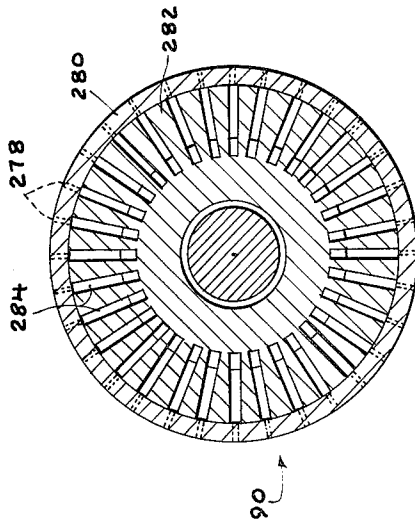


Fig. 29

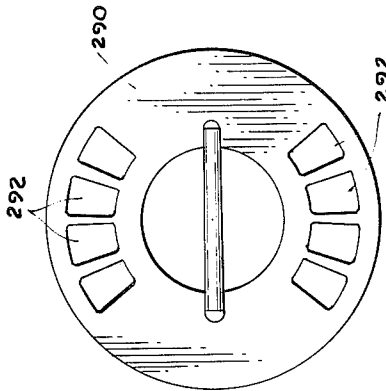


Fig. 30

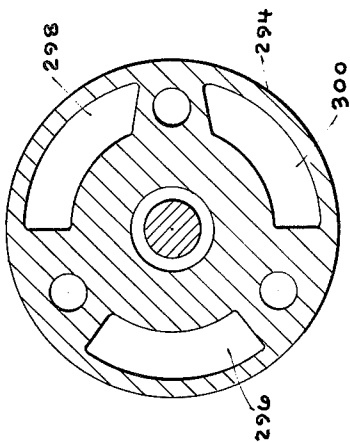


Fig. 31

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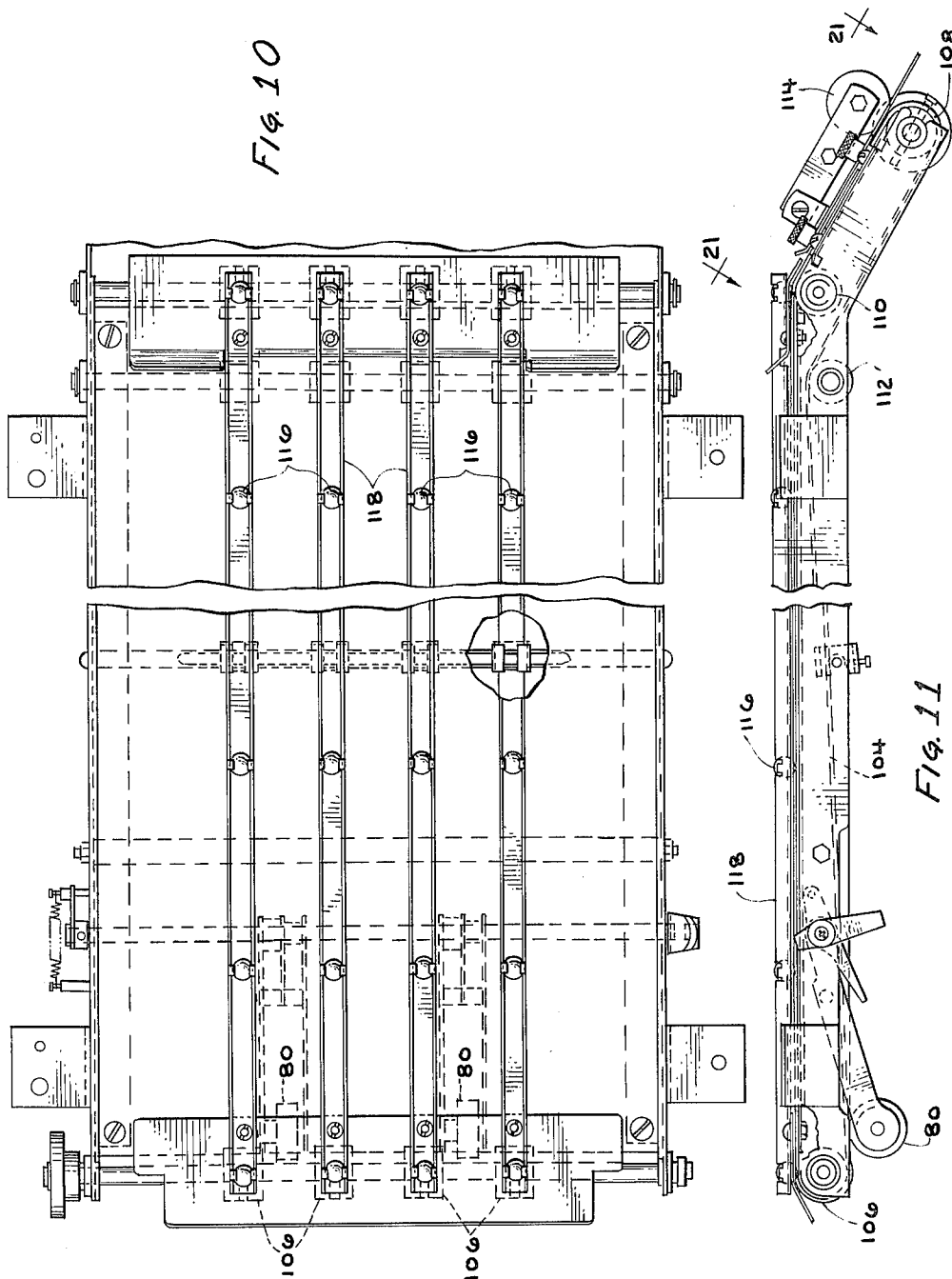
W. R. FOWLIE ETAL

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FACSIMILE PRINTING MACHINE

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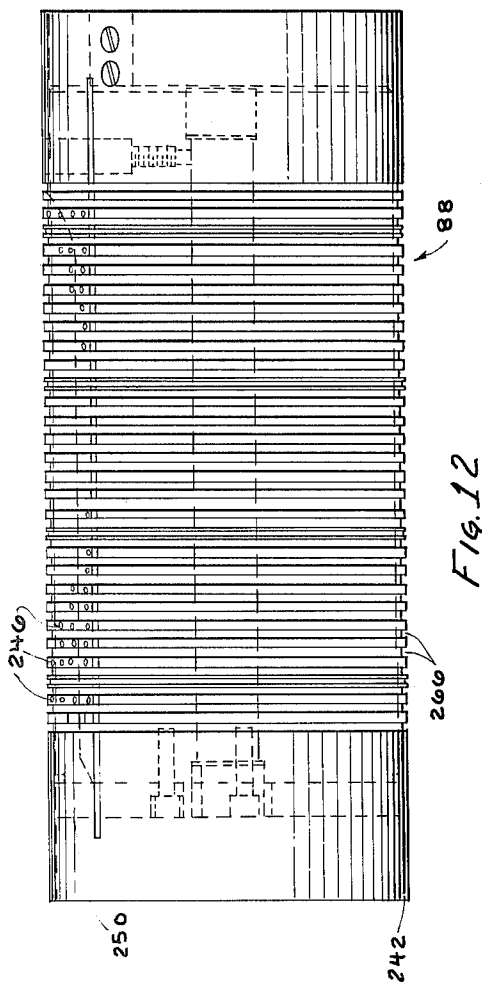


Fig. 12

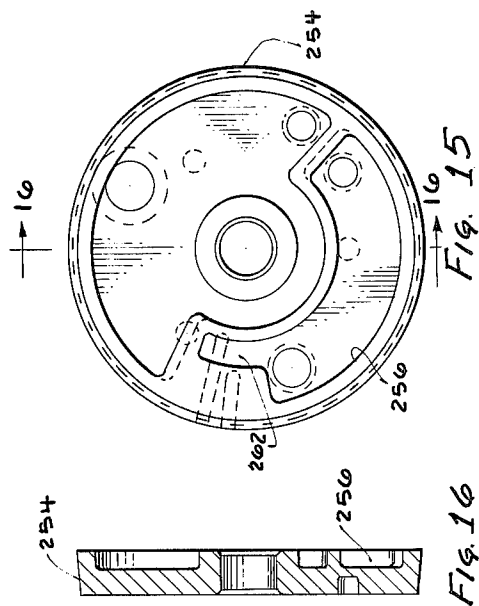


Fig. 15

Fig. 16

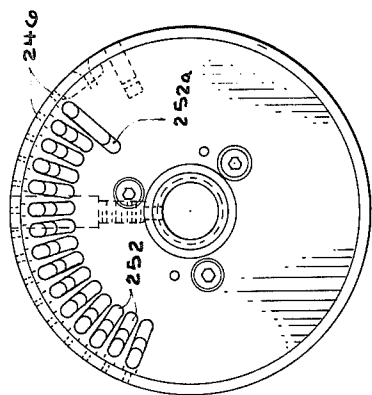


Fig. 13

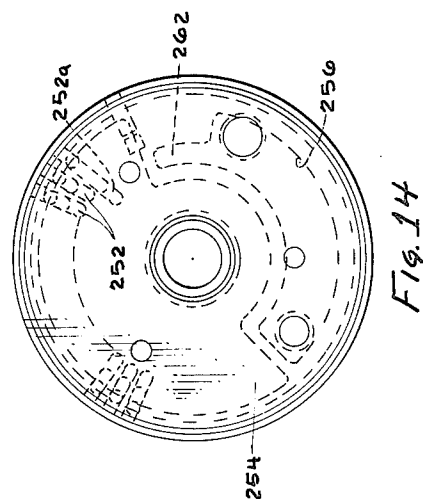


Fig. 14

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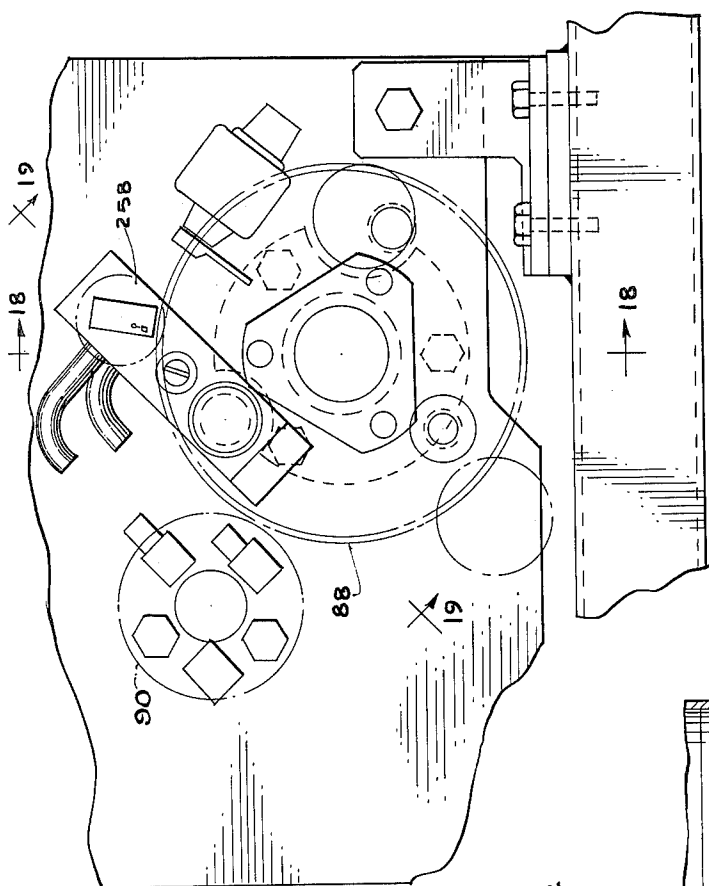


