Dec. 20, 1966 U. BRENNEISEN ETAL 3,292,572

DEVELOPING DEVICE

Filed Jan. 14, 1964 3 Sheets-Sheet 1

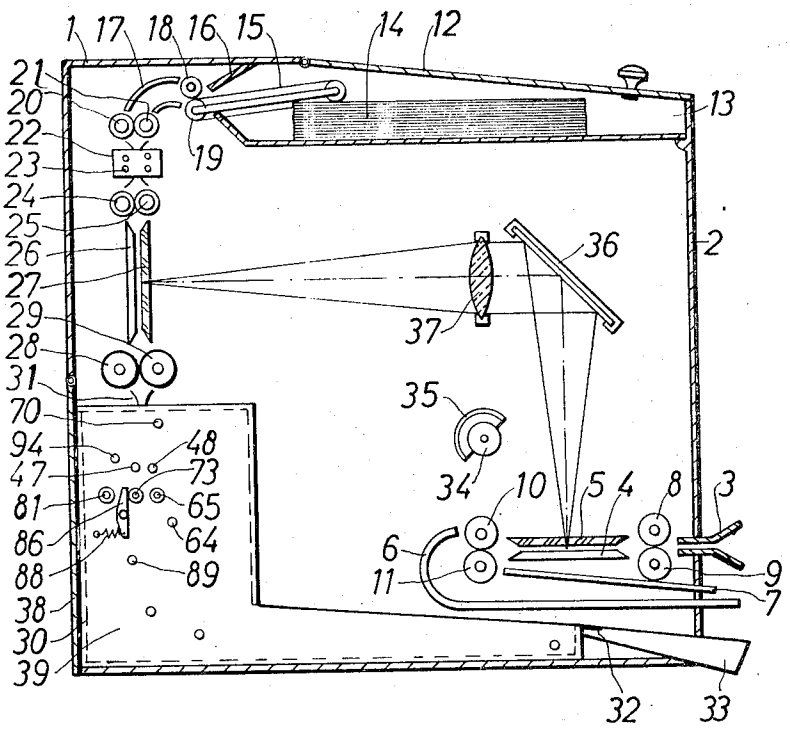

FIG. 1

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DEVELOPING DEVICE

Filed Jan. 14, 1964 3 Sheets-Sheet 2

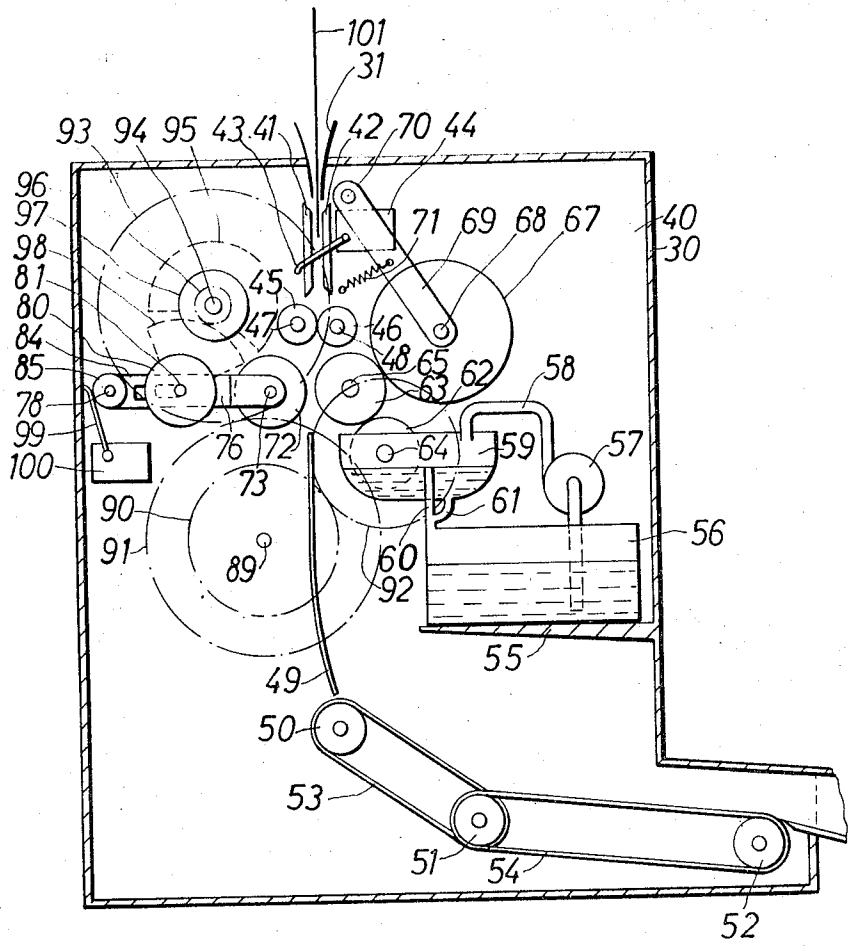

FIG. 2

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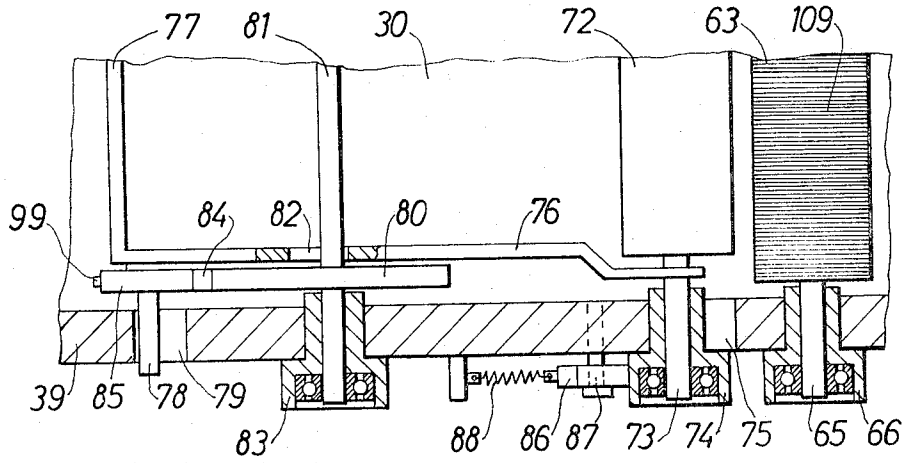

FIG. 3

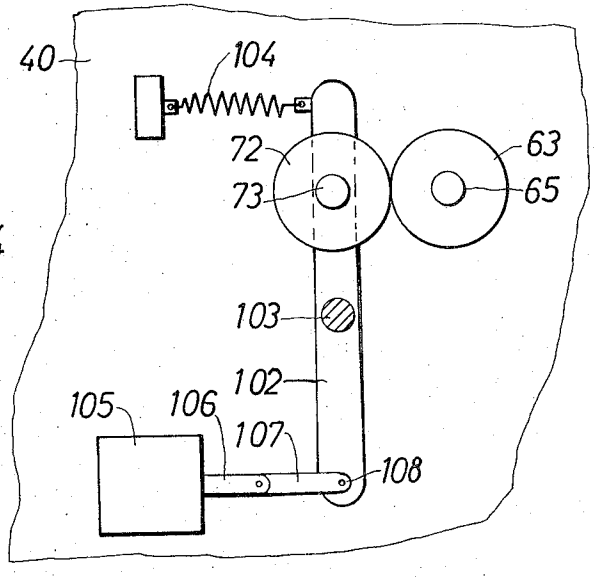

FIG. 4

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DEVELOPING DEVICE

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6 Claims. (Cl. 118—1)

The invention relates to a developing device for applying developer to copying material passing through it sheet by sheet, especially for electrophotographic apparatus.

In known electrophotographic copying apparatus with a built-in developing device for sheetwise development of copying material, the developing device is constantly in the operative state, i.e. during the whole time that the copying apparatus is switched on.

