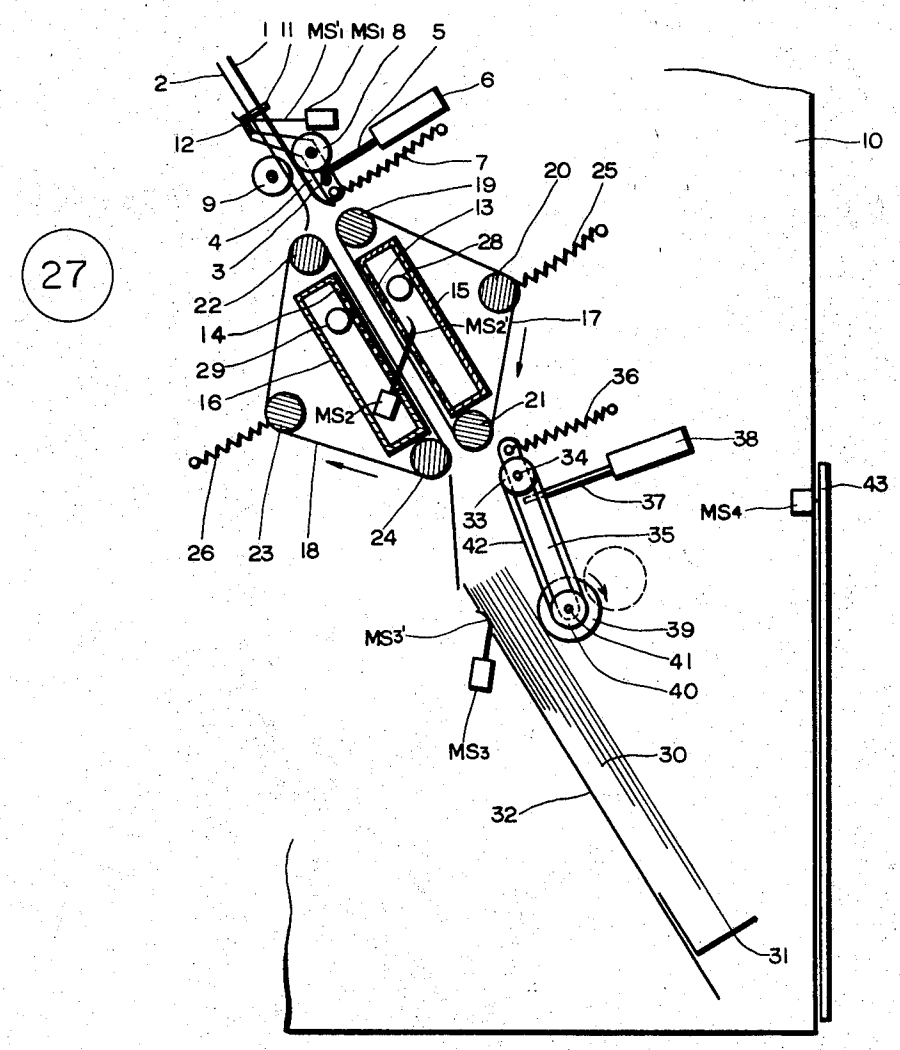
Sept. 15, 1970 KOJI NODA 3,528,739

COPYING MACHINE

Filed May 16, 1968 4 Sheets-Sheet 1

FIG. 1



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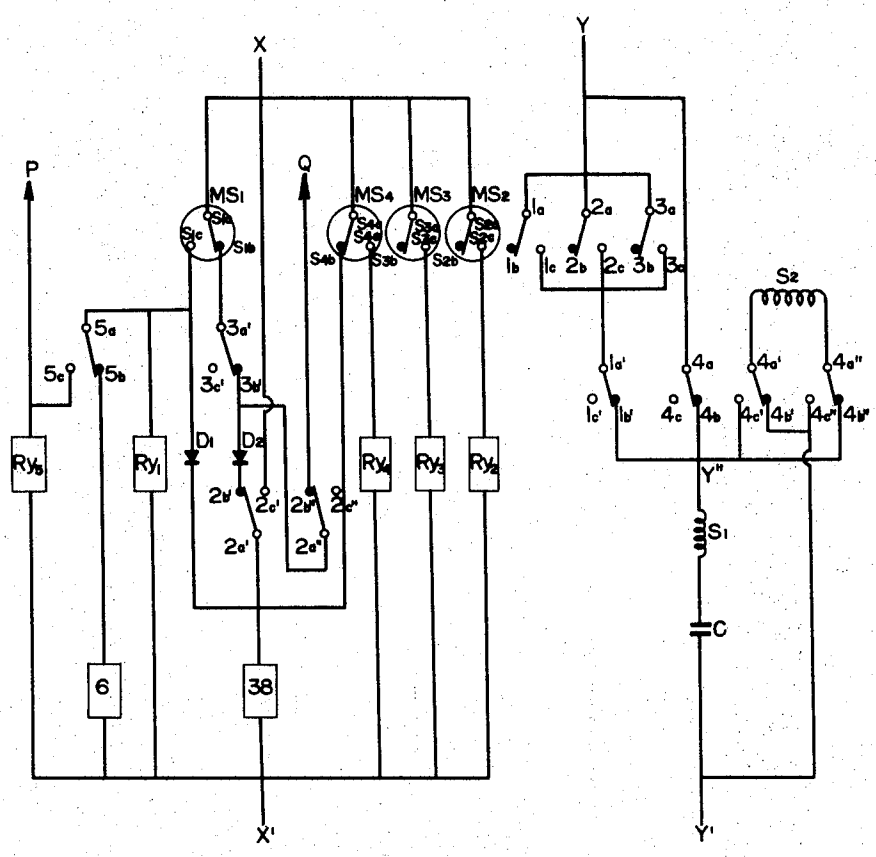
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FIG. 2



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FIG. 3

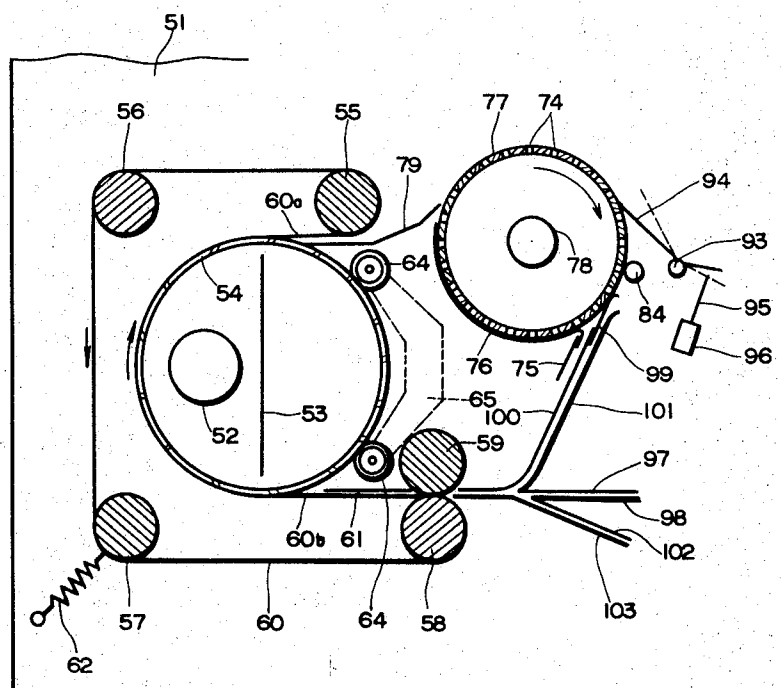
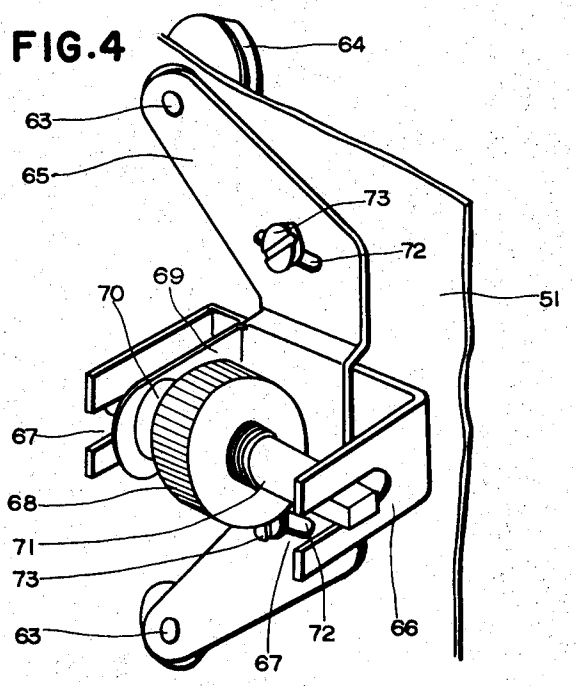