Fig. 17

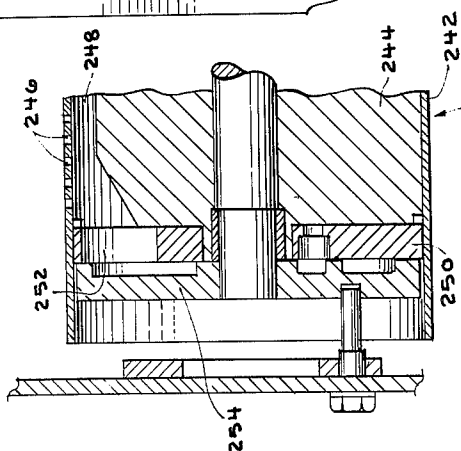


Fig. 18

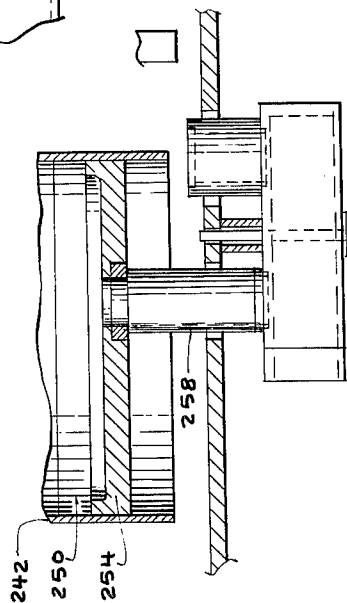


Fig. 19

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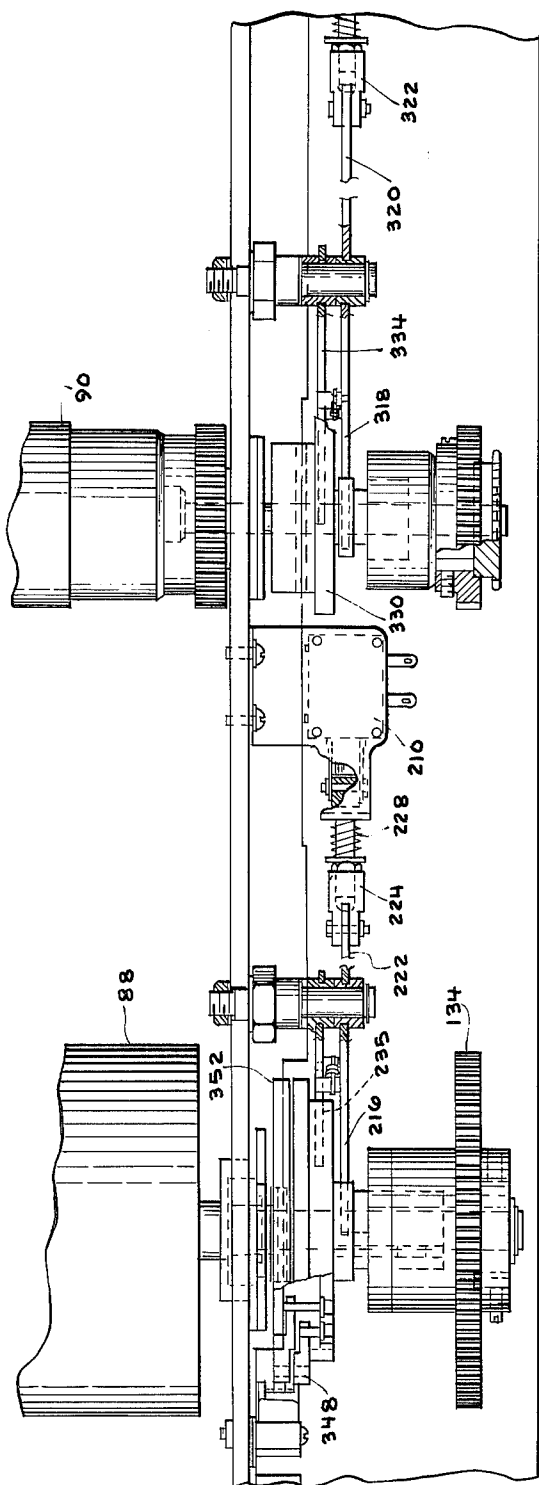


Fig. 20

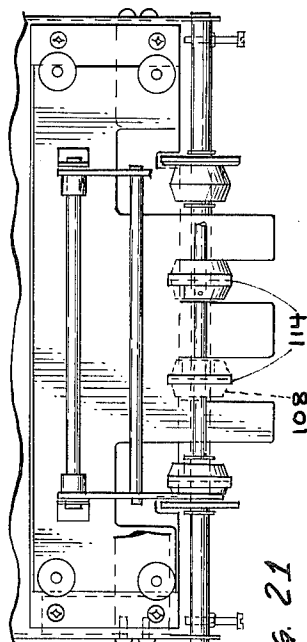


Fig. 21

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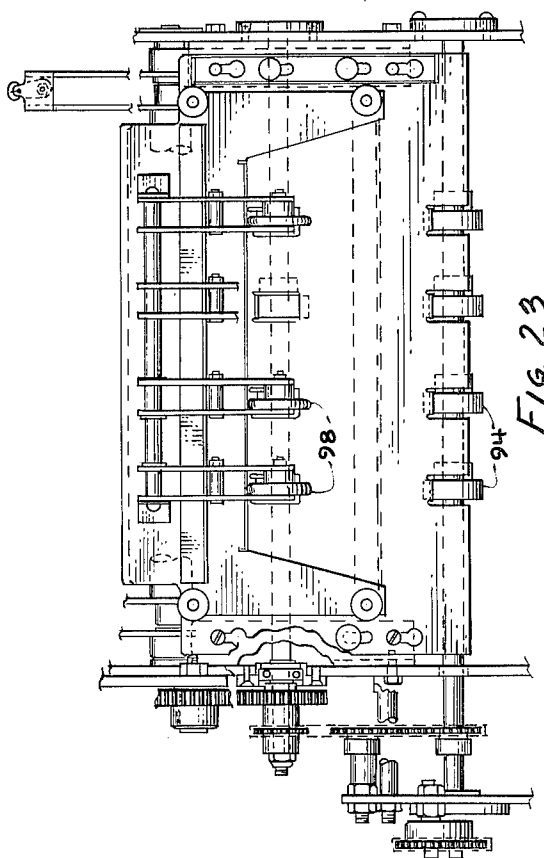
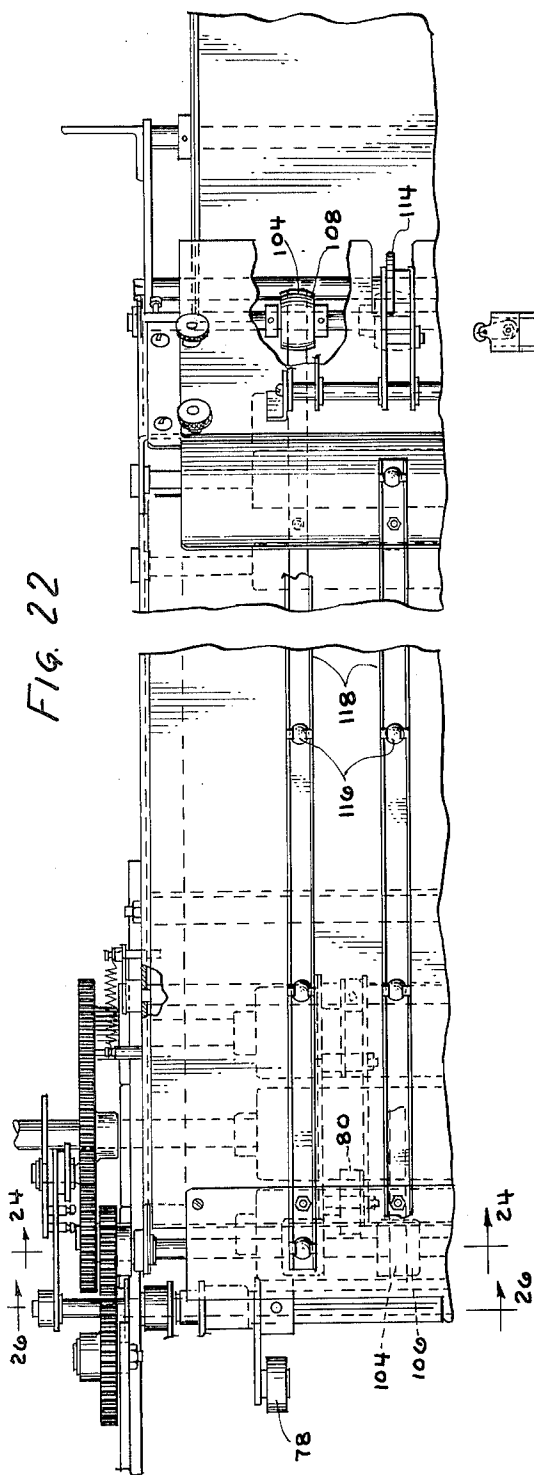
W. R. FOWLIE ETAL

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FACSIMILE PRINTING MACHINE

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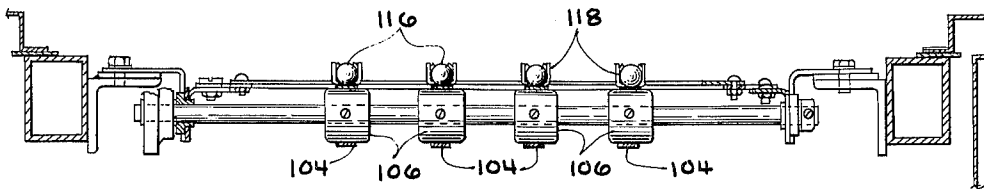