It has been found that this is in many cases undesirable.

To improve apparatus of the abovementioned kind it is therefore proposed according to the invention to provide means, along the path of the sheets of copying material, which are influenced by the copying material and which convert the developing device from the inoperative condition.

In particular, the means arranged along the path of the copying material and influenced by it may comprise an electric switch or a light barrier arranged in front of the point where the material is developed and an arrangement which renders the developing device operative with some delay after the switch device has been actuated, and the developing device may be returned to the inoperative condition by a time switch arrangement formed, for example, by a gearing and having preferably an adjustable switching time, or alternatively the device may be returned to the inoperative condition by the means controlled by the copying material, in dependence upon the length of the format of the copying material.

In a preferred embodiment of the invention, the developing device comprises a developer roller for applying developer to the copying material as well as a guide and/or contact pressure roller situated opposite the developer roller, one of which is displaceably mounted. In particular, the contact pressure roller may be displaceable transversely to the path of the copying material by means of slides which are controlled by cam plates. The cam plates may be connected to a drive motor through a magnetic clutch, the above-mentioned switch being then connected into the circuit of the magnetic clutch. Another switch controlled by the slides may be connected in parallel with the first switch.

Alternatively, the contact pressure roller may be arranged on rotatably mounted levers which are displaceable, for example by means of an electromagnet into the circuit of which the switch influenced by the copying material is to be connected.

The contact pressure roller may be coated with a layer of conductive rubber. The developer roller and the device for controlling the contact presure roller and/or the paper transporting means of the developer device may be connected to a common drive shaft. In this arrangement, the developing device together with the container for developer, the developer roller and the contact pressure roller and the device for controlling one of these rollers may form a separate unit, preferably arranged in a housing, replaceably mounted in the copying apparatus.

The developing device according to the invention not only has the advantage of using the developer extremely economically but also has the further considerable advantage that the copying material can be supported on the rear surface at the point where it is developed without the support receiving any developer during the intervals between the passage of successive sheets of copying paper. Since no developer is applied to the support, there is no risk of developer being accidentally applied to the rear surface of the copying material in front of the support.

Some preferred embodiments of the invention are described more fully in the description given below with reference to the accompanying drawings.

In these drawings,

FIG. 1 is a longitudinal section through an electrophotographic office copying apparatus,

FIG. 2 shows on a larger scale the developing device of the apparatus of FIG. 1, with the wall of the housing removed,

FIG. 3 is a plan view, partly in section, of part of the apparatus of FIG. 2 and

FIG. 4 shows part of a further embodiment of the developing device.

The electrophotographic office copying apparatus shown in FIG. 1 is an optical continuous copying apparatus in which the original to be copied and the copying material pass at the same speed through an illumination station and an exposure station respectively during the exposure process. The original is exposed episcopally and copied stripwise on to the copying material to the scale 1:1.

In detail, the apparatus shown in FIG. 1 comprises a housing 1 in which all the parts of the copying apparatus are arranged. At one end wall 2 of the housing 1 is an inlet slot 3 for introducing the original to be copied, and situated adjacent to this slot is the illumination station comprising a lower guide plate 4 and an upper, light permeable contact pressure plate 5. On leaving the illumination station, the original is guided by a U-shaped guide plate 6 to an outlet slot 7 in the end wall 2 through which it leaves the housing 1. The pairs of conveyor rollers 8, 9 and 10, 11 serve to convey the original through the illumination station.

In the upper part of the housing 1 is a container 13 which can be closed in a light-proof manner by a cover 12 which can be folded back. A stack 14 of electrophotographic sheets of paper, provided, for example, with a zinc oxide layer, is inserted in this container. A leafing device 15 known per se and therefore shown only diagrammatically in FIG. 1 moves the uppermost sheet of the stack 14 into a gap 16 behind which are curved guide elements 17 with two pairs of conveyor rollers 18, 19 and 20, 21 through which the sheet of copