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PAPER FEEDING DEVICE FOR COPYING MACHINES

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Fig. 1.

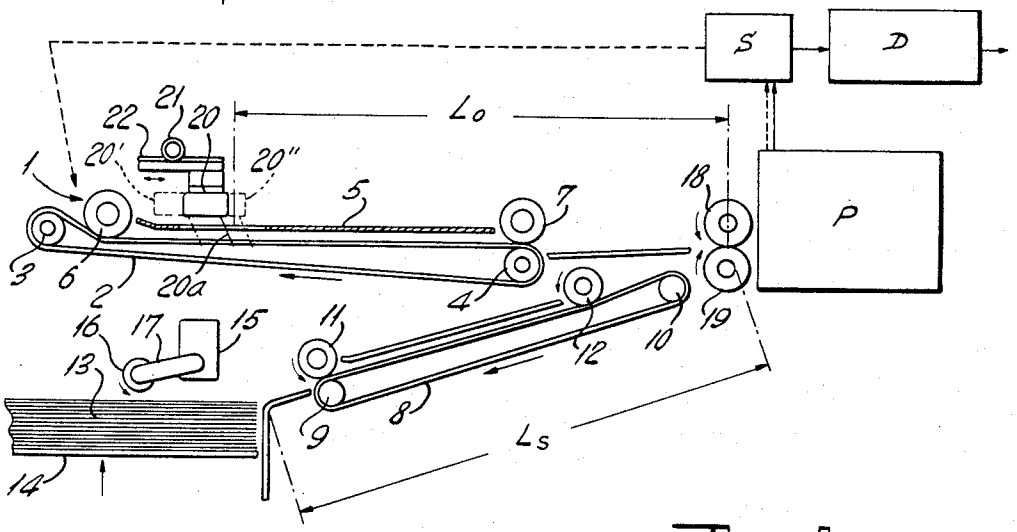


Fig. 2.

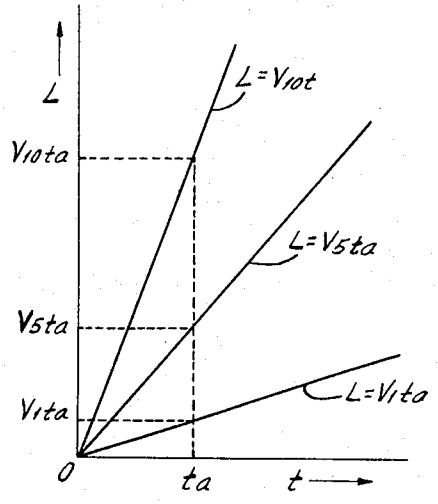
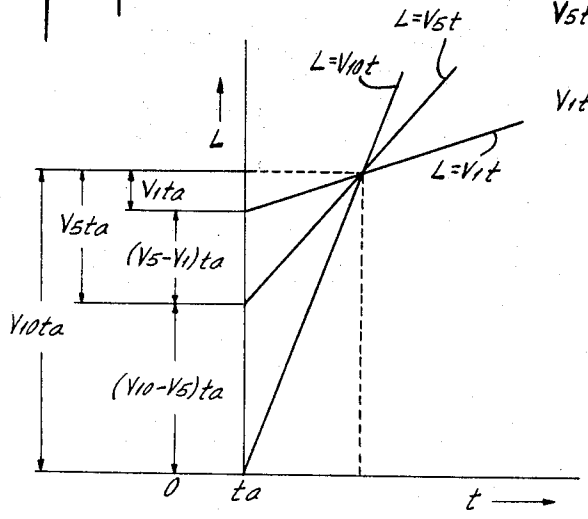


Fig. 3.



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PAPER FEEDING DEVICE FOR COPYING MACHINES

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ABSTRACT OF THE DISCLOSURE

In a copying machine, feed means for sensitized paper adapted to adjust the speed of advance of said paper in relation to the original sheet to insure continued alignment of said sheets as they progress through the machine.

This invention relates to a copying machine of the type in which an original document is automatically superimposed on a sheet of sensitized paper and the combined sheets are then fed into an exposure device. More particularly, the invention relates to a copying machine adapted to receive the original document, automatically remove a sheet of sensitized paper from a storage stack, superimposed the original document on the sensitized sheet in a predetermined position relative thereto, and advance the combined document and sensitized sheet into an exposure device at a pre-selected advance rate. The invention relates to the feed mechanism for the type of machine described above, and more particularly to the sensing element which initiates the advance of the sensitized sheet.