FIG. 24

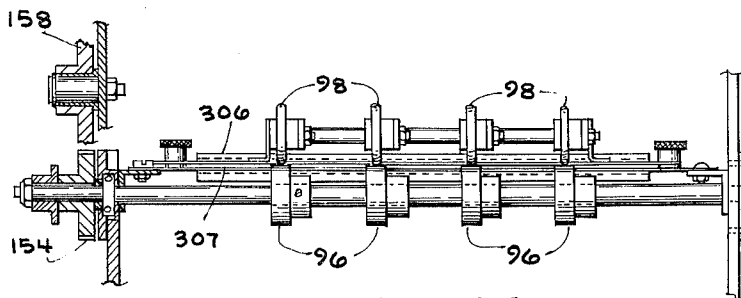


FIG. 25

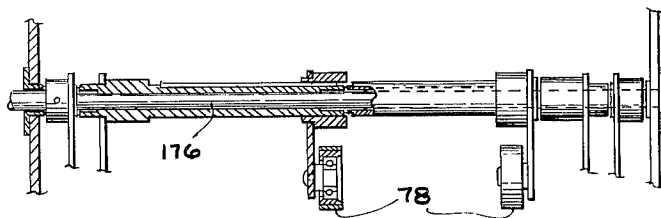


FIG. 26

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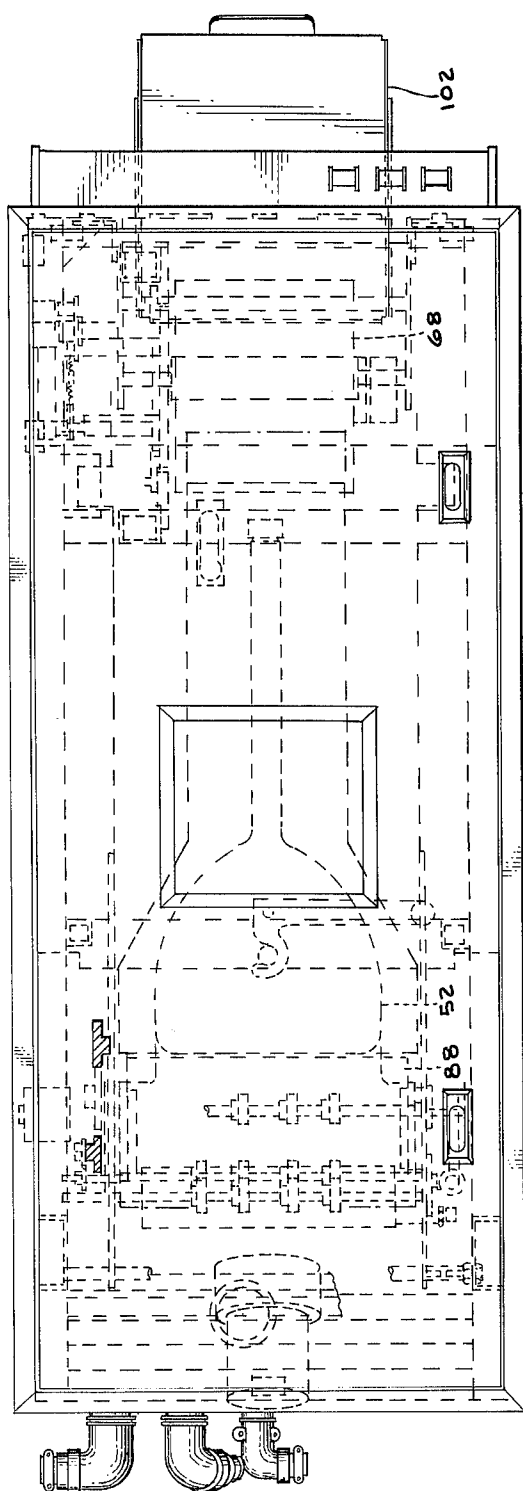


Fig. 27

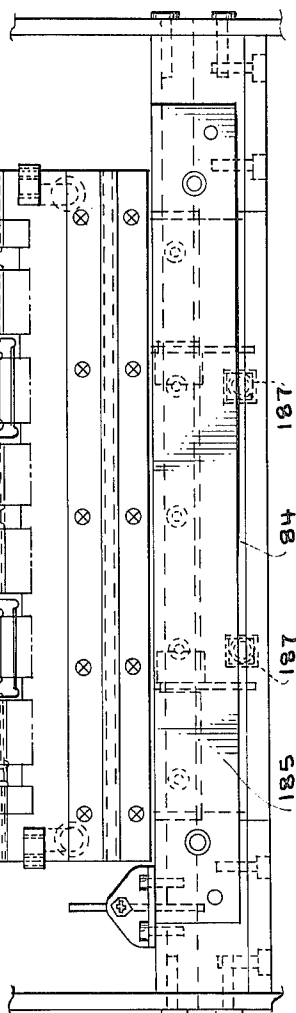


Fig. 28

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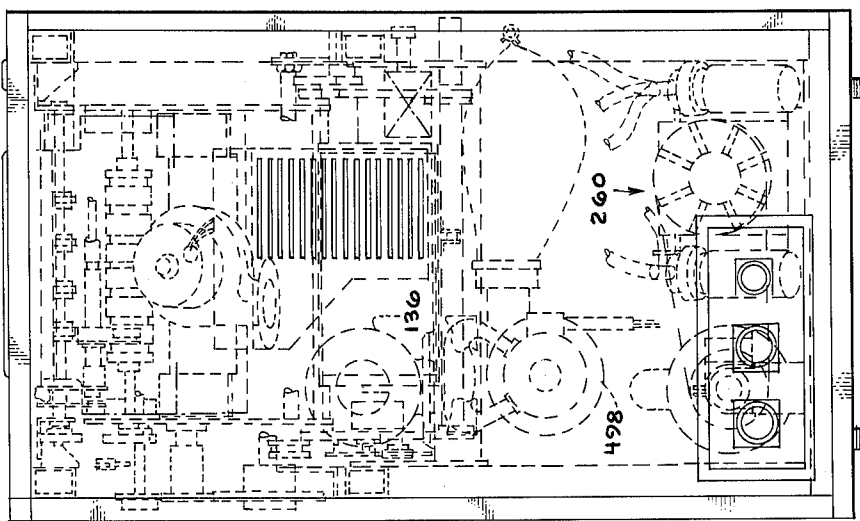


Fig. 32

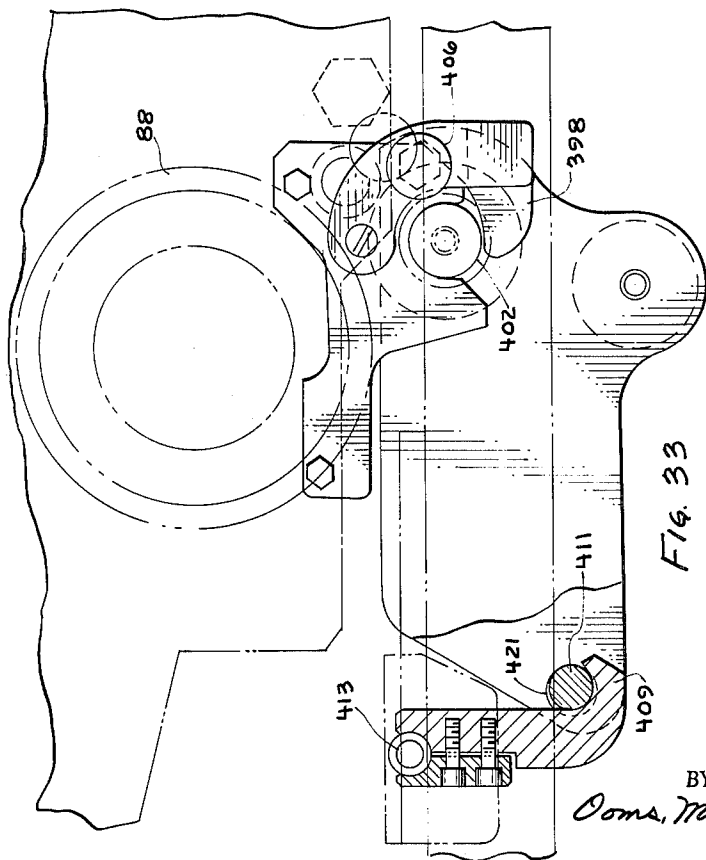


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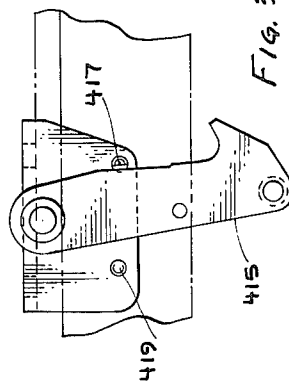


Fig. 34

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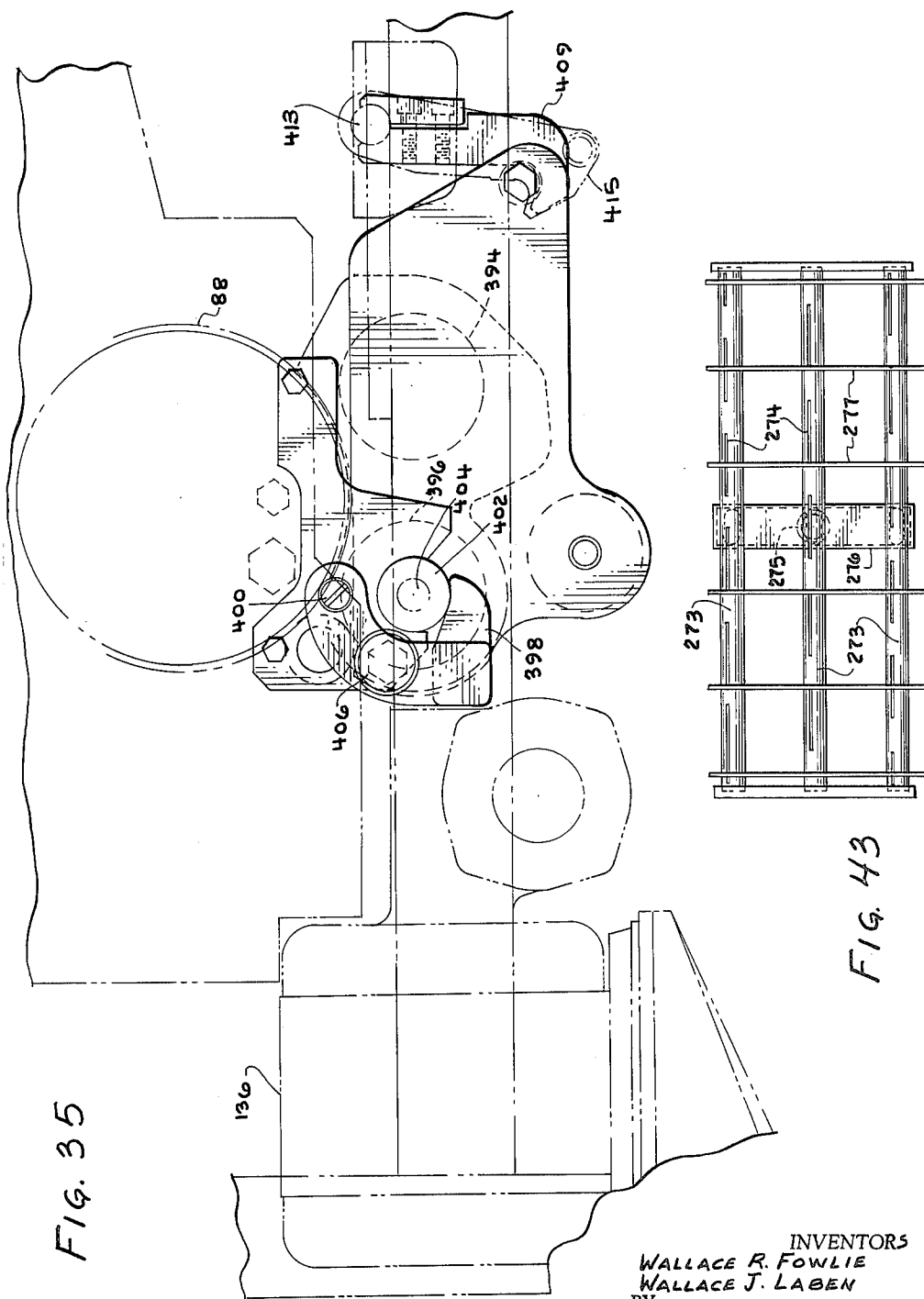