FIG. 4



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FIG. 5

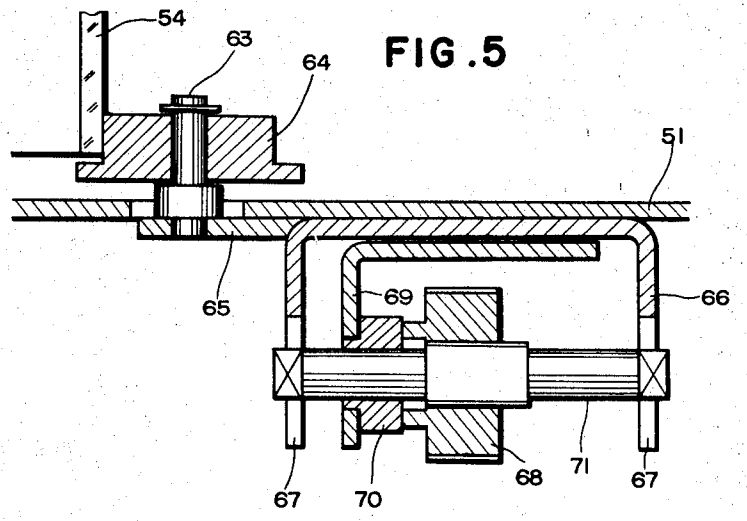


FIG. 6

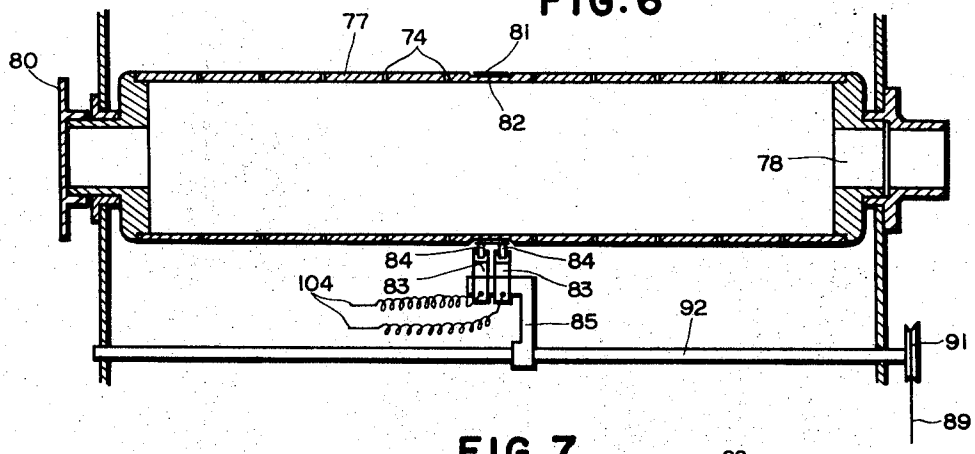
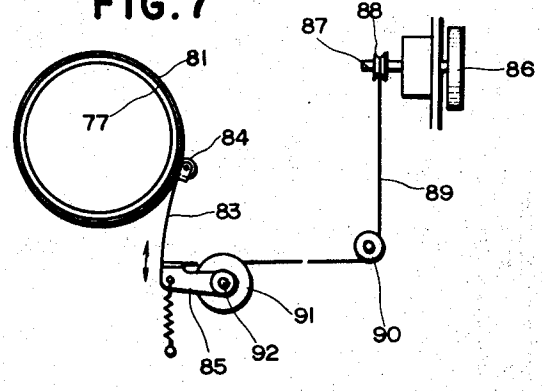


FIG. 7



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United States Patent Office 3,528,739 Patented Sept. 15, 1970

3,528,739

COPYING MACHINE

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Filed May 16, 1968, Ser. No. 729,593
Claims priority, application Japan, May 20, 1967, 42/32,018; May 23, 1967, 42/32,688
Int. Cl. G03b 27/12
U.S. Cl. 355—109 7 Claims

ABSTRACT OF THE DISCLOSURE

A copying machine has a first feeding device which moves sheets from a stack of copying paper one at a time upwardly and at an angle and a second feeding device having a pair of suction box and endless belt assemblies. If more than one sheet of copying paper is fed between the assemblies, one is transported by one assembly to a discharge device, and the remaining sheets are returned by the other assembly to the stack. A rotatably-mounted drum defines a copying zone and receives a sheet from the discharge device upon application of a proper signal. A position regulator equalizes the distances traversed by the sides of the original. Finally, a regulator compensates for the time delay between the application of the signal to the copying paper feeding device and actual start of the movement of the copying paper.

The present invention relates to a copying machine. and more particularly to such a copying machine as comprising a device for automatically feeding a stack of copying papers one by one without fail to the copying zone. The machine also comprises a device for regulating the position of an original which is repeatedly and cyclically returned to said copying zone and for regulating the position of each sheet of copying papers to be supplied to said copying zone so that said original and the successively arriving copying papers may always assume a correct position relative to the copying zone and correct registration with each other.

It is desired to make a plurality of copies from a single original completely automatically in this type of copying machine. For attaining this purpose the copying papers housed in a stack must be fed to the copying zone one by one without fail and in a cycle correctly synchronized with the travelling movement of the original repeatedly and cyclically returned to the copying zone. When two or more sheets of copying paper happen to be fed at the same time to the copying zone, not only untreated copying papers would be produced but also various troubles in the copying machine would result thereby. Furthermore when timing of copying paper feeding is not correctly synchronized with the movement of the original in the copying device it will be obvious that the shear in copying will occur. In order to correctly register the original repeatedly brought into the copying zone such as the exposing zone in a photostatic copier, at least the following conditions must be satisfied; (i) The position of the original at the copying zone should not be deviated from that for the first copying operation, and (ii) Each time the original is fed to the copying zone the copying paper should be delivered from the copying paper feeding device in correct relationship with the original with regard to the position thereof. Other various problems must be solved for providing a commercially satisfactory copying machine of the type referred to.

One of the objects of the present invention is to provide a copying machine comprising a copying paper feeding device which may pass only one sheet of copying paper at a time to the copying zone and which returns to the stack of copying paper all but one sheet when two or more sheets are taken from the stack.

Another object is to provide a copying machine comprising a copying paper feeding device adapted to hold the copying paper at the discharge portion thereof and to release and feed the paper to the copying zone upon receiving the signal therefor.