It is an object of the invention to avoid variations in the relative positions of the original document and the sensitive sheet as they enter the exposure device, where such variations might otherwise occur as the result of variations of the advance rate from one machine cycle to the next.

Further objects of the invention will be apparent from the following description, in which:

FIG. 1 shows a schematic side view of a feed device embodying the invention, and

FIG. 2 and FIG. 3 are graphs illustrating relationships between the position of an original document within the feed device and the time of activation of the sensitized paper advancing mechanism.

Referring to FIG. 1, an insertion mouth **1** is shown adapted to receive the leading edge of an original document (the "original" hereafter). An original so inserted is received on conveyor belt **2** which is driven in the direction of the arrow by the rollers **3** and **4**. A guide plate **5** is provided above, and parallel with, the conveyor belt **2**. An original feed roller **6** and a feed-out roller **7** cooperate with conveyor belt **2** and rollers **3** and **4** to advance the original through the machine.

Beneath the structure just described there is located a device for advancing a sheet of sensitized paper, comprising an endless conveyor belt **8** driven by rollers **9** and **10** in the direction of the arrow. Rollers **11** and **12** are driven by contact with conveyor belt **8** in the direction of the arrows. A guide plate extends between these rollers above

the belt surface. A stack of sensitized paper **13** is held within the machine, supported on a perpendicularly movable sensitized paper support platform **14**. A sensitized paper feeding device **15** of a type well known in the art comprises a rotatable feed-out roller **16**, mounted on a supporting arm **17**. The feeding device is activated by an electric signal from a microswitch **20** which is located above the conveyor belt **2** and has a sensing wire **20***a* projecting into the path of the original through a hole in guide plate **5**. When the leading edge of the original strikes the sensing wire, the microswitch is closed and a signal transmitted. Activation of feeding device **15** results in rotation of the feed-out roller **16** which drives the top sheet of sensitized paper **13** into the bight between roller **11** and conveyor belt **8**.

With both conveyors in operation the sensitized paper and the original are fed along converging paths into the bight between the guide rollers **18** and **19**, where the original is superimposed on the sensitized paper. Rotation of the guide rollers as shown by the arrows feeds the combined original and sheet of sensitized paper into an exposure device P from which they may pass to an automatic separating device S. Here the sensitized paper is separated from the original and is fed to a developing section D where it is developed and discharged from the machine. The original may also be discharged or, as an alternative, returned for a second cycle by mechanism not shown to the insertion mouth **1**, as indicated by a dashed line.

It is desirable in machines of the type described to provide for means to vary the rate of advance of the sensitized paper and the superimposed original into the exposure device P. Such variations may be required in order to match the exposure time to the characteristics of the original or of the sensitized paper, for example. Since both the original and the sensitized paper must advance between guide rollers **18** and **19**, in synchronism, one way to achieve variations in the advance rate is to vary equally the rate of roller **16**, conveyor belts **2** and **8**, and the various other guide rollers. It has been found, however, that an adjustment producing equal variations in the rates of these components will not always result in a desired superimposition of the original on the sensitized paper at the new rate of advance. In other words, if, for example, a desired superimposition is achieved when the advance rate has a certain value, and that value is doubled by doubling the speed of the rollers and conveyor belts, it will usually be found that the desired superimposition no longer takes place. Instead, the original will reach the guide rollers **18** and **19** too far in advance of the sheet of sensitized paper.

The cause of the misalinement mentioned above is as follows: There is a fixed delay between the time that the leading edge of the original activates the microswitch **20** and the time that the uppermost sheet of sensitized paper begins to move from stack **13** at the selected advance rate. The delay is the result of the inability of components such as feeding device **15** and roller **16**, instantaneously to reach operating position and a steady speed. In a machine in which the guide rollers and conveyor belts always operate at a fixed speed, this fixed delay can be compensated for by properly positioning the microswitch **20**. For example, suppose it is desired

that the leading edges of both the original and the sensitized paper coincide as they pass through guide rolls **18** and **19**. With both conveyor belts travelling at the desired fixed speed, it is only necessary to position microswitch **20** so that the time required for the leading edge of the original to travel from the sensing wire **20***a* to the bight of guide rolls **18** and **19** equals the sum of the delay time of feeding device **15** and the time required for the leading edge of the sensitive paper to move from stack **13** to the bight of these rolls.