FIG. 35

FIG. 43

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FACSIMILE PRINTING MACHINE

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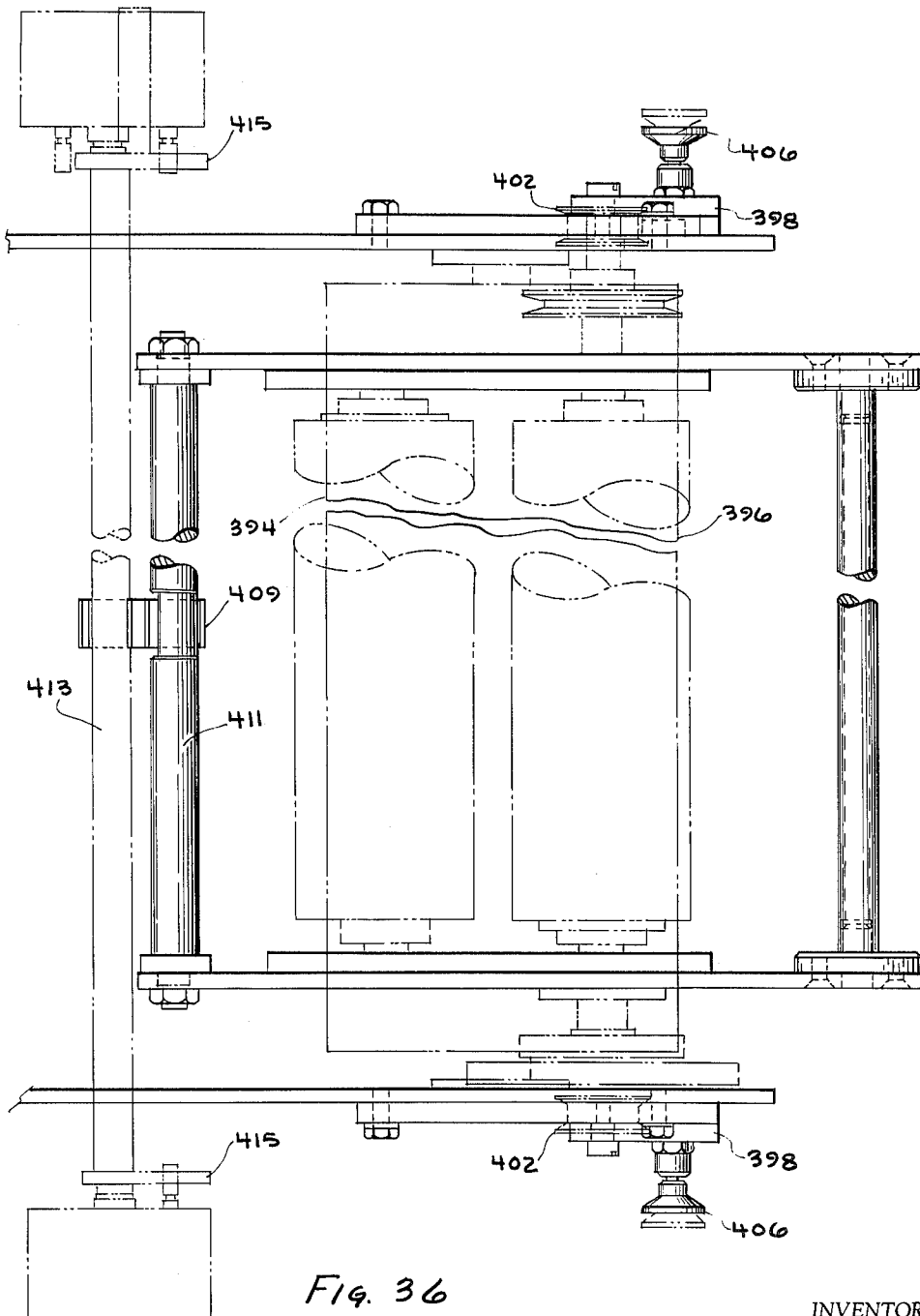


Fig. 36

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W. R. FOWLIE ET AL

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Fig. 37

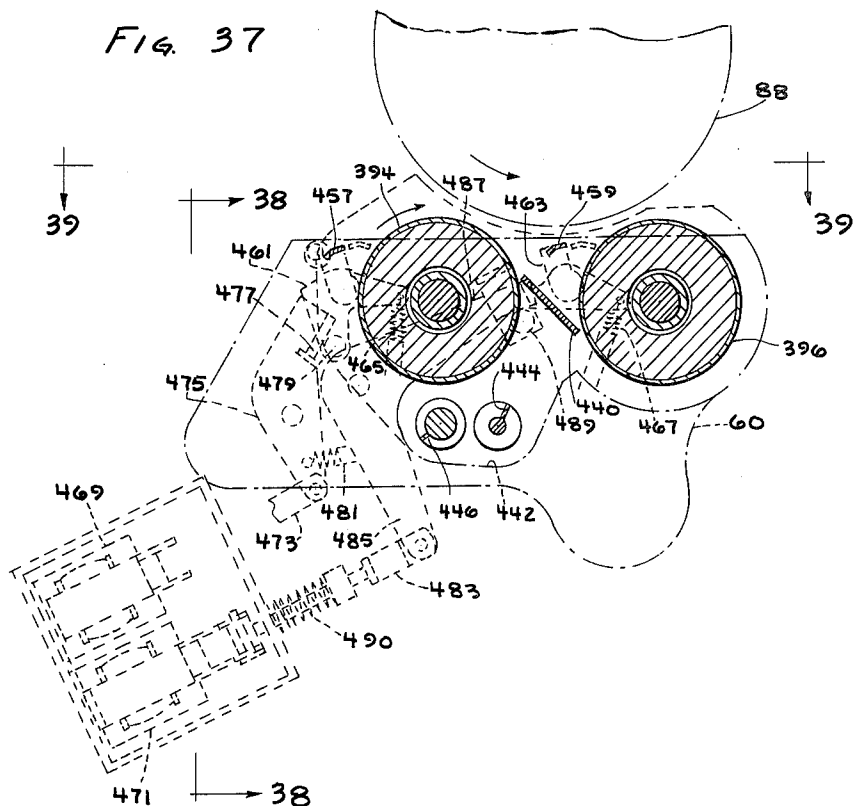
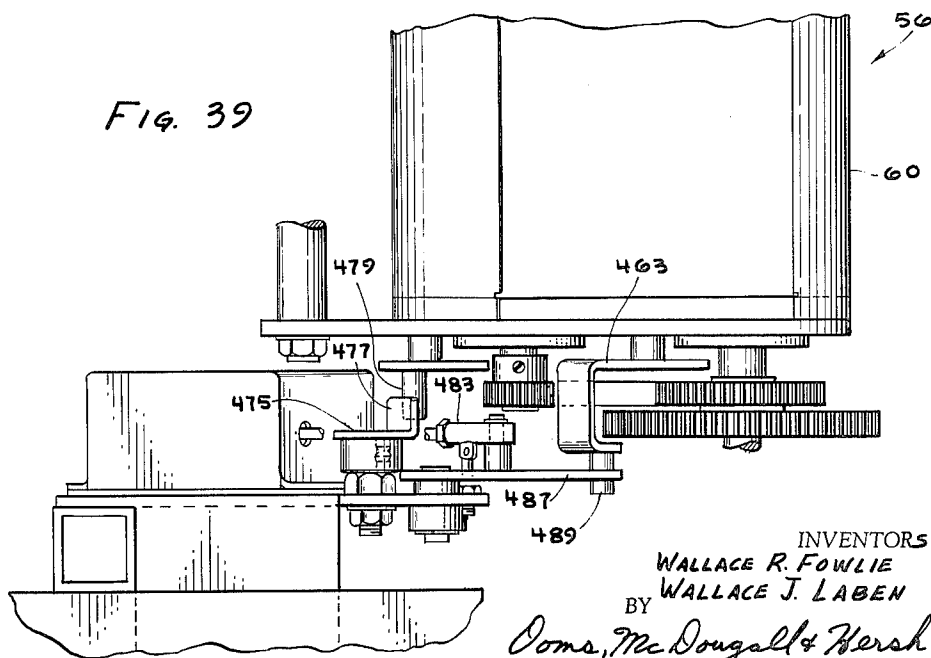


Fig. 39



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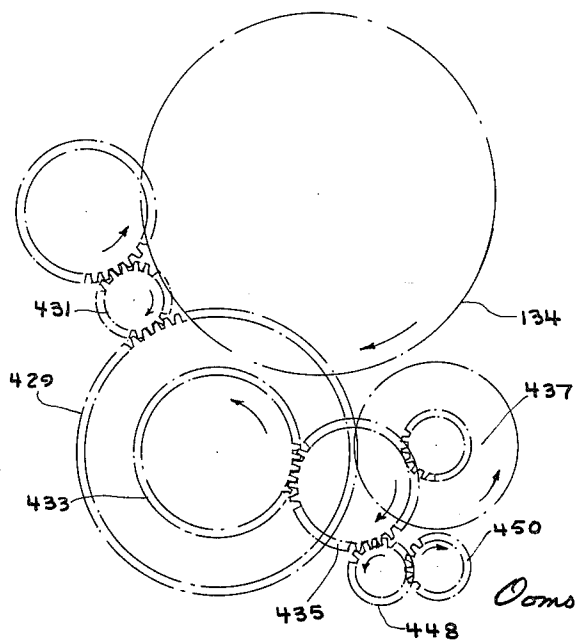
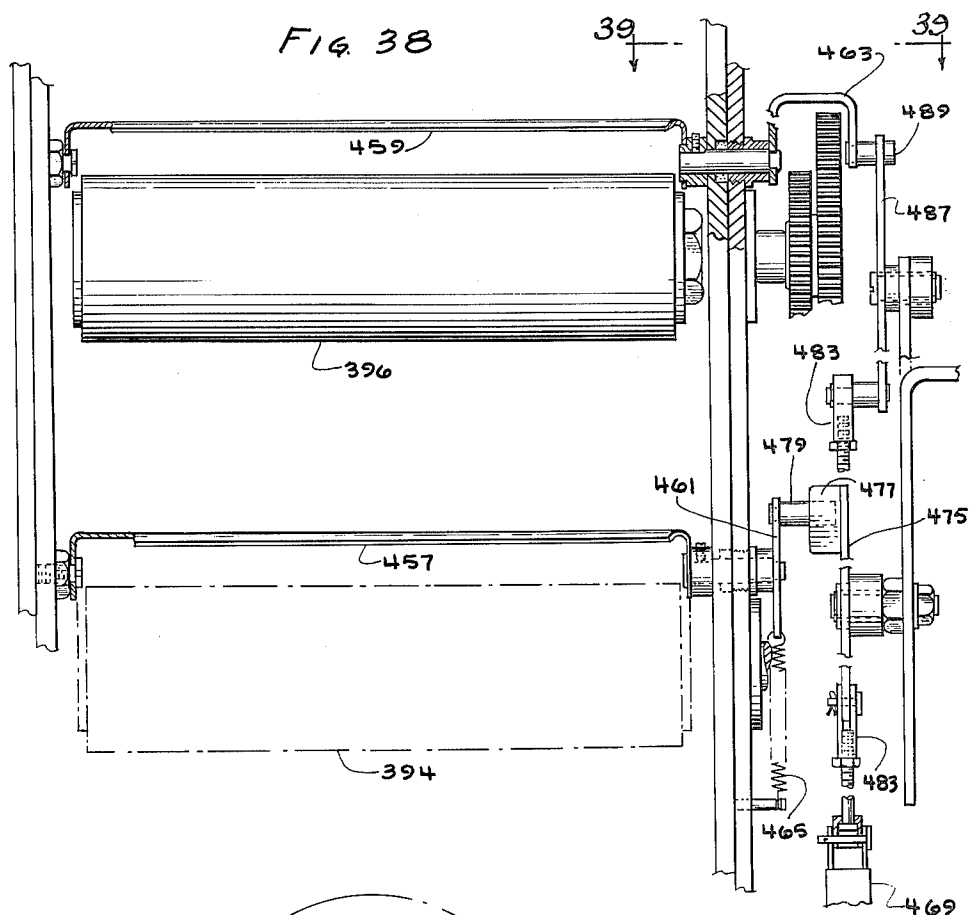
W. R. FOWLIE ETAL

3,238,920

FACSIMILE PRINTING MACHINE

Filed June 29, 1962

20 Sheets-Sheet 19



INVENTORS
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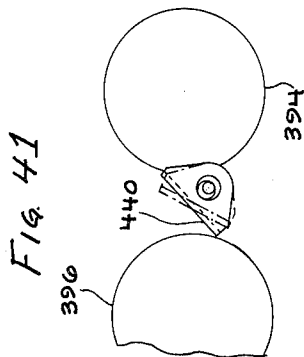
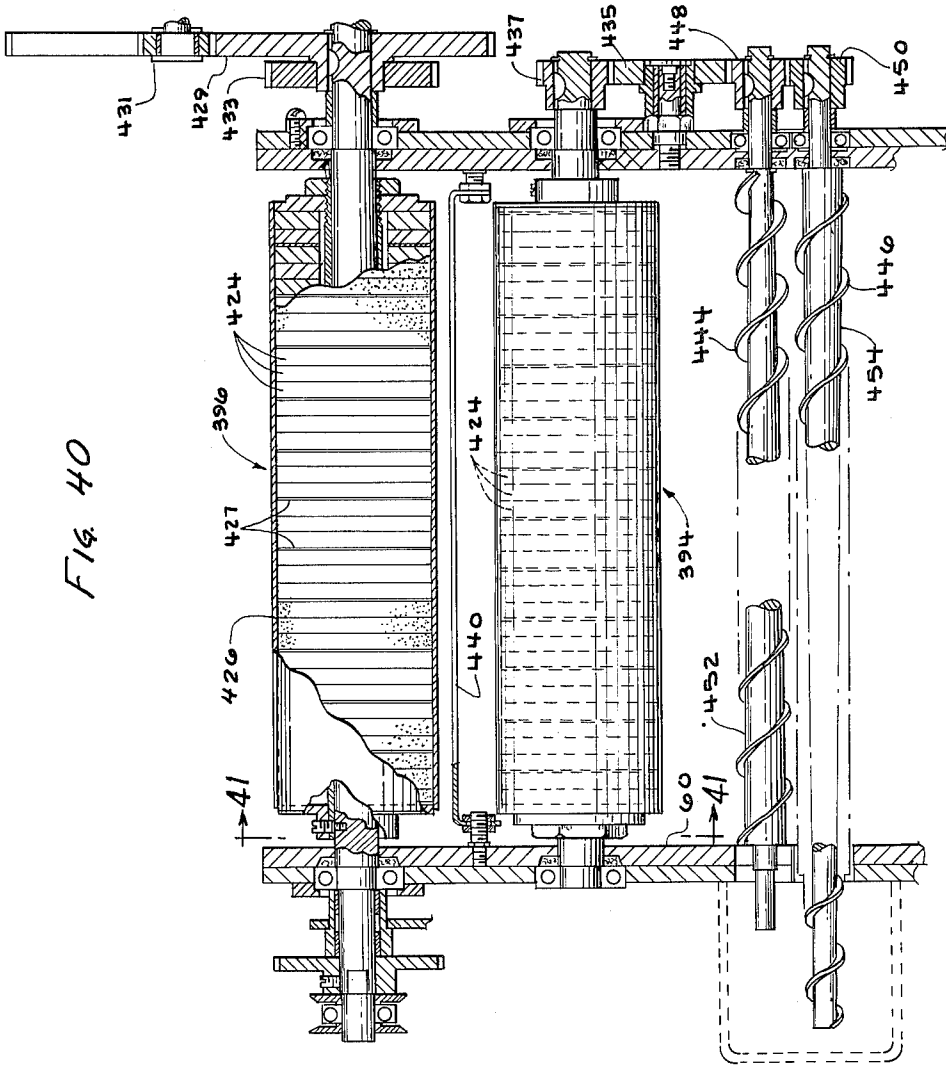
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W. R. FOWLIE ETAL
FACSIMILE PRINTING MACHINE

3,238,920

Filed June 29, 1962

20 Sheets-Sheet 20



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3,238,920

FACSIMILE PRINTING MACHINE

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Filed June 29, 1962, Ser. No. 206,503
10 Claims. (Cl. 118—637)

This invention relates to facsimile systems for transmitting and reproducing documents, drawings and the like. A facsimile system generally comprises a scanning machine for scanning the documents to be transmitted, so as to translate the light and dark areas of each document into electrical signals; a transmission medium, such as a wire line, a coaxial cable, or a radio link, for transmitting the facsimile signals to a more or less distant point; and a printing machine at the distant point for reproducing the document in response to the incoming facsimile signals.

The present invention pertains particularly to a facsimile printing machine for reproducing documents in response to facsimile signals.

One object of the present invention is to provide a new and improved facsimile printing machine in which the document is reproduced on a sheet of paper or other suitable material, cut from a web which may be unwound from a supply roll.

A further object is to provide a new and improved facsimile printing machine of the foregoing character, comprising a feed mechanism whereby the leading portion of the web is fed to a main or printing cylinder, is taken by the main cylinder and carried through the machine past devices which reproduce a copy of the document to be printed on the web, and then is severed from the supply portion of the web at a point in advance of the main cylinder, so that none of the paper or other material is wasted.

It is a further object of the present invention to provide a new and improved facsimile printing machine having means for feeding the severed leading end of the web past the severing device to the main or printing cylinder; vacuum means on the main cylinder for taking the leading end of the web and carrying it around the cylinder; an electrostatic facsimile printing device opposite the cylinder for producing an electrostatic latent image on the web; a developing device adjacent the main cylinder for applying a toner to the electrostatic image to render it visible; means for carrying the leading end of the web to a fuser cylinder; vacuum means on the fuser cylinder for taking the web and carrying it around the fuser cylinder; a fusing device adjacent the fuser cylinder for fusing the toner to the web; means for taking the web from the fuser cylinder and carrying it to a delivery station; and means for operating the severing device so as to sever the leading portion of the web from the remaining supply portion so that the leading portion becomes a separate sheet, the supply portion being stopped in preparation for printing another sheet.

Another object is to provide a new and improved facsimile printing machine having means for delaying the operation of the developer until the leading end of the web has been carried around the main cylinder to the developer, and means for stopping the action of the developer as the trailing end of the severed sheet reaches the developer.

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A further object is to provide a new and improved facsimile printing machine having means for actuating the vacuum device on the main cylinder as the leading end of the web arrives at the main cylinder, and means for actuating the vacuum device on the fuser cylinder after sufficient delay to permit the leading end of the web to reach the fuser cylinder.

Further objects and advantages on the present invention will appear from the following description, taken with the accompanying drawings, in which:

FIG. 1 is a general diagrammatic elevational view showing the over-all layout of a facsimile printing machine to be described as an illustrative embodiment of the present invention.

FIG. 2 is a general side elevation of the facsimile printing machine.

FIG. 3 is a fragmentary diagrammatic plan view showing certain of the feed rollers and the device for severing the web.

FIG. 4 is a diagrammatic elevational view of the feed rollers and severing mechanism of FIG. 3, partly in section along a line 4—4 in FIG. 3.

FIG. 5 is a fragmentary elevational section showing the feed mechanism from one side.

FIG. 6 is a fragmentary elevational view showing the feed mechanism and the associated drive from the opposite side.

FIG. 7 is an elevational sectional view showing cycling clutches for driving certain components of the machine.

FIG. 8 is a diagrammatic elevational view showing the vacuum porting arrangements of the main and fuser cylinders.

FIG. 9 is a longitudinal section through the fuser cylinder, generally along a line 9—9 in FIG. 8.

FIG. 10 is a fragmentary plan view showing the delivery conveyor, detached from the machine.

FIG. 11 is a side elevation of the delivery conveyor of FIG. 10.

FIG. 12 is an elevational view showing the main cylinder.

FIG. 13 is an end view of the main cylinder.

FIG. 14 is an end view of the vacuum valve for the main cylinder.

FIG. 15 shows the vacuum valve from the opposite side.

FIG. 16 is a section taken generally along a line 16—16 in FIG. 15.

FIG. 17 is a fragmentary elevational view showing the vacuum connections to the main and fuser cylinders.

FIG. 18 is a sectional view taken generally along a line 18—18 in FIG. 17.

FIG. 19 is a sectional view taken generally along a line 19—19 in FIG. 17.

FIG. 20 is a plan view showing details of the drive for the main and fuser cylinders.

FIG. 21 is a fragmentary plan view showing the delivery end of the delivery conveyor, the view being taken generally as indicated by a line 21—21 in FIG. 11.

FIG. 22 is a fragmentary plan view of the delivery conveyor mounted on the machine.

FIG. 23 is a fragmentary plan view taken generally as indicated by the line 23—23 in FIG. 5.

FIG. 24 is a section taken generally along a line 24—24 in FIG. 22.

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FIG. 25 is a section taken generally along a line 25—25 in FIG. 5.

FIG. 26 is a section taken generally along a line 26—26 in FIG. 22.

FIG. 27 is a general top view of the facsimile printing machine.

FIG. 28 is a fragmentary elevational view showing certain of the feed rollers and guides, and also the severing device, the view being taken generally as indicated by the line 28—28 in FIG. 4.

FIG. 29 is an end view of the fuser cylinder showing the vacuum ports thereon.

FIG. 30 is an end view of the rotary vacuum valve for the fuser cylinder.

FIG. 31 is a cross section through the stationary vacuum valve member for the fuser cylinder.

FIG. 32 is a general rear view of the facsimile printing machine.

FIG. 33 is a diagrammatic side elevation showing the developer.

FIG. 34 is a fragmentary elevational view showing a portion of a latching arrangement employed on the developer.

FIG. 35 is an elevation of the developer from the opposite side.

FIG. 36 is a diagrammatic plan view of the developer.

FIG. 37 is a diagrammatic elevational section of the developer, showing the mechanism for stopping the action of the developer.

FIG. 38 is a diagrammatic elevational section taken generally along a line 38—38 in FIG. 37.

FIG. 39 is a diagrammatic plan view taken generally as indicated by the line 39—39 in FIG. 38.

FIG. 40 is a diagrammatic horizontal section through the developer.

FIG. 41 is a detailed section along the line 41—41 in FIG. 40.

FIG. 42 is a diagrammatic elevation showing the gear train for the developer.

FIG. 43 is a fragmentary plan view, taken as indicated by the line 43—43 in FIG. 8.

As already indicated, FIG. 1 illustrates the general layout of a facsimile printing machine 50 to be described as an illustrative embodiment of the present invention. The illustrated machine 50 employs an electronic printing tube 52 which is adapted to receive the electrical facsimile signals and to translate the signals into such a form that the document being transmitted will be reproduced on a web 54 made of paper or other suitable material. Any suitable facsimile reproduction device may be employed in the illustrated machine, but it is preferred that the electronic printing tube 52 be of the type which is adapted to produce an electrostatic latent image of the document on the web 54. The latent electrostatic image is then rendered visible by means of a developer 56. In this case, a fixer or fuser 58 is also employed so that the developed image will be rendered permanent.