A further object is to provide a copying machine comprising a copying paper feeding device in which every operating means thereof may automatically start their respective operations necessary for satisfactorily feeding copying papers when a stack of copying papers are housed in the rack and the cover plate is closed.

Still another object is to provide a copying machine comprising a copying paper feeding device adapted to produce a signal indicating the absence or exhaustion of the copying paper stock and to stop the operation of the copying machine.

Still another object is to provide a copying machine comprising a copying paper feeding device adapted to automatically return the copying papers present at various portions thereof to the housing rack when the cover plate is opened in order to exchange the stacked copying papers with a stack of copying papers of a different size.

Still another object is to provide a copying machine comprising a position regulating device adapted to equalize the travelling distances of both sides of an original which is repeatedly brought into the copying zone so that the original may always assume the same position at the copying zone.

Still another object is to provide a copying machine comprising a second position regulating device adapted to produce a signal to be applied to the copying paper feeding device to synchronize the feeding operations with the movement of the original passing through the copying zone.

Other objects and a fuller understanding of the invention may be had by carefully referring to the following description made in conjunction with the accompanying drawings, in which;

FIG. 1 is a schematic sectional view of an automatic copying paper feeding device usable in the copying machine according to the present invention,

FIG. 2 is an electric circuit diagram of the copying paper feeding device,

FIG. 3 is a schematic sectional view of the photocopying device with a position regulating device for the original, and a second position regulating device for the copying papers,

FIG. 4 is a perspective view of a travelling distance adjusting means for regulating the position of the original,

FIG. 5 is a sectional view of the travelling distance adjusting means,

FIG. 6 is a partial sectional view of the second position regulating device, and

FIG. 7 is a schematic side view of the second position regulating device.

Like parts are designated by like numerals and symbols throughout the drawings which illustrate a preferred embodiment of the present invention used with a photocopier or photostatic copying machine.

The copying paper feeding device to be used in the copying device according to the present invention comprises a rack means for housing a stack of copying papers, said rack means being located at the lowermost portion of the copying device and inclined; a first feeding means arranged thereabove and adapted to intermittently

contact with the sheet of copying paper of the stack so as to feed the copying papers one by one upwardly and at an angle; a second feeding means having a pair of suction box and running belt assemblies and located diagonally above said rack means so that when two or more sheets of copying papers are occasionally supplied between said two assemblies one assembly feeds only one sheet to the next stage while the other assembly separates the remainder of the copying paper from said one sheet and returns it to said housing rack; and discharging means located above said second feeding means so as to receive each sheet of copying paper therefrom and feed same to the copying zone upon receiving a signal therefrom.

This feeding device can be used in various types of copying machines such as mimeographic, photographic, xerographic, and so on, and consequently the copying paper may be not only photosensitive paper but also usual plain paper so far as said feeding device is concerned.

Referring to FIG. 1, there is provided a discharge means which comprises a pair of cooperating guide plates **1, 2** so as to provide a passageway for the copying paper therebetween. A pair of arms **4** are pivotally supported by pins **3** on either side of the passageway. The arms **4** are biased counter-clockwise by a spring **7** secured to the lower end thereof, as seen in the figure, while a solenoid **6** is associated with the arms **4** through a link **5** secured thereto, so as to rotate the arms **4** clockwise upon actuation of the solenoid **6**. The arms **4** are pivotally supported by the shaft of spaced rollers **8**, made of a suitable frictional and resilient material, such as rubber. Rollers **9** made of the same material as the rollers **8**, are provided on the opposite side of the passageway, so as to cooperate with the rollers **8**. The shaft of the rollers **9** are pivotally supported by a side wall **10** of the machine frame and rotated in synchronism with the copying paper feeding speed in a following operation.

The free ends of the pair of arms **4** are interconnected by a stopper plate **12** to support a suitable number of stopper pieces **11**. The stopper pieces **11** are related with a microswitch MS_1 through an actuator MS_1' disposed in the proximity of the stopper pieces. The microswitch MS_1 is turned ON when the leading edge of a copying paper travelling through the passageway strikes the stopper pieces **11**, and turned OFF after the trailing edge of the copying paper passes through the stopper pieces **11**, by means of the actuator MS_1'. In this particular embodiment, the cooperating guide plates **1, 2** have suitable notches and openings to allow proper disposition and movement of the rollers **8, 9**, the stopper pieces **11**, the actuator MS_1' and the stopper support plate **12**.

When the solenoid **6** is actuated, the arms **4** are angularly displaced clockwise, so as to move the rollers **8** away from the passageway and position the stopper pieces **11** across the cooperating guide plates **1, 2** for blocking the passageway therebetween. Upon de-energization of the solenoid **6**, the arms **4** are angularly moved counter-clockwise to bring the rollers **8** on the passageway, or toward the cooperating rollers **9**, and remove the stopper pieces **11** from the passageway to clear it.

There is provided second feeding means underneath said passageway defined by the cooperating guide plates **1** and **2**, which second feeding means comprises a pair of suction boxes **15, 16** connected to a drafting machine (not shown) through openings **28, 29** and having small holes **13** and **14** bored in the opposedly arranged surface walls thereof, as shown in the figure. A pair of belts **17, 18** are extended around series of rollers **19, 20, 21**, and **22, 23, 24**, respectively. Springs **25** and **26** are connected to the rollers **20** and **23**, respectively, so as to keep the belts **17** and **18** in tension. A reversible motor **27**, such as a condenser motor, is provided to drive the belts **17, 18** in either of the forward and the rearward directions through suitable transmission means. The orifices **13** are distributed over the entire span of the passageway wall of the suction box **15**, while the orifices **14** in the other suction box **15** are formed only on a part of the passageway while leaving the inlet area of the passageway wall of the box **16** imperforated. A microswitch MS_2 is mounted on the suction box **16** so that its actuator MS_2' extends across the passageway but is retractable therefrom when engaging with the entering copying paper.

A suitable number of copying papers **30** can be held in the casing as shown in the lower portion of the figure. The position of a lower wall **31** for supporting a stack of copying papers can be adjusted to keep the leading edge of the copying papers at a predetermined constant level, regardless of the size of the copying papers. A housing rack **32** for supporting the papers has a notch at the upper end thereof, so that the actuator MS_3' of a microswitch MS_3 can be engaged with the copying papers stacked thereon. The position of the microswitch MS_3 is such that the distance between the aforesaid microswitch MS_2 and the leading edge of the copying papers **30** is considerably shorter than the distance between the trailing edge of the stacked copying papers **30** and the microswitch MS_3.

Above said housing rack **32**, there is arranged first feeding means which comprises an arm lever **35** pivoted on a shaft **34** fixed to the machine frame **10**, on which shaft **34** is rotatably mounted a pulley **33** to be driven by the reversible motor **27** through any suitable gearings. On the free end of said arm **35** is mounted a shaft **41** on which a pulley **40** is rotatably mounted so as to be driven by said pulley **33** through a driving endless belt **42** extended around said pulleys. On said pulley **40** is integrally and coaxially mounted a frictional feed roller **39** which may be made of rubber or any other substitute suitable for frictionally contacting with and forcingly feeding upwardly the uppermost copying paper of the stack when said roller **39** is rested thereon and driven. Said roller **39** is normally rested on the stack of copying papers on the housing rack **32** owing to the gravity and a spring means **36** provided at the other end of said arm **35**. The arm **35** is connected with a solenoid **38** so that when said solenoid **38** is energized said roller **39** may be angularly displaced (clockwise in FIG. 1) about the shaft **34** into its inactive position (as shown by a dotted line).