If, however, the speed of the conveyor belts is to be made variable, there is no single position at which the microswitch **20** can be placed which will result in proper superimposition of the original on the sensitive paper at all speeds. This may be shown by examining the operation of the machine at various speeds. Referring to FIG. 2, let L represent the distance which the original travels after the microswitch **20** is activated by its leading edge; let t denote the time after the microswitch **20** is activated; let t_a be the delay time lapse between the instant when the microswitch **20** is activated and the instant when the sheet of sensitized paper begins moving at the selected advance rate; and let v_1, v_5, and v_{10}, respectively, represent the lowest, an intermediate, and the highest velocities at which the original and the sensitized paper are to be transported. If the microswitch sensing wire **20***a* is located at a distance L_o such that the leading edges of both the original and the sensitized paper coincide upon entering the bight of guide rolls **18** and **19**, when the speed of the belts is v_5, then $L_o=v_5t_a+L_s$ where L_s is the distance which the leading edge of the sensitized paper must travel to reach guide rolls **18** and **19**. If L_o and L_s remain fixed in accordance with the expression just given, but the speed of the belts and rollers is increased to v_{10}, then the original will reach guide rolls **18** and **19** before the sensitized paper, and the leading edge of the original will be a distance D_{10} ahead of the leading edge of the sensitized paper, where $D_{10}=(v_{10}-v_5)t_a$. It can be shown that if the speed of the belts and rolls is reduced to v_1 under the same conditions, then the sensitized paper will reach the guide rolls **18** and **19** first, the leading edge thereof preceding the leading edge of the original by an amount D_1 where $D_1=(v_5-v_1)t_a$.

The undesirable overlaps D_{10} and D_1 may be eliminated by means of a movable mount for microswitch **20**. As shown, this comprises a rack **22** movable toward and away from guide rolls **18** and **19** and a pinion **21** having a fixed axis and meshed with the rack. The microswitch is mounted on the rack and moves therewith. If the distance L_o from the microswitch sensing wire **20***a* is set so that the edges coincide when the speed equals v_5 (i.e., $L_o=v_5t_a+L_s$), then the microswitch will be in the position shown in solid lines in FIG. 1. If the belt and roller speed is increased to v_{10}, then the microswitch is moved by rack **22** away from guide rolls **18** and **19** to the position **20'** (shown in dashed lines), so that the distance from the microswitch sensing element **20***a* to guide rolls **18** and **19** is equal to the expression

$$L_o+(v_{10}-v_5)t_a$$

If the speed v_1 is employed, the rack moves the microswitch closer to the guide rollers **18** and **19** so that the distance between them is equal to the expression

$$L_o-(v_5-v_1)t_a$$

The adjustments of the microswitch position described may be made by linking pinion **21** to the controls which set the speed of the belts, so that a manual adjustment of the belt speed control automatically adjusts the microswitch. Such adjustments will cancel out the undesirable mismatching otherwise caused by variations in the feed rate. For example, pinion **21** may be splined to rotatable shaft bearing an exposure dial (not shown) and connected to any one of various well known speed control devices (also not shown) in order to regulate the output speed of such control device. A suitable speed control might be a cone drive. Turning pinion **21** in such a direction as to move the microswitch **20** away from guide rollers **18** and **19** would increase the output speed of the cone drive.

Referring to FIG. 3, it can be seen that if a desired overlap (or no overlap if that is desired) occurs when advance rate v_5 is employed, then the same overlap may be had if advance rate v_{10} is employed if the microswitch is moved away from guide rollers **18** and **19** by an amount $(v_{10}-v_5)t_a$. A line with slope equal to v_{10} when plotted with distance along the vertical axis and time along the horizontal axis strikes the vertical axis at a given point, which has been made the origin in FIG. 3. If the point on this line (the line being indicated by "$L=v_{10}t$") at t_a is ascertained, and a second line (indicated as "$L=v_5t$") with slope v_5 is drawn through said point, it will strike the vertical axis at a point which is a distance $(v_{10}-v_5)t_a$ above the origin. Moving the microswitch away from guide rollers **18** and **19** by this distance will compensate for the speed change from v_5 to v_{10} and will maintain the same overlap at advance rate v_{10} as at v_5. If a line having slope v_1 is drawn through the point on line "$L=v_{10}t$" it will strike the vertical axis at a point above the point where the line "$L=v_5t$" strikes said axis. The distance between said points of intersection with the vertical axis is $(v_5-v_1)t_a$ and if the microswitch is advanced this amount toward the guide rollers **18** and **19** when the advance rate is decreased from v_5 to v_1, the desired overlap will be maintained.