Developers of various types may be employed, but the illustrated developer 56 is of the type comprising a trough or other receptacle 60 adapted to hold a supply of finely powdered material 62 which is applied to the surface of the web 54, after the latent electrostatic image has been produced on the web by the electronic printing tube 52. The powdered material 62 may comprise a mixture of finely powdered iron and a finely powdered toner material, which may comprise various suitable plastics capable of being fused to the surface of the paper web. The toner material should be black or some other dark color. It will be understood that the toner material adheres to the latent image, due to electrostatic attraction. In this way, the latent image is rendered visible by the toner.

The fixer or fuser 58 is adapted to develop sufficient

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heat to fuse the toner particles so that the toner will adhere permanently to the web 54. In this case, the fuser 58 comprises a plurality of tubular heat lamps 64 mounted in a trough-shaped reflector 66 and directed upon the web 54 after it has left the developer 56.

In the illustrated machine, the web 54 is unrolled from a supply roll 68. After passing over a guide roller 70, the web 54 passes around a pair of S-lock rollers 72 and 74, and then over the main drive roller 76. In this case, the rollers 72, 74 and 76 may be continuously rotated. However, the web 54 is not advanced unless it is pressed against the roller 76 by nip rollers 78 which are movable into and out of engagement with the roller 76. The nip rollers 78 may be frictionally driven by the web 54. A one-way roller 80 engages the web above the roller 76 to prevent the web from backing up when the nip rollers 78 are out of engagement with the web.

From the rollers 76 and 78, the web passes to a severing device 82, which may comprise a movable knife 84 acting in cooperation with a stationary bed knife 86. The severing device 82 is adapted to cut off the leading end of the web so that the reproduced document will be cut into a separate sheet. The reproduced document may be of any desired length.

At the beginning of each cycle of the machine, the nip rollers 78 are moved toward the roller 76 so as to press the web 54 against the roller 76. The rollers 72, 74 and 76 then advance the leading edge of the web past the severing device 82 to a main cylinder or drum 88. Means are provided on the cylinder 88 to take the leading end of the web and to carry the web around the cylinder 88 and past the electronic printing tube 52 and the developer 56. Preferably, such means take the form of vacuum porting in the cylinder 88, whereby the web is sucked against the surface of the cylinder. Such vacuum porting will be described in detail shortly.

From the main cylinder 88, the leading end of the web passes to a fuser cylinder 90 which also has means for taking and carrying the web. Preferably, such means take the form of vacuum porting in the cylinder 90, as will be described in detail shortly. The cylinder 90 carries the web past the heat lamps 64 of the fuser 58.

After passing around the fuser cylinder 90, the leading end of the web is fed between two sets of nip rollers 92 and 94, and then between two more sets of nip rollers 96 and 98. The rollers 92, 94, 96 and 98 may be driven so as to rotate continuously. Thus, these rollers propel the web after it leaves the fuser cylinder 90.

From the nip rollers 96 and 98, the web is directed to a delivery conveyor 100, which carries the facsimile copy to the front end of the machine and deposits the copy in a receiving tray 102. The copy is severed from the web 54 by the cutting knife 84, which is actuated upon receipt of a cutoff signal from the transmitting station. Simultaneously with the action of the knife 84, the nip rollers 78 are disengaged from the web, whereupon the web is stopped. However, the severed sheet is propelled by the cylinders 88 and 90 and the rollers 92—96 to the delivery conveyor 100.

In this case, the delivery conveyor 100 comprises a plurality of laterally spaced endless belts or tapes 104 which are strung around end rollers 106 and 108 and intermediate rollers 110 and 112. Nip rollers 114 engage the roller 108 so as to propel the facsimile copy into the receiving tray 102. The facsimile copy is held against the tapes 104 between the rollers 106 and 110 by a series of rollers 116 which may take the form of balls rotatably mounted on guide bars or members 118 disposed over the tapes.

As shown to advantage in FIG. 5, a curved guide plate 122 is provided around the S-lock roller 72 to facilitate the threading of the web 54. It will be seen from FIG. 6 that gears 124, 126 and 128 are connected to the rollers 72, 74 and 76. The gears 126 and 128 mesh with the gear 124. A smaller gear 130 is also connected

to the roller 76. It will be seen that a larger gear 132 meshes with the gear 130 and also meshes with a large gear 134 which is coaxial with the main cylinder 88. Through a suitable train of gearing, the gear 134 is driven by a main drive motor 136, shown in FIGS. 32 and 35.

The nip rollers 92 and 94 may be fitted with sprockets 140 and 142 (FIG. 6) which may be driven by a chain 144, threaded around a drive sprocket 146 connected to the fuser cylinder 90. By suitable gearing, the fuser cylinder 90 may be continuously rotated by the main drive motor 136. In this case, a second sprocket 148 is connected to the nip rollers 92 and is employed to drive a chain 150 which is threaded around a sprocket 152 by the nip rollers 96. The rollers 98 may be frictionally driven by the rollers 96.

As shown, a gear 154 is also connected to the rollers 96 and is employed to drive a gear 156 through an intermediate gear 158. The gear 156 is connected to the conveyor rollers 106.

The nip rollers 78 may be moved into and out of engagement with the drive roller 76 by the action of a solenoid 162 (FIG. 6) having an armature 164 which is connected by means of a link 166 to a swingable lever 168. The solenoid 162 is adapted to swing the lever 168 in a counterclockwise direction against the biasing action of a return spring 170. In this case, a cam 172 is connected to the lever 168 for moving the nip rollers 78 into engagement with the drive roller 76. It will be seen that the nip rollers 78 are mounted on arms 174 which are secured to a shaft 176. An arm 178 is also mounted on the shaft 176 and is fitted with a roller 180 which engages and follows the cam 172. A spring 182 is provided to bias the arm 178 in a counterclockwise direction so that the roller 180 will be pressed against the cam 172. The spring 182 tends to separate the nip roller 78 from the drive roller 76. When the solenoid 162 is energized, the cam 172 is swung in a counterclockwise direction so as to swing the arms 174 and 178 in a clockwise direction. Thus, the nip rollers 78 press the web 54 against the drive roller 76. The solenoid 162 is operated in response to a control signal received from the transmitting station, when it is desired to transmit and reproduce a document over the facsimile system. After each document is transmitted, the solenoid 162 is de-energized so as to stop the web 54.

As shown to advantage in FIG. 4, the cutting knife 84 may be slidably mounted in a supporting block 185. Springs 187 (FIG. 3) may be provided to retract the knife 84 out of engagement with the bed knife or abutment 86. The knife 84 may be operated by a plurality of pusher arms 187 secured to a shaft 189. In this case, the knife 84 is actuated by a solenoid 192 having an armature 194 which is connected by means of a link 196 to an arm 198 on the shaft 189. A return spring 200 may be provided to swing the arm 198 in a clockwise direction when the solenoid 192 is deenergized. As the transmission of each document is completed, the solenoid 192 is energized in response to a control signal received from the transmitting station. In this way, the cutting knife 84 is actuated to sever the web. Simultaneously, the web is stopped by the de-energization of the solenoid 162.

To guide the web, closely spaced guide plates 203 and 205 extend from the nip rollers 76 and 78 to the severing device 82, as shown to advantage in FIG. 4. The severing device 82 is positioned closely adjacent the main cylinder 88 so that the leading end of the web travels directly downwardly to the main cylinder from the cutting device.

In order to insure that the main cylinder 88 will be properly oriented at the beginning of each cycle, it is preferred to rotate the main cylinder through a single revolution during each cycle of the machine. After the main cylinder 88 has been stopped, the sheet being

printed may be dragged around the main cylinder by the positive propelling action of the nip rollers 92 and 94.

The main cylinder 88 may be rotated through a single revolution by any suitable single-revolution drive mechanism, operable in response to a control signal received from the transmitting station. To rotate the main cylinder 88, the illustrated machine is provided with a single-revolution clutch 208 (FIG. 7) operable by the momentary energization of a solenoid 210. In general, the single-revolution clutch mechanism 208 comprises a wedging type clutch 212 which is adapted to form a driving connection between the continuously rotating gear 134 and the main cylinder 88. The clutch 212 has a control collar 214 which rotates with the main cylinder 88 when the clutch is engaged. The clutch 212 is disengaged by stopping the collar 214. This is accomplished by a pawl 216 which is engageable with a pin 218 on the collar 214. The pawl 216 is swingable about a pivot 220 and is connected to an arm 222. A link 224 extends between the arm 222 and the armature 226 of the solenoid 210. A return spring 228 is provided to swing the pawl 216 inwardly, into the path of the pin 218, when the solenoid 210 is de-energized.

When the solenoid 210 is momentarily energized, the pawl 216 is swung clockwise to release the pin 218 so as to permit the collar 214 and the main cylinder 88 to rotate. After one revolution, the pawl 216 again arrests the pin 218 so as to disengage the clutch 212.

To insure precise indexing of the cylinder 88 after each revolution, an indexing cam or disk 231 may be secured to the cylinder 88. As shown, the disk 231 is formed with a detent notch 233 adapted to receive a detent pawl 235. In this case, the detent pawl 235 is freely mounted on the pivot 220 and is adapted to be moved outwardly by a pin 237 on the clutch releasing pawl 216. The detent pawl 235 is biased inwardly by a spring 239 connected between the pin 237 and the detent pawl. Thus, the detent pawl 235 is swung outwardly by the pin 237 when the solenoid 210 is energized. At the conclusion of one revolution, the detent pawl 235 is pulled into the notch 233 by the spring 39.

It has already been indicated that vacuum porting is preferably provided in the main cylinder 88 to take and to carry the web. Such vacuum porting is shown to best advantage in FIGS. 12-19. The illustrated roller 88 comprises a cylindrical shell 242 which is fitted over a core 244. A large number of suction holes 246 are formed in the shell 242. It will be seen that the suction holes 246 are arranged in longitudinal rows which are spread over approximately one-quarter of the surface of the cylinder. A separate manifold slot or passage 248 is formed in the core 244 to communicate with each of the rows of holes 246. In this case, a rotary valve disk or member 250 is secured to one end of the core 244 and is formed with vacuum slots or ports 252 communicating with the slots 248. As shown to advantage in FIG. 13, the first row of holes 246 has a special valve port 252a which is somewhat longer in radial extent than the other slots 252.

The valve member 250 rotates with the cylinder 88 and is engaged by a stationary slide valve member or disk. As shown to advantage in FIGS. 14 and 15, the stationary valve member 254 is formed with an arcuate valve groove or passage 256 which is connected through a conduit 258 to a suitable vacuum pump 260 (FIG. 2). The valve groove 256 extends through an angle somewhat greater than 90 degrees. To communicate with the first valve port 252a, the valve groove 256 has an extension 262 at its leading end. It will be seen that the extension 262 communicates with the radially inward portion of the groove 256 and thus is adapted to register with the longer first port 252a, but not with the other ports 252. The first port 252a is adapted to take the extreme leading end of the web 54. The action of the other ports 252 is delayed for a small angle so that suction is not applied to

the web immediately behind the leading end until the surface of the cylinder passes the electronic printing tube 52. This arrangement makes it possible for the web to be pressed against the printing tube 52 by a set of spring fingers associated with the tube. The cylinder 88 is formed with peripheral grooves 266 to receive the spring fingers. After all of the ports 252 have passed the groove 256, the suction is shut off from the main cylinder so that the web can be dragged along the surface of the main cylinder. Such dragging action occurs after the main cylinder has completed its single revolution.