Another microswitch MS_4 is mounted on the machine frame **10**, so as to be actuated by a cover **43** of the copying paper feeding device. The microswitch MS_4 is turned ON when the cover **43** is closed on the device, while it is turned OFF upon opening the cover **43**.

Now, referring to the circuit diagram of FIG. 2, the control circuit further comprises a pair of diodes D_1 and ing machine according to the present invention, comprises the aforesaid microswitches MS_1, MS_2, MS_3, and MS_4 for detecting the position of the copying paper being fed to the copying zone of the machine and for detecting availability or presence of paper on the housing rack. Relays RY_1, RY_2, RY_3, and RY_4 are respectively connected to normally open contacts of said microswitches; namely between common contacts S_{1a}, S_{2a}, S_{3a}, S_{4a} and normally open contacts S_{1c}, S_{2c}, S_{3c}, S_{4c}, respectively. Another relay RY_5 is connected in parallel with the relay RY_1 through its own normally open contacts *5a–5c*. Each relay has normally closed contacts and normally open contacts; namely normally closed contacts *1a–1b*, *1a'–1b'*, *2a–2b*, *2a'–2b'*, *2a''–2b''*, *3a–3b*, *3a'–3b'*, *4a–4b*, *4a'–4b'*, and *5a–5b*, and normally open contacts *1a–1c*, *1a'–1c'*, *2a–2c*, *2a'–2c'*, *2a''–2c''*, *3a–3c*, *4a–4c*, and *5a–5c*. The reversible motor **27** has a coil S_1, another coil S_2, and a capacitor C connected in series with the coil S_1. The control circuit for regulating the operation of the copy- D_2, copying paper feed order signal terminal P, and an empty signal terminal Q for indicating the non-availability or absence of the copying paper on the housing rack. Terminals X, X' represent positive and negative ter-

minals of a D.C. power source for actuating the relays, while terminals Y, Y' represent A.C. power source terminals for actuating the reversible motor **27**.

The operation of the copying paper feeding device of the aforesaid construction will now be described in three stages; namely, preparatory operation, copying operation, and paper replacing operation.

(I) PREPARATORY OPERATION

When a main power source switch (not shown) is closed, the rollers **9** are rotated by a main driving motor (not shown) at a revolving speed synchronized with the driving speed in the subsequent copying operation. At the same time, actuating voltages are applied across the terminals X, X', and across the terminals Y, Y', respectively.

Let it be assumed that there is no copying paper available on the housing rack **32** and the cover **43** is closed. Under such conditions, the microswitches MS_1, MS_2, and MS_3 are turned OFF, to keep the relays RY_1, RY_2 and RY_3 de-energized or OFF, while the microswitch MS_3 and the RY_4 are turned ON. Such conditions will be referred to as "State 1," hereinafter.

Under State 1, the solenoid **6** is not actuated, to keep the rollers **8** and **9** in contact with each other, while retracting the stopper pieces **11** out of the passageway between the guide plates **1** and **2**. The solenoid **38** is energized by a circuit tracing from the terminal X, through the contacts S_{1a}–S_{1b} of the microswitch MS_1, the contacts *3a'–3b'* of the relay RY_3, the diode D_2, the relay contacts *2a'–2b'*, and the winding of the solenoid **38** itself, and to the terminal X'. Thus, the arm **35** rotates counter-clockwise, to move the frictional feed roller **39** away from the stacked copying paper **30** toward the position shown by the broken line in FIG. 1. At the same time, the voltage of the terminal X is branched off from the circuit of the solenoid **38** behind the relay contacts *3a'–3b'*, and delivered to the empty signal terminal Q through the normally closed relay contacts *2a''–2b''* of the relay RY_2. By actuating any alarm means such as an indicating lamp or a buzzer (not shown) with the voltage on the terminal Q, the situation of non-availability of the copying papers **30** at the housing rack can be indicated. Since the RY_4 is energized in conjunction with the relay RY_1 through the microswitches MS_4 and MS_1, respectively, under such conditions, no driving voltage is applied across the terminals Y'', Y', or across the winding S_2 of the reversible motor **27**. Thus, the reversible motor **27** remains inactuated.

Then, upon opening the cover **43** for placing the copying papers **30** on the housing rack **32**, the microswitch MS_4 is turned OFF, to de-energize the relay RY_4. Accordingly, a driving voltage is applied across the terminals Y'', Y', to start the reversible motor **27**. The reversible motor **27** rotates in either direction, upon application of the driving voltage across the terminals Y'', Y', depending on whether the relay RY_4 is energized or not; and consequently whether the contacts *4a'–4b'* and *4a''–4b''* are closed or the contacts *4a'–4c'* and *4a''–4c''* are closed. In the illustrated embodiment, the belts **17**, **18** and the feed roller **39** are assumed to rotate in the direction as shown by arrows in FIG. 1, when the contacts *4a'–4c'* and *4a''–4c''* are closed.

Upon stacking the copying papers **30** on the rack **32**, the microswitch MS_3 is turned ON, to close the contacts *3a'–3c'* of the RY_3 while opening the contacts *3a'–3b'*, and hence, the voltage is removed from the empty signal terminal Q, to diminish the empty signal therefrom. However, as long as the microswitch MS_4 is turned OFF, the solenoid **38** is kept energized. Thus, the feed roller **39** is kept at the position shown by the dotted line in FIG. 1, or away from the copying papers **30**. Such conditions will be referred to as "State 2" hereinafter.

When the cover **43** is closed, the microswitch MS_4 and the relay RY_4 are turned ON, to interrupt the circuit through the solenoid **38**, so that the feed roller **39** is brought into contact with the copying paper **30**, by the clockwise rotation of the arm **35**. At this moment, the microswitch MS_3 is kept ON, while the microswitches MS_1 and MS_2 are kept as turned OFF, so that the driving voltage is applied across the terminals Y'', Y', through the normally open contacts *3a–3b* of the relay RY_3 and the normally closed contacts *1a'–1b'* of the relay RY_1. The windings S_1, S_2 and the capacitor C of the reversible motor **27** are energized, to rotate the reversible motor **27** and other related devices in the direction as represented by the arrows in FIG. 1. Such conditions will be referred to as "State 3" hereinafter.

As a result the uppermost sheet of the copying papers **30** is fed forward by the feed roller **39** into the passageway between the running belts **17**, **18**. When the leading edge of the copying paper **30** reaches the lower end of the suction box **15**, the copying paper **30** is attracted by the suction force through the orifices **13**, to the belt **17**, so that the copying paper may be fed through the passageway by the travelling belt **17**.

If two or more sheets of the copying papers are simultaneously fed by the feed roller **39** between the belts **17**, **18**, both sheets are initially attracted to the belt **17** in the manner described above. The lower sheet will proceed together with the upper sheet for a time, until it is attracted by the holes **14** in the suction box **16**, whereupon the lower sheet is attracted to the belt **18** by the suction force of the air flow through the holes **14** and the weight of the copying paper **30** itself. Since the belt **18** runs in the direction shown by the arrows, the lower sheet of copying paper, upon arrival at the roller **24**, will drop by its own weight and return to the housing rack **32**.

The copying paper **30** now present in said passageway further proceeds and moves the actuator MS_2' to turn on the microswitch MS_2. The solenoid **38** is, thus energized through the normally open contacts *2a'–2b'* of the relay RY_2, which contacts are now closed, so as to move the feed roller **39** away from the stacked copying paper to the dotted line position. The movement of the traveling copying paper is thus not affected by the rotation of the feed roller **39**. While being attracted by the endless belt **17**, the leading edge of the sheet of copying paper enters between the rollers **8** and **9**, which are to rotate in opposite direction while being in contact with each other. The copying paper is then fed at the same speed as the surface speed of the driven roller **9**. The linear speed of the belt **17** is preferably selected to be the same as the surface speed of the roller **9**, but, even if the linear speed of the belt **17** differs slightly from the surface speed of the roller **9**, the copying paper **30** can be fed satisfactorily, as long as the frictional force between the copying paper **30** and the rollers **8**, **9** is greater than the suction force through the perforations **13**.