It will be realized that in the event that it is desired to feed the original and the sensitized paper into guide rolls **18** and **19** with their leading edges out of register by a fixed amount which remains independent of the rate of advance, this can also be accomplished by a suitable choice of the dimensions L_o and L_s. Such an out-of-register adjustment may be desirable in order to allow automatic separator S to pull the sheets apart after exposure in exposure device P. Once the desired out-of-register overlap has been established for feed velocity, v_5, for example, further adjustments of the position of microswitch **20** by the rack and pinion in response to velocity changes (as to v_{10}, for example) will maintain the desired overlap. Thus the arrangement shown is equally applicable to a machine in which the leading edge of the sensitized paper precedes (or follows) that of the document through the exposure device by a fixed amount. Subsequent speed adjustments will not vary the desired overlap.

It will be recognized that structural variations may be employed to practice the invention disclosed. For example, a cam-and-follower may be substituted for the rack and pinions as a means of moving microswitch **20**, the cam being mounted on the speed control shaft. Alternatively, instead of microswitch **20**, a movable photoelectric cell may be employed to sense the position of the leading edge of the original and initiate feeding of the sensitized paper, Finally, instead of employing a single, movable microswitch a plurality of fixed microswitches located at varying distances from the guide rollers **18** and **19** may be employed. In such a structure the belt speed control is coupled with a multiposition switch which connects the feed device to the particular microswitch which is properly distant from the guide rollers for the particular speed selected. The microswitch **20** for speed v_5 would be at a position indicated in solid lines in FIG. 1, that for speed v_{10} at position **20'** and that for speed v_1 at position **20''**. The multiposition switch may be a rotary one mounted on a speed control shaft.

In view of the possibility of using a plurality of fixed microswitches as just described, the term "effective position of the sensing means" is used herein to designate the position of that sensing means which responds to the presence of the leading edge of the original. The phrase "varying the effective position of the sensing means" is

used to refer not only to the step of moving a single microswitch where a single microswitch is used, but also to the step of disconnecting the second sensitized paper feeding device from one microswitch and connecting it to a second microswitch placed at a different distance from guide rolls **18** and **19**, when a plurality of microswitches are used.

The following is claimed:

1. In a feeding device having first means for advancing during a feeding cycle a first piece of sheet material having a leading edge at a selected rate of advance along a first path; sensing means for sensing the presence of the leading edge of the first piece of sheet material at a measuring point along the first path when said first piece of sheet material is in the first path and for generating a signal in response to said presence at said measuring point; second means for advancing a second piece of sheet material having a leading edge at the selected rate of advance along a second path in response to the signal generated by the sensing means, the operation of said second means being characterized by a substantially constant delay period between the generation of the signal by the sensing means and the starting of the advance of the second piece of sheet material at the selected rate of advance; and speed control means for changing the selected rate of advance between successive feeding cycles of the feeding device; the improvement comprising position selection means for varying the effective position of the sensing means and thereby varying the position of the measuring point along the first path and connecting means linking the speed control means and the position selection means for causing the position selection means to vary the effective position of the sensing means and thus to move the measuring point along the first path in the direction of travel of the first piece of sheet material when the speed control means is operated to decrease the rate of advance of said first piece of sheet material and for causing the position selection means to move the fixed point along the first path in a direction opposite to the direction of travel of the first piece of sheet material when the speed controls means is operated to increase the rate of advance of said first piece of sheet material.

2. The device of claim **1** wherein the position selection means comprises means for moving the effective position of the sensing means in a direction opposite to the direction of movement of the first piece of sheet material when the advance rate of said first piece of sheet material is increased, said movement of the effective position of the sensing means being equal to the product of the substantially constant delay period and the difference between the new advance rate and the old advance rate.