The orientation of the stationary valve member 254 is such that the first vacuum port 252a comes into registration with the extension 262 of the groove 256 as the leading end of the web reaches the cylinder 88 after being propelled past the cutting knife 84 by the rollers 76 and 78. Thus, vacuum is applied to the first row of holes 246 so as to suck the leading end of the web against the cylinder 88. The vacuum carries the web around the cylinder for somewhat less than one-half revolution, whereupon the port 252a moves out of registration with the groove 256 so that the leading end of the web may be directed to the fuser cylinder 90.

Strippers 270 are provided to peel the web from the main cylinder 88. The web is then directed along wires 272 to the fuser cylinder 90, as shown to advantage in FIG. 8. The guide wires 272 are mounted on a plate 272a. The strippers 270 may extend into the grooves 256 in the main cylinder 88. As shown, the strippers 270 are formed by end portions of the guide wires 272. To hold the web against the guides 272, air is blown against the lower side of the web by a plurality of air tubes 273 having upwardly directed slots or openings 274 therein. The air may be supplied from the pump 260 through a conduit 275 and a manifold 276 to the tubes 273. This arrangement for holding the web against the guides 272 avoids any damage to the fragile, newly developed image on the web. Lower guide wires 277 are also provided, but the air supplied by the tubes 273 normally prevents the web from touching the lower guide wires.

Vacuum porting is also provided on the fuser cylinder 90 to take the web and carry it around the fuser cylinder. Such vacuum porting is shown to best advantage in FIGS. 8, 9, and 29-31. Thus, the cylindrical surface of the fuser cylinder is formed with a plurality of vacuum openings 278 (FIG. 29) which are arranged in longitudinal rows spread around the entire circumference of the cylinder. As already indicated, the fuser cylinder is preferably rotated continuously by suitable gearing. The vacuum openings 278 are formed in a cylindrical shell 280 which is fitted over a core 282. The shell 280 is preferably made of stainless steel or some other material which will be resistant to the heat of the fuser lamps 64. Longitudinal manifold slots or ports 284 are formed in the core 282 to register with the rows of openings 278. One end of the core 282 is fitted with a rotary valve member 286 (FIG. 9) having vacuum ports 288 therein, registering with the slots 284. The valve member 286 rotates with the cylinder 90.

To regulate the supply of vacuum to the fuser cylinder 90, an intermittently rotatable valve disk 290 is mounted in sliding engagement with the valve member 286. When the web is to be taken by the fuser cylinder 90, the valve disk 290 is caused to rotate through one-half revolution, by a drive mechanism to be described in detail shortly. As shown, the valve disk 290 has two sets of ports 292 (FIG. 30) which extend entirely through the disk. Each set of ports 292 is spread over approximately 90 degrees. The two sets of ports are diametrically opposite each other. In this case, there are four of the ports 292 in each set.

As already indicated, one side of the valve disk 290 engages the rotating valve member 286. The other side of the valve disk 290 is engaged by a stationary slide valve 294 (FIGS. 9 and 31). Three arcuate valve grooves

296, 298 and 300 are formed in the stationary slide valve member 294. The valve groove 296 extends for an angle of approximately 90 degrees and is supplied with vacuum derived from the vacuum pump 260. When the valve disk 290 is stationary, the ports 292 are out of registration with the valve groove 296, so that vacuum is not applied to the portion of the cylinder 90 along which the web 54 travels. When the valve disk 290 is rotated through one-half revolution, one set of the ports 292 moves into and then out of registration with the valve groove 296. The leading port 292 moves into registration with the groove 296 as the leading end of the web arrives at the fuser cylinder 90. Thus, vacuum is applied to the vacuum openings 278 under the web so that the web will be sucked against the cylinder 90 and will be carried around the cylinder to its point of departure from the cylinder.

The valve grooves 298 and 300 may be supplied with either vacuum or air under pressure. These grooves are disposed adjacent the ports of the fuser cylinder 90 opposite from the portion traversed by the web 54. The purpose of the grooves 298 and 300 is to provide a flow of air through the openings 278, along the portions of the cylinder 90 away from the web, so as to cool the cylinder 90. This arrangement reduces the heating of the fuser cylinder by the heat lamps 64 of the fuser 58.

The web is peeled from the fuser cylinder by strippers 302 (FIG. 8) and is directed by guides 304 between the nip rollers 92 and 94. The web then passes between guide plates 306 and 307 to the rollers 96 and 98.

The valve disk 290 for the fuser cylinder 90 may be rotated through one-half revolution by a clutch mechanism 308, similar to the clutch mechanism 208 for the main cylinder 88. The fuser clutch 308 is controlled by a solenoid 310. When the solenoid 310 is energized momentarily, the clutch 308 causes the valve disk 290 to rotate through one-half revolution.

As in the case of the clutch 208, the clutch 308 comprises a wedging type clutch 312 having a control collar 314 which may be stopped to disengage the clutch. In this case, two diametrically opposite pins 316 are provided on the control collar 314. The pins 316 are adapted to be engaged and stopped by a pawl 318 connected to a lever 320 which is operable by the solenoid 310. A link 322 is connected between the lever 320 and the armature 324 of the solenoid 310. A return spring 326 biases the link 322 in such a direction as to urge the pawl 318 inwardly, for engagement with the pins 316. When the solenoid 310 is energized, the pawl 318 is swung outwardly to release the pins 316. After releasing one of the pins 316, the pawl returns inwardly to stop the other pin.

To insure accurate initial positioning of the valve disk 290, a detent disk or cam 330 is connected to the valve disk 290. It will be seen that the detent disk 330 is formed with two diametrically opposite detent notches 332, each of which is adapted to receive a detent pawl 334. As in the case of the clutch 308, the detent pawl 334 is freely swingable about the pivot 336 for the clutch-operating pawl 318. A pin 338 is provided on the clutch-operating pawl 318 to swing the detent pawl 334 outwardly when the solenoid 310 is energized. In this way, the detent disk 330 is released so that the valve disk 290 may rotate. A spring 340 is connected between the pin 338 and the detent pawl 334 to draw the pawl inwardly when the solenoid 310 is de-energized. Thus, after each half revolution, the detent pawl 334 enters one of the detent notches 332 to stop the detent disk 330.

The operation of the solenoid 310 is preferably delayed a considerable interval after the main cylinder 88 starts rotating so that the valve disk 290 will start rotating after the leading end of the web has reached the fuser cylinder 90. In this case, the solenoid 310 is energized by a switch 344 which is operable by a notch 346 in a timing cam or disk 348 which rotates with the main cylinder 88. In this way, the solenoid 310 is actuated after

the main cylinder has traveled through a major portion of its revolution.

The operation of the developer 56 is also started and stopped in accordance with the movement of the paper around the main cylinder 88. Thus, the operation of the developer is delayed until the main cylinder 88 has rotated sufficiently to carry the leading end of the paper web to the developer. The operation of the developer continues until the facsimile copy sheet has been severed from the web and also for an interval thereafter, until the trailing end of the sheet is about to pass the developer. By this arrangement, the powdered toner material is applied to substantially the entire sheet. However, the toner material is not applied to the bare surface of the main cylinder.

The starting of the developer 56 is controlled by a second timing cam or disk 352 which rotates with the main cylinder 88. A notch 354 is formed in the disk 352 to operate a switch 356 which initiates the operation of the developer.

The stopping of the developer 56 is controlled by a timer 361 which is actuated simultaneously with the actuation of the cutting knife 84. In this case, the timer 361 comprises two timing cams 363 and 365 which are rotated through one revolution, following the momentary energization of a solenoid 367. The timing cam 363 is behind the cam 365 in FIG. 7. Notches 369 and 371 are formed in the cams 363 and 365 to operate switches 373 and 375. The switch 373 is behind the switch 375 in FIG. 7. These switches 373 and 375 shut down the developer in a sequential manner, as will be described in greater detail shortly.

The timing cams 363 and 365 are adapted to be rotated by a wedging type clutch 378 having a control collar 380 which may be stopped to disengage the clutch. In this case, the control collar 380 is formed with a notch 382 adapted to receive a pawl 384. It will be seen that that pawl 384 is connected to a lever 386 which in turn is connected to the solenoid 367. A return spring 391 is provided to bias the lever 386 in a clockwise direction so as to move the pawl 384 into the notch 382 at the completion of one revolution.

As shown to advantage in FIGS. 36-42, the illustrated developer 56 comprises two applicator rollers 394 and 396 which are rotatably mounted in the trough or receptacle 60 and are adapted to apply the powdered developer composition 62 to the paper as it travels around the main cylinder 88. One end of the trough 56 is supported by a pair of latches or hooks 398 which are swingable about pivots 400 and are adapted to be received under bearings 402 on the shaft 404 for the roller 396. Spring-type locking plungers are employed to retain the hooks 398 in their locked positions. The plungers 406 may be pulled out so that the hooks 398 may be swung away from the bearings 402 to provide for easy removal of the developer from the machine.

The other end of the developer receptacle 60 is supported by a hook or latch 409 which is swingable under a cross rod 411 on the receptacle 60. The latch 409 is secured to a shaft 413. Levers 415 are mounted on the shaft 413 for releasing and engaging the hook 409. Each lever 415 is movable between stop pins 417 and 419. The cross rod 411 is eccentrically mounted on rotatable hubs 421. By turning the hubs 421, the exact elevation of the developer 56 may be adjusted. When the hook 409 is swung away from the rod 411, the developer receptacle 60 may be swung down to afford easy access to the top of the receptacle, for cleaning or other servicing.

As shown to advantage in FIG. 40, each of the illustrated applicator rollers 394 and 396 comprises a plurality of permanent magnets 424 mounted within a nonmagnetic, substantially cylindrical shell 426 which may be made of brass or the like. In this case, each of the permanent magnets 424 is in the form of a circular disk. The magnets 424 are arranged in groups of two or three with nonmagnetic spacers 427, made of fiber or the like,

disposed between groups. Within each group, the poles of the magnets are given the same orientation. However, the poles of adjacent groups are oppositely oriented.

The magnets 424 attract the powdered iron which is employed in the powdered developer composition 62 so that the composition will adhere to the outside of each of the rollers 394 and 396 in a fairly thick layer. As shown to advantage in FIG. 37, there is a definite spacing between the main cylinder 88 and each of the rollers 394 and 396. Thus, the rollers 394 and 396 do not actually come into engagement with the paper web passing around the main cylinder 88. However, when the developer is in operation, the layer of powdered material adhering to each of the rollers 394 and 396 comes into engagement with the paper web so as to develop the latent electrostatic image on the web.

The rollers 394 and 396 might be driven intermittently to stop and start the operation of the developer. However, in this instance the rollers are driven continuously by a gear train which is shown to advantage in FIG. 42. Thus, a gear 429 is connected to the roller 396 and is adapted to mesh with a smaller gear 431 which in turn meshes with the gear 134. Another gear 433 is also secured to the roller 396 and is adapted to mesh with a gear 435, meshing in turn with a gear 437, connected to the roller 394. To circulate the powdered developer composition, the developer is provided with a slanting scraper 440 (FIG. 37) which is positioned between the rollers 394 and 396. The scraper 440 scrapes the developer composition off the roller 394 after the roller has passed the main cylinder 88. The scraped material flows down the scraper and is taken up by the roller 396 so that the material is again carried past the main cylinder 88. The scraper 440 scrapes the material off the lower portion of the roller 396, whereupon the material falls into the lower portion of the developer receptacle 60.