As the leading edge of the copying paper moves the actuator MS_1' the associated microswitch MS_1 is turned ON, to energize the solenoid **6** by a circuit tracing from the terminal X, through the normally open contacts S_{1a}–S_{1c} of the microswitch MS_1, which is now closed, the normally closed through contacts are *5a–5b* of the relay RY_5, through the winding of the solenoid **6** itself, and to the other terminal X'. Thus, the arms **4** rotate clockwise, to move the idler rollers **8** away from the cooperating driving rollers **9** and to block the passageway between the guide plates **1**, **2**, by projecting the stopper pieces **11** therebetween. At the same time the relay RY_1 is energized to open the normally closed contacts *1a'–1b'*. Thus, the current through the winding S_1 and the capacitor C is interrupted to stop the reversible motor **27** after some rotations by inertia. Thus, the copying paper is held against the belt **17** at the trailing portion thereof while maintaining the leading edge thereof in abutment with the stopper pieces **11**. Such condition will be referred to as the "State 4" hereinafter.

If a feed order signal pulse is applied to the terminal

P under such condition, the copying paper is ready to be fed to the next copying zone. The copying paper feeding device is now in the "ready" position.

(II) COPYING OPERATION

In the aforesaid State 4, the copying paper is ready to be supplied to the copying zone with the leading edge thereof abutting with the stopper pieces **11**, while the microswitches MS_1, MS_2, MS_3, MS_4 are turned ON, the solenoids **6**, **38** are energized, and the relay RY_5 is de-energized.

If a feed order signal pulse is applied to the terminal P in this state, the relay RY_5 is energized to close its normally open contacts *5a–5c* to complete the self-hold circuit, while opening its normally closed contacts *5a–5b*. Accordingly, the solenoid **6** is de-energized, to cause the arms **4** to rotate counter-clockwise for retracting the stopper pieces **11** from the passageway between the guide plates **1** and **2**, so that the copying paper can be fed to the next copying operation. As the trailing edge of the copying paper **30** passes through the actuator MS_2', the microswitch MS_2 is turned OFF. The voltage from the solenoid **38** is blocked by the diode D_2 and no voltage is applied to the terminal Q.

When the trailing edge of the copying paper passes the actuator MS_1', the microswitch MS_1 is turned OFF, to release the self-holding of the relay RY_5 and de-energize the solenoid **38**. Thus, the arm **35** rotates clockwise, so as to bring the feed roller **39** into operative engagement with the copying paper **30** on the housing rack **32**. At the same time, the driving voltage is applied across the terminals Y'', Y', to start the reversible motor **27**. Now the copying paper feeding device is in the aforesaid State 3, and hence, the next sheet of copying paper **30** is fed from the rack **32** toward the passageway, so that the device moves into the State 4.

If a feed order pulse signal is applied to the terminal P during the period of time when the copying paper is proceeding from the State 2 to State 4, the copying paper cannot jump to the next copying process abruptly. However, such application of the feed order signal pulse is harmless, as long as the linear speed of the belt **17** and the surface speed of the feed roller **39** are determined, corresponding to the copying paper feeding speed in the succeeding copying operation.

The operation in the case where the copying papers stacked in the casing are used up during the copying operation, will now be described. Let it be assumed that the last sheet of the copying paper in the rack **32** is taken out and the copying paper feeding device has moved into the aforesaid State 2, then the microswitch MS_2 is turned ON at first, to energize the solenoid **38**, the limit switch MS_1 is turned ON to actuate the solenoid **6**, and the reversible motor **27** stops. At this moment, the only difference in the circuit condition from the preceding case where the copying papers **30** are present on the rack **32** is in that both the microswitch MS_3 and the relay RY_3 are turned OFF and de-energized, respectively. Therefore, upon application of a feed order signal pulse on the terminal P, the copying paper in the discharge means is forwarded to the copying zone, and at the same time the microswitch MS_2 is turned OFF to de-energize the relay RY_2. The circuit conditions become identical with the aforesaid State 1, so that the empty signal is produced at the terminal Q. The empty signal can be used to hold starting of the next copying operation, or to automatically expel the original out of the copying machine, or any other suitable operation for alarming. By following through the aforesaid preparatory operation, the conditions of the State 4 can be achieved, to resume copying.

(III) EXCHANGING OPERATION

Generally speaking, any practical and useful copying machine should be capable of making copies of various dimensions, by using copying papers of different sizes.

In this particular embodiment of the present invention, as illustrated in FIGS. 1 and 2, exchange of the copying papers on the paper holder **32** can be carried out as follows.

Upon opening the cover **43**, the microswitch MS_4 is opened to de-energize the relay RY_4, and the direction of current through the winding S_2 of the reversible motor **27** is changed, with respect to that in the winding S_1 thereof. Thus, the reversible motor **27** begins to rotate in the opposite direction, so as to drive the belt **17** in a direction opposite to the arrow in FIG. 1. Thus, the copying paper held by the belt **17** with its leading edge in contact with the stopper pieces **11** is now retracted. The relation among the operative characteristics and the disposition of the microswitch MS_1, the relative position of the rollers **8**, **9**, and the movement of the belt **17** are such that, the leading edge of the copying paper passes through the gap between the rollers **8** and **9** before the gap is closed by turning OFF the microswitch MS_1 in response to the separation of the leading edge from the actuator MS_1'. After the copying paper reaches the lower end of the belt **17**, or at the roller **21**, the copying paper drops by its own weight onto the rack **32**. Thereafter, the copying papers on the housing rack **32** can be replaced with a stack of copying papers of a different size. Thereby, the circuit conditions of the aforesaid State 2 are established, to allow the copying operation to be effected in the aforesaid manner.

Even when the circuit conditions of the copying paper feeding device are not in the aforesaid State 4, the reversible motor **27** begins to rotate in the opposite direction upon opening of the cover **43**, so as to insure satisfactory replacement of the copying papers on the rack **32**.

As described in the foregoing, with the automatic copying paper feeding device, the copying machine of the present invention can store a stack of copying papers of any desired size and feed the copying papers without fail one sheet at a time responsive to each feed order signal. The salient features of the feeding device are as follows.

(1) Upon closing the cover after placing a stack of sheets of copying paper onto the paper holder, the copying paper feeding device automatically becomes ready for next operation.

(2) Each copying paper taken out of the paper holder is held at a predetermined position, so as to be forwarded to the copying zone from said position in the feeding device responsive to a suitable electric signal. Thus, the relationship of the copying paper to the original to be copied can be accurately controlled in the next copying process.

(3) Even when two or more sheets of the copying papers should be occasionally taken out of the paper holder at a time, only one of them is forwarded through the regular route of feeding while the rest of the sheets are automatically returned to the paper holder.

(4) The presence of the copying paper is checked automatically, and when there is no copying paper available on the paper holder, an empty signal is produced, and the copying paper feeding device is automatically stopped. The empty signal can be used to automatically prevent a subsequent copying operation or to expel the original to be copied out of the copying machine.

(5) The replacement of the copying papers with those of a different size can be easily done, without mixing the two different size papers, because upon opening of the cover, all the copying papers held by the feeding device are automatically returned to the paper holder.