3. An improvement in a copying machine, said copying machine having means for feeding an original at a desired advance rate along a first path, means for changing the advance rate from one cycle of the machine to the next, removal means for removing a sensitized sheet of paper from a storage container and feeding it at the advance rate along a second path converging with the first path, said removal means being activated by a signal and said removal means being characterized by a substantially constant delay period from the time that the signal is received to the time that the sensitized sheet of paper begins traveling along the second path at the desired advance rate, said improvement comprising a sensing means for generating the signal when a selected portion of the original reaches a measuring point in the first path and connecting means for cooperating with the means for changing the advance rate and with the sensing means to move the effective position of the sensing means, and thus of the measuring point, in a direction opposite to the direction of advance of the original when the rate of advance is increased and in the same direction as the original when the rate of advance is decreased.

4. A copying machine comprising a first conveyor belt adapted to carry an original having a leading edge at a selected rate of advance in an advancing direction; a sensing device in the path of an original being carried on the first conveyor belt and adapted to sense the leading edge of the original as said leading edge reaches a measuring point, said sensing device being adapted to originate a signal when it senses the leading edge; a storage device adapted to hold a plurality of sheets of sensitized paper; a feeding device connected to the sensing device and adapted, upon receipt of a signal from the sensing device, to feed a sheet of sensitized paper from the storage device to a second conveyor belt; a second conveyor belt adapted to receive a sheet of sensitized paper from the feeding device and to carry said sheet at the selected rate of advance; a speed control connected to the conveyor belts and adapted to change the rate of advance from one machine cycle to the next; and a position selector coupled both to the speed control and to the sensing device and adapted to change the effective position of the sensing device and thus the measuring point in accordance with changes in the rate of advance.

5. The device of claim **4** wherein the feeding device is characterized by a substantially constant delay period between the time when the signal is received and the time when the feeding device feeds a sheet of sensitized paper to the second conveyor belt and wherein when the rate of advance is increased, the position selector changes the position of the measuring point in a direction opposite to the advancing direction by an amount equal to the product of the delay period and the difference between the old rate of advance and the new rate of advance.

6. The device of claim **5** where the position selector comprises a rack on which the sensing device is mounted, said rack being movable to and fro in the direction of travel of the original, and a pinion meshed with the rack and connected to the speed control for rotation in response to those adjustments of the speed control which vary the rate of advance, said pinion, when rotated, effecting motion of the rack.

7. The device of claim **5** wherein the position selector comprises a cam follower on which the sensing device is mounted and a cam in driving relation to the cam follower, said cam being connected to the speed control for rotation in response to adjustments of the speed control which vary the rate of advance.

8. The device of claim **5** wherein the sensing device comprises a plurality of sensing elements, each of which is adapted to sense the leading edge of the original at a different position during its advance and to generate a signal when it senses said leading edge, and in which the sensing device further comprises a multiposition switch movable into a plurality of positions, in each one of which positions a difference sensing element is connected to the feed device and thereby is adapted to transmit its signal thereto, and in which the position selector comprises a coupling between the speed control and the multi-position switch adapted to change the position of said switch in accordance with changes in the rate of advance.

9. A copying machine comprising a first conveyor belt operable at a selected advance rate and adapted to transport an original having a leading edge along a first path; a second conveyor belt operable at the selected advance rate and adapted to transport a sheet of sensitized paper having a leading edge along a second path converging with the first path; speed control for varying the selected rate of advance between cycles of the machine; rotatable member associated with the speed control and rotatable in response to those changes in the setting of the speed control which vary the selected rate of advance; a pinion mounted on and rotatable with the rotatable member; a rack meshed with said pinion and movable in response to rotation of said pinion to and fro along the direction of the first conveyor belt, said rack being movable in a direction contrary to the direction of motion of the original in the first path when the rotatable member rotates in response to changes in the setting of the speed

control which increase the rate of advance; a microswitch movable with the rack and having a sensing wire positioned in the first path and adapted to emit a signal when the sensing wire contacts the leading edge of an original moving in the first path, a storage device adapted to support a stack of sheets of sensitized paper; and a feeding device connected to the microswitch and activated by a signal from the microswitch, said feeding device when so activated being adapted to feed a sheet of sensitized paper from the storage device to the second conveyor belt.

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