The receptacle 60 is preferably formed with a well 442. The developer composition is preferably circulated and agitated in the well by two augers 444 and 446 which are driven continuously in opposite directions. Thus, one of the augers carries the powdered material longitudinally in one direction, while the other auger carries the material in the opposite direction. In this case, the augers 444 and 446 are fitted with gears 448 and 450 which mesh with each other. The gear 448 meshes with the continuously driven gear 435.

As shown to advantage in FIG. 40, the augers 444 and 446 are formed with shafts or cores 452 and 454 which taper longitudinally but in opposite directions. Thus, the core 452 of the auger 444 flares in the direction in which the powdered material is conveyed, so as to assist in transferring the powdered material to the other auger 446. Similarly, the core 454 of the auger 446 flares in the direction in which the material is conveyed.

In the illustrated construction, the operation of the developer 56 is adapted to be started and stopped by two scrapers 457 and 459 which are adapted to scrape the powdered developer material off the rollers 394 and 396. When the developer 56 is in operation, the scrapers 457 and 459 are moved away from the rollers 394 and 396 so that the rollers are able to carry the powdered developing material upwardly against the paper web on the main cylinder 88. The scrapers 457 and 459 are mounted on levers 461 and 463 for movement toward and away from the rollers 394 and 396. Springs 465 and 467 bias the levers 461 and 463 in such a direction as to move the scrapers 457 and 459 toward the rollers 394 and 396. The scrapers 457 and 459 are adapted to be moved away from the rollers 394 and 396 by solenoids 469 and 471. Thus, a link 473 is connected between the solenoid 469 and a lever 475 having an arm 477 which is engageable with a stop pin 479 on the lever 461. A return spring 481 biases the lever 475 away from the pin 479.

Similarly, a link 483 is connected between the solenoid

471 and a lever 485 having an arm 487 which is engageable with a stop pin 489 on the lever 463. The solenoid 471 acts against a return spring 490.

Both of the solenoids 469 and 471 are energized when the developer is operating, so as to hold the scrapers 457 and 459 away from the rollers 394 and 396. When the developer is shut down, the solenoids 469 and 471 are deenergized in sequence, so as to permit the scrapers 457 and 459 to move toward the rollers 394 and 396. In this way, most of the powdered material is scraped off the rollers so that the powdered material does not come into engagement with the bare surface of the main cylinder 88.

It has already been indicated that the operation of the developer 56 is stopped by the action of the timer 361 after the paper copy sheet has been severed from the web by the movable cutting knife 84. Thus, the switches 373 and 375 are operated sequentially by the cam notches 369 and 371. In this case, the solenoid 469 is de-energized by the operation of the switch 373, as the trailing end of the paper approaches the roller 394. The solenoid 471 is de-energized by the operation of the switch 375 as the trailing end of the paper approaches the roller 396. This action prevents the powdered developer material from being deposited on the main cylinder 88 and other parts of the printing machine.

As shown to advantage in FIG. 8, a cleaning device 492 may be employed to remove any powdered material that may be deposited on the main cylinder 88 during the normal operation of the machine. As shown, the cleaning device 492 comprises an elongated tube 494 having openings 496 therein, opposite the upper portion of the main cylinder 88. The tube 494 may be connected to a suitable vacuum cleaner 498 (FIG. 32). A brush 500 may be mounted on the tube 494 in advance of the openings 496 to sweep the powdered material off the main cylinder 88. A pad 502 made of felt or the like may be mounted on the tube 494 in trailing relation to the openings 496 to wipe powdered material off the main cylinder 88. In this way, the powdered material is kept from finding its way into the bearings and other moving parts of the machine.

The facsimile printing machine of the present invention is extremely efficient and is capable of operating at high speeds. The machine will reproduce a document of any desired length and then will cut the facsimile copy of the document from the supply web. There is no wastage of the supply paper. The leading end of the web is carried very effectively around the main cylinder and the fuser cylinder by the vacuum porting arrangements of the cylinders.

It will be understood that various modifications, alternative constructions and equivalents may be employed, without departing from the true spirit and scope of the invention, as exemplified in the foregoing description and defined in the following claims.

We claim:

1. In a facsimile printing machine, the combination comprising a main cylinder, means for rotating said main cylinder through a single revolution in response to a starting signal, means for feeding a web of copy material to said main cylinder in response to said starting signal, vacuum means on said main cylinder for taking and carrying said web, an electronic printing device adjacent said main cylinder for producing a latent electrostatic facsimile image on said web, a developer along said main cylinder for applying a developing composition to the web so as to render said latent image visible, means for starting said developer as a delayed response to said starting signal, a second cylinder,

- means for carrying the web from said main cylinder to said second cylinder, means along said second cylinder for fixing the facsimile image as developed by said developer, additional vacuum means on said second cylinder for taking and carrying the web, means including a pair of nip rollers for taking the web from said second cylinder, means for continuously rotating said nip rollers to propel the web after the main cylinder has rotated through its single revolution, severing means for cutting the leading portion from the web to form a separate copy sheet, said severing means being disposed between said feeding means and said main cylinder, means for operating said severing means in response to a stopping signal, and means for stopping said developer as a delayed response to said stopping signal so as to avoid the application of the developer composition to the bare main cylinder.
2. In a facsimile printing machine, the combination comprising a main cylinder, a first pair of nip rollers for selectively feeding a web of copy material to said main cylinder, vacuum means on said main cylinder for taking and carrying the web, selectively operable means for applying and relieving pressure between said nip rollers for selectively propelling the web to said main cylinder, a second cylinder, means for carrying the web between said main cylinder and said second cylinder, vacuum means on said second cylinder for taking and carrying the web, a second pair of nip rollers for receiving the web from said second cylinder, means for continuously driving said second pair of nip rollers, and severing means for cutting the web between said main cylinder and said first pair of nip rollers so that the leading portion of the web is formed into a separate copy sheet.
 3. In a facsimile printing machine, the combination comprising a main cylinder, feeding means for feeding a web of copy material to said main cylinder, means for actuating said feeding means in response to a starting signal, means for rotating said main cylinder through a single revolution in response to said starting signal, vacuum means including a rotary vacuum valve connected to said main cylinder for taking and carrying the web during a portion of said single revolution, a second cylinder, means for carrying the web between said main cylinder and said second cylinder, additional vacuum means including an additional rotary vacuum valve connected to said second cylinder for taking and carrying the web, and means for taking the web from said second cylinder.
 4. In a facsimile printing machine, the combination comprising facsimile printing means for producing a latent image on a web of copy material, developing means for developing the latent image to render the image visible, fixing means for rendering the developed image permanent, selectively operable means for feeding a web of copy material to said printing means, means for carrying the web from said printing means to said developing means and then to said fixing means, timer means for actuating said developing means as a

delayed response to the actuation of said feeding means,
 additional timer means for actuating said fixing means as a further delayed response to the actuation of said feeding means,
 and means for severing the web between said feeding means and said printing means to produce a separate copy sheet.

5. In a facsimile printing machine,
 the combination comprising facsimile printing means for producing a latent image on a web of copy material,
 developing means for developing the latent image to render it visible,
 feeding means for feeding a web of copy material to said printing means and then to said developing means,
 means for starting the operation of said feeding means in response to a starting signal,
 means for starting the operation of said developing means after a delay from the starting of said feeding means,
 means for stopping the operation of said feeding means in response to a stopping signal,
 means for severing the web at a point between said feeding means and said printing means as a simultaneous response to said stopping signal,
 said severing means forming a separate copy sheet,
 means for taking and carrying said copy sheet from said developing means,
 and means for stopping said developing means after a delay from the stopping of said feeding means.

6. In a facsimile printing machine,
 the combination comprising a main cylinder,
 means for rotating said main cylinder through a single revolution in response to a starting signal,
 means for feeding a web of copy material to said main cylinder in response to said starting signal,
 vacuum means on said main cylinder for taking and carrying said web,
 a printing device adjacent said main cylinder for producing a latent electrostatic facsimile image on said web,
 a developer along said main cylinder for applying a developing composition to the web so as to render said latent image visible,
 timer means for starting said developer as a delayed response to said starting signal,
 severing means for cutting the leading portion from the web to form a separate copy sheet,
 said severing means being disposed between said feeding means and said main cylinder,
 means for operating said severing means in response to a stopping signal,
 and additional timer means for stopping said developer as a delayed response to said stopping signal so as to avoid the application of the developer composition to the bare main cylinder.

7. In a facsimile printing machine,
 the combination comprising a main cylinder,
 a first pair of nip rollers for selectively feeding a web of copy material to said main cylinder,
 vacuum means on said main cylinder for taking and carrying the web,
 a second cylinder,
 means for carrying the web between said main cylinder and said second cylinder,
 vacuum means on said second cylinder for taking and carrying the web,
 a second pair of nip rollers for receiving the web from said second cylinder,
 means for continuously driving said second pair of nip rollers,
 and severing means for cutting the web between said

main cylinder and said first pair of nip rollers so that the leading portion of the web is formed into a separate copy sheet.

8. In a facsimile printing machine,
 the combination comprising facsimile printing means for producing a latent image on a web of copy material,
 developing means for developing the latent image to render the image visible,
 selectively operable means for feeding a web of copy material to said printing means,
 means for carrying the web from said printing means to said developing means,
 timer means for actuating said developing means as a delayed response to the actuation of said feeding means,
 and means for severing the web between said feeding means and said printing means to produce a separate copy sheet.

9. In a facsimile printing machine,
 the combination comprising a cylinder,
 first feeding means for positively feeding the severed leading end of a web of copy material to said cylinder,
 means for starting said feeding means in response to a starting signal,
 means for rotating said cylinder through a single revolution in response to said starting signal,
 said last mentioned means being effective to stop said cylinder after a single revolution,
 vacuum ports in a portion of the periphery of said cylinder for taking the leading end of the web and carrying the web around said cylinder for a portion of said revolution,
 second feeding means for positively propelling the web beyond said cylinder,
 means for carrying the leading end of the web between said cylinder and said second feeding means,
 said second feeding means being effective to slide the web around said cylinder after the completion of the single revolution of the cylinder,
 means for stopping said first feeding means in response to a stopping signal,
 and means for severing the web between said first feeding means and said cylinder in response to said stopping signal,
 said second feeding means being operative after the stopping of said first feeding means to remove and discharge the severed leading portion of the web from said cylinder.

10. In a facsimile printing machine,
 the combination comprising a cylinder,
 first feeding means for positively propelling the severed leading end of a web of copy material to said cylinder,
 means for starting said first feeding means in response to a starting signal and then stopping said first feeding means in response to a stopping signal,
 means for rotating said cylinder through a predetermined angle in response to said starting signal and then stopping said cylinder when said predetermined angle of movement is completed,
 said cylinder having vacuum means for sucking the leading end of the web against said cylinder and carrying the web around said cylinder for a portion of said angle of movement,
 second feeding means for positively propelling said web away from said cylinder,
 means for carrying the leading end of said web between said cylinder and said second feeding means,
 said second feeding means being effective to slide said web around said cylinder when said cylinder is stopped after completion of said angle of movement,
 and means for severing said web between said first feed-

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ing means and said cylinder in response to said stop-
ping signal,
said second feeding means being effective after the stop-
ping of said first feeding means to propel the severed
leading portion of the web from said cylinder. 5

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