A regulating device for position of the original in the copying machine according to the present invention will now be described, referring to an embodiment as illustrated in FIGS. 3 to 7. In FIG. 3, a transparent cylinder **54** is pivotally supported by a frame wall **51** of the copying machine, so as to rotate around a light source **52** for exposure and a reflector **53**, both secured to the frame wall **51**. Substantially half of the circumference

of the rotary transparent cylinder **54** is in contact with a plurality of endless belts **60**, which are guided by rollers **55**, **56**, **57** and **58**, so as to have a pair of horizontal parallelly running portions **60***a* and **60***b* adjacent to the transparent drum **54**. The roller **55** is driven by a main driving motor (not shown), to turn the endless belts **60** in a direction as shown by arrows in the figure. A spring **62** is provided between the frame wall **51** and the roller **57**, in order to keep the endless belts stretched with tension. The provision of the spring **62** is not, of course, limited to the roller **57**, but it can be provided for any other rollers, e.g. the roller **56** or **58**.

The other half of the circumferencial surface of the transparent drum **54** is engaged with holding wheels **64**. As best shown in FIG. 4, each holding wheel **64** is pivotally supported by an associated holding wheel shaft **63**, which is in turn mounted on a holding member **65** secured to the frame wall **51** by a screw **73**. The holding member **65** has a transversely elongated position adjusting slot **72**, and the screw **73** passing through the slot **72** secures the holding member **65** to the frame wall **51**.

There is provided opposite the guide wheels **58**, associated idle wheels **59** which guide the endless belts **60** therebetween. A guide plate **61** is placed above the horizontal running portion **60***b* of the endless belt **60**, with a suitable spacing therebetween, so that a passageway is formed.

Referring to FIGS. 4 and 5, the position adjusting device for the original is illustrated in more detail which device is used to make fine adjustment of the position of the transparent drum **54** by moving the holding wheels **64** parallel to the horizontal flights **60***a*, **60***b* of the endless belt **60**, in the space between the guide wheels **55** and **58**. The adjustment is made by turning an adjusting nut **68**, which threadably engages a threaded shaft **71**, the shaft being carried by a U-shaped adjusting shaft holder **66**. The adjusting shaft holder **66** is secured to the frame wall **51**, and each leg thereof has a notch **67**, as shown in the figures. The ends of adjusting shaft **71** are respectively held in the notches **67**, so that the shaft **71** is neither rotatable nor movable relative to the adjusting shaft holder **66**. The adjusting screw **68** is mounted at about the longitudinal mid-point of the adjusting shaft **71**, so that as the adjusting screw **68** is rotated, the adjusting screw **68** can move relative to the adjusting shaft **71**. The adjusting nut **68** is connected to the holding member **65** through a connector **70** which is inserted between the bent-portion or leg **69** of the U-shaped plate **65** and the adjusting screw **68** itself. The leg **69** is always urged against the adjusting nut **68** by means of the spring **62** (FIG. 3).

Referring to FIGS. 3, 6 and **7**, the second position regulating device for copying papers shall be explained together with its associated elements. A perforated cylinder **77** having fine holes **74** formed in the circumferential wall thereof is also rotatably mounted on the frame wall **51** of the copying machine, substantially in parallel with the transparent cylinder **54**. A sealing member **76** is disposed on the light source side of the perforated drum **77**, by securing one end thereof to a sealing member holder **75**, while leaving the opposite end thereof free. The sealing member **76** is made of flexible material and its light source side surface is adapted to reflect the light therefrom. One end **78** of the perforated drum **77** passes through a duct with a drafting means or suction means (not shown), so as to attract the sealing member **76** to the perforated drum **77** by air flow through the orifices **74** over the surface of the drum **77**.

A scraper **79** is disposed between the transparent drum **54** and the perforated drum **77**. One end of the scraper **79** is resiliently urged against the transparent cylinder **54**, while the opposite end thereof is brought in the proximity of the perforated drum **77**.

A driving wheel **80**, to be driven in one direction by a motor (not shown), is integrally mounted on one end of the perforated drum **77**, as best seen in FIG. 6. An end disk having an opening **78** is mounted on the opposite end of the perforated drum **77** so as to be sealingly connected with said duct for suction. Said perforated drum **77** is made of electrically insulating material, such as plastics, or sheet metal coated with insulating compound, such as aluminum plate covered with aluminum oxide film and iron sheet with plastic coating. An annular groove **82** is formed on the peripheral surface of the perforated dum **77** approximately at the longitudinal center thereof so as to have an electrically conductive ring **81** embeded therein.

The second position regulating device for detecting the position of the original travelling in the copying machine and for producing a signal ordering copying paper comprises, in addition to said perforated drum **77**, the following cooperative members. Collector rollers **84** are rotatably mounted an electrically conductive resilient holder **83** to be urged against the conductor ring **81** embedded around the perforated drum **77**. Lead wires **104** are respectively connected to the collector rollers **84** for a purpose to be explain hereinafter. The collector roller holder **83** is supported by a support arm **85** in such a way that the position thereof may be adjusted, which support arm is made of electrically insulating material or metallic material with insulating material inserted between the holder **83** and the arm **85**. In other words, the support arm **85** is electrically insulated from the lead wires **104** and from the perforated drum **77** so that electrical current to be supplied through the lead wires **104** is interrupted while the copying paper, which is of electrically insulating property, is passing between said drum **77** and the collector rollers **84**.

The support arm **85** is also provided with a speed control dial **86** of the copying machine driving motor, as shown in FIG. 7. The support arm **85** is secured to a shaft **92**, which adapted to rotate through a small angle in response to rotation of the speed control dial **86**. The dial **86** is coupled to a shaft **87** which carries, a pulley **88**. Another pulley **91** is secured to the driven shaft **92**, and a flexible and inextensible endless belt **89** extends between the pulleys **88** and **91** through an intermediate guide pulley **90**. In the particular embodiment, as illustrated in FIG. 7, the shaft **92** is adapted to move the support arm **85** clockwise in response to an increase in the operative speed by turning the speed control dial **86** in one direction and counterclockwise response to speed reduction by turning the dial **86** in the other direction. The collector rollers **84** move up and down in response to the clockwise and the counterclockwise movement of the support arm **85**, respectively. The mechanical connection between the speed control dial **86** and the support arm **85** is not limited to the aforesaid combination of the pulleys and belts, but it can be accomplished by an other suitable means, such as linkage, cam and followers, gearings, etc.

A movable scraper **94** to control feeding of the original is pivotally supported by a pin **93** secured to the frame wall **51**, so as to extend over the collector rollers **84** (FIG. 3). The scraper is biased counterclockwise in FIG. 3 by a suitable means, such as a spring (not shown) so as to urge the free end of the scraper **94** against the perforated drum **77**. The opposite end of the scraper **94** is connected to a solenoid **96** through a link **95**. The scraper is adapted to be pulled by the solenoid **96** upon actuation thereof to assume the position shown by the broken line in FIG. 3. On the other hand, as long as the solenoid **96** is not energized, the scraper **94** is in contact with the perforated drum **77**, whereby the feeding of the original is controlled depending on the desired number of copies to be made.

Furthermore there are preferably provided means for guiding the travel of the original and the copying papers; original expelling means; treated copying paper feeder adapted to discharge the copying paper after copying

treatment; electric control means to control the entire original position regulating device. More particularly, the original guide means includes a shutter means (not shown) to control the insertion of the original, a pair of guide plates **97, 98** for guiding the original during the initial insertion or introduction, and a pair of second guide plates **100, 101** for guiding the original during the repeated copying operation. The second guide plate has a scraper **99** formed at the upper end thereof so as to be kept in contact with the perforated drum **77** and the lower end thereof disposed adjacent to the horizontal guide plate **61**. The copying papers guiding means includes a pair of guide plates **102, 103**, to receive the copying paper, from the copying paper feeding device. The exposed copying paper guiding means includes a transfer means which serves to separate the treated copying paper from the original laminated thereto and to transfer the thus separated copying paper toward the subsequent operation zone.

The operation of the position regulating device of the aforesaid construction will now be described. When a main power source switch (not shown) is turned ON, the light source **52**, a driving motor (not shown), and a fan for suction (not shown) are actuated. At the same time the passageway between the guide plates **97, 98** is blocked by a shutter means (not shown), and a sheet of the copying paper is brought to a predetermined ready position and held thereby the stopper pieces in the copying paper feeding device as described in the foregoing referring to FIGS. 1 and 2. A sheet of original is inserted into the original guide means so that the leading edge of the original moves the shutter member. The desired number of copies to be taken from the original is set on a counter (not shown). Then, the start switch is turned ON.

Under such conditions, the solenoid **96** is actuated, to turn the scraper **94** clockwise to the position shown by a dotted line in FIG. 3. At the same time, the shutter of the original guide passageway and the stopper pieces of the copying paper feeding device are released, so that the original and the copying paper proceed through the passageway between the guide plates **97, 98** and another passageway between the guide plates **102** and **103**. The original is automatically overlaid and registered on the copying paper, as the two passageways merge into a common passageway leading to the endless belt **60**. The thus registered original and copying paper are fed by the rollers **58, 59** onto the horizontally running portion **60***b* of the endless belt **60**, and further to the copying zone or the radiation portion of the transparent cylinder **54** to be exposed.

When the original is fed to the perforated drum **77**, it is attracted to the periphery of the cylinder **77** by suction force of the air flow through the orifices **74**, so that the original moves into contact between the conductor ring **81** and the collector rings **84**. On the other hand, the exposed copying paper is forwarded to the succeeding operation by the exposed copying paper feeder.

As the trailing edge of the original passes through the shutter means, the original passageway is blocked again by the shutter means, while as the trailing edge of the copying paper passes through the stopper pieces **11**, a succeeding copying paper is automatically brought to the predetermined positions and held there by the stopper pieces.

When the contact between the conductor ring **81** and the collector rollers **84** is broken by the original passing there, the current through the lead wires **104** is interrupted. This current interruption can be used as a pulse signal for releasing the stopper pieces **11**, by any conventional means obvious for those skilled in the art. Thus, the succeeding copying paper proceeds through the passageway between the guide plates **102** and **103**. Simultaneously, the original enters the passageway defined by the guide plates **100** and **101**, and it is automatically overlaid and registered on the copying paper and fed onto the endless belt **60**, in the manner similar to the first copying operation as described in the foregoing.

When the number of copying papers passing through the stopper pieces **11** amounts to the predetermined number of copies, which has been programmed into the counter, the solenoid **96** is de-energized responsive to the passage of the original through the contact between the foil conductor **81** and the collector rollers **84**, whereby the movable scraper **94** is turned counterclockwise to the position as depicted by the solid line in FIG. 3. As the original is fed to the perforated drum **77** next time, it is guided by the thus turned scraper **94**, so as to be expelled to a certain outlet position by the original expelling means against the suction force over the drum **77**.

The production of the desired number of copies from the single original can be automatically carried out in the aforesaid manner. In order to correctly register the original, repeatedly brought to the copying zone or the exposing portion, with each copying delivered from the copying paper feeding device, however, at least the following four conditions should be satisfied.

(a) When the original is introduced into the copying machine, the position of the leading edge of the original should be in a proper position with the leading edge of the first copying paper, which is going to be delivered out of the copying paper feeding device.

(b) When the original is moving into the passageway between the guide members **97** and **98**, the side edges in the feeding direction (to be referred to as "both sides") should be in a proper position relative to the corresponding both sides of the copying paper being delivered from the copying paper feeding device.

(c) When the original is repeatedly fed into the copying zone, the position of the original should not deviated from that in the first copying operation.

(d) Each time the original is fed to the copying zone, the copying paper should be delivered from the copying paper feeding device in a correct relationship with the original, with respect to the position thereof.

Among the aforesaid four conditions, (a) and (b) are related to the first copying operation and can be achieved easily, while the conditions (c) and (d) related to the second and subsequent copying operations are not easily satisfied. However, for successful production of a plurality of copies in an automatic and continuous manner, all the four conditions must be strictly satisfied.

The first and second position regulating devices of the present invention as referred to intend to satisfy the conditions (c) and (d).

As regards the condition (c), travelling distances of the original at the both sides thereof, which correspond respectively to the total spans at the both sides starting from the contact between the rollers **58, 59** and extending along the half of the circumference of the transparent cylinder **54**, the guide plate **79**, the upper half of the perforated drum **77**, and the passageway between the guide plates **100, 101**, and back to the rollers **58, 59**, should be exactly equal. Such distances of the original travel can be controlled by the first position regulating device as illustrated in FIGS. 4 and 5, whereby the position of the holding wheels **64** is finally moved without affecting other conditions of the copying machine. More particularly, the travel distance of either side can be adjusted by loosening the screw **73** (FIG. 4), which secures the holding plate **65** to the frame wall **51** of the copying machine, and turning the adjusting nut **68** so as to move the transparent drum **54** in the desired direction by a necessary distance, and upon completion of the adjustment, tightening the screw **73** again to secure the holding plate **65** to the frame wall **51** at the thus adjusted position. It has been ascertained by experiments that the travel distances of the original at both sides can be so adjusted as to eliminate the deviation of the actual position of the original from the desired position during the considerably many repeated copying operations.

As regards the condition (d), the timing of the feed order signal, for starting to feed the copying paper from the copying paper feeding device, should be selected correctly corresponding to the movement of the orignal through the aforesaid route. In other words, such timing can be successfully controlled by applying the feed order signal to the copying paper feeding device when the original passes through the contact between the conductor ring **81** and the collector rollers **84** to interrupt the current though the lead wires **104** so as to provide a suitable feeding interval. Upon receiving the signal, the stopper pieces **11** in the feeding device are released to allow the further movement of the copying paper toward the copying zone. However, there is inevitably a time delay between the application of the feed order signal to the feeding device and the actual start of the copying paper movement, due to various mechanical inertias in the feeding device. During such delay time period, the original travels over a certain distance, which can be represented by $\Delta 1$. The magnitude of $\Delta 1$ is, in general, proportional to the travelling speed of the original. Accordingly, an error due to such time delay can be corrected or compensated for, by adjusting the contact position between the conductor ring **81** and the collector rollers **84**. More specifically, referring to FIG. 7, the angular position of the support arm **85** which holds the collector rollers **84** can be changed by setting the dial **86** to the travelling speed of the original. Such setting is transmitted through the pulley **88** secured to the shaft **87** of the dial **86**, the other pulley **91** secured to the shaft **92** of the support arm **85**, and a belt **89** extending between the pulleys **88** and **91**. In other words, when the original travels fast, the support arm **85** is turned clockwise to raise the collector rollers **84**, so that the feed order signal can be generated slightly earlier to compensate for the aforesaid $\Delta 1$ for this fast travel of the original. It is apparent that similar compensation can be made for slow movement of the original. Thus, the position of the copying paper for each copying operation can be maintained properly, relative to the movement of the original.

As described in the foregoing, according to the present invention, the original is always registered properly with the copying paper for each of the repeated copying operations by using the travel distance adjusting means, to keep travelling distances of the original at both sides substantially equal; and each other, and the detecting means for position of the original to adjust the timing of copying paper feeding responsive to the travelling speed of the original. The copying machine according to the present invention, thus, can attain following advantages.

(1) The original can be registered correctly with each of the copying papers for each copying operation for producing a plurality of copies from a single original. The adjustment of the travel distances can be made simply by carring out fine adjustment of the transparent drum position by manually turning the adjusting screw, without adversely affecting the function of other portions of the copying machine. Thus, it has become unnecessary to manufacture the parts of the copying machine very accurately and to assemble the parts with excessive care. Therefore, the copying machine can be manufactured easily and a lower cost.

(2) The registration of the original with the copying paper is not affected by the difference in the travelling speed of the original, because the timing of the start of the copying paper feeding is adjusted automatically in response to the travelling speed of the original, by using the setting on the speed control dial. Thus, very accurate registration of the original and the copying paper can be insured.

(3) The deviation of the position of the copying paper relative to the original can be minimized for repeated and many copying operations, by using the special copying paper feeding device. Thus, considerably many copies can be satisfiably produced.

Although the present invention has been described with a certain degree of particularity, it should be understood that the above illustration has been made only by way of example and that various changes and modifications in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A copying machine for automatically producing a plurality of copies from a single original repeatedly brought into the copying operation zone, which includes a copying paper feeding device comprising a rack means for housing a stack of copying papers, a first feeding means adapted to intermittently contact with the uppermost sheet of copying paper of the stack so as to frictionally feed the copying papers one by one upwardly and at an angle, a second feeding means having a pair of suction box and running endless belt assemblies and located diagonally above said rack means so that when two or more sheets of copying paper are occasionally supplied between said two assemblies one of said assemblies feeds only one sheet while the other one of said assemblies separates the remainder of the copying paper from said one sheet and returns it to said rack means by gravity, discharging means located diagonally from said second feeding means so as to receive each sheet of copying paper therefrom and hold same there for discharging same to be fed to the copying zone upon receiving each signal; a rotatably mounted drum, said copying zone being defined by the space between one-half of the circumferential surface of said drum and a running endless belt extended around a plurality of rollers; means for regulating the position of the original and adapted to finely and horizontally shift one end of said drum so as to equalize distances traversed by both sides of the original; means for detecting the position of the original and including a drum made of electrically insulating material and having an electrically conductive ring embedded around the circumferential surface thereof, and two electrically conductive members insulated from each other but normally in contact with said conductive ring so as to produce a pulse signal when the travelling original interrupts contact between said two conductive members and said conductive ring for actuating said discharging means of said copying paper feeding device to release the sheet of copying paper; a position regulating means for moving said conductive members relative to said conductive ring so that the time delay between application of said signal to the copying paper feeding device and actual start of movement of the copying paper is compensated for; and guide means for allowing the original to repeatedly travel around said two drums.

2. A copying machine as set forth in claim **1**, in which said first feeding means comprises an arm lever pivotally mounted on the machine frame and having a frictional roller rotatably mounted at the free end thereof, a spring means for urging said roller to contact the uppermost copying paper in the stack to forcingly feed said copying paper upwardly when driven, and a solenoid for moving said arm lever against the force of said spring means so as to disengage said frictional roller from the copying paper when energized.

3. A copying machine as set forth in claim **2**, in which said second feeding means comprises a pair of endless belts respectively extending around a plurality of rollers so as to produce a diagonal passageway for feeding the copying paper between the oppositely arranged running portions thereof, a pair of suction boxes respectively arranged behind said oppositely running portions of the endless belts and formed with perforations in the respective opposite surface walls thereof so that when the leading edge of the copying paper supplied from said first feeding means arrives at the inlet of said passageway one of said suction boxes attracts and forwards said copying paper with the

aid of the associated belt while the other suction box attracts excess copying papers for separation thereof from said first copying paper and expels same with the aid of the associated running belt from the passageway toward said rack means, and a microswitch provided at said passageway so as to energize said solenoid of said first feeding means when the leading edge of the entering copying paper engages with an actuator thereof to move said first feeding means away from the stacked copying papers on said rack means.

4. A copying machine as set forth in claim 3, in which said discharge means comprises a pair of plate members for producing a passageway therebetween for feeding the copying paper, a pair of rollers oppositely arranged at the inlet of said passageway, one of said rollers being forcedly driven while the other is freely rotatably mounted on a pivotally mounted arm so as to normally contact said freely rotatable roller with said driven roller with the aid of a spring means, said arm having a stopper at the free end thereof, a solenoid for moving said arm when energized to disengage said freely rotatable roller from said driven roller and bring said stopper into said passageway for blocking the same, and a microswitch provided approximately at the outlet of said passageway so as to energize said solenoid when the leading edge of the copying paper engages with an actuator of said microswitch.

5. A copying machine as set forth in claim 3, in which said rack means comprises a casing adapted to house a stack of copying papers and positioned so as to be inclined, the lower end wall of said casing being adapted to move along the casing bottom wall so that the leading edge of the copying papers housed in a stack in said casing may always occupy the same position regardless of the size of the copying paper, and a microswitch provided approximately at the upper end of said casing so that the distance therefrom to the trailing edge of the copying paper stacked in the casing is substantially longer than the distance between the leading edge of said copying paper and said microswitch of said second feeding device, whereby opening a cover member for access to the casing for exchanging the copying papers present in said feeding means with sheets of copying paper of a different size, said last-mentioned microswitch reversely driving a main motor with aid of a microswitch provided at said cover to expel all copying papers present in various portions of said feeding device back to said casing and when the last copying paper has passed over said last-mentioned microswitch of the casing with said cover member kept closed an alarm signal is produced for informing absence of the copying paper stock.

6. A copying-paper machine as set forth in claim 1, in which said means for regulating the position of the original comprises a holder member for supporting one end of said copying operation drum so as to freely rotate with the half circumferential surface thereof which contacts said running endless belt, an externally threaded rod journalled into flanges integral with a frame for said copying machine, and a notched nut screwed on said rod and abutting with said holder member so that rotation thereof may cause fine shift of said nut relative to said rod and consequently the machine frame so that said holder member abutting with said nut may be accordingly shifted for causing fine horizontal movement of the copying operation drum.

7. A copying machine as set forth in claim 1, in which said further position regulating means comprises a dial disk and mechanical connecting means for transmitting turning movement of said dial disk to said conductive members so as to be finely moved circumferentially relative to said perforated suction drum while resting on said conductive ring.

References Cited

UNITED STATES PATENTS

2,941,653 6/1960 Kriemelmeyer ..... 198—31

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271—64; 355—102

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,528,739 Dated Sept. 15, 1970

Inventor(s) Koji Noda

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 1, after "the", first occurrence, should be --uppermost--. Column 4, line 52, after "circuit" should be --for regulating the operation of the copying--; lines 52-53, delete "further comprises a pair of diodes D_1 and ing"; line 71, delete "for regulating the operation of the copy-" after "circuit" and insert --further comprises a pair of diodes D_1 and--. Column 6, lines 59-60, after "which" delete "is now closed, the normally closed through contacts are" and insert --contacts are now closed, through the normally closed contact--. Column 10, line 13, "embeded" should be --embedded--; line 19, before "an" should be --on--; line 23, "explain" should be --explained--; line 48, before "response" should be --in--; line 55, "an" should be --any--. Column 12, line 19, after "copying" should be --paper--; line 34, "deviated" should be --deviate--. Column 13, line 4, "orignal" should be --original--; line 10, "though" should be --through--; line 46, "; and" should be --to--; line 62, after "and" should be --at--.

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(SEAL)
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Edward M. Fletcher, Jr.
Attesting Officer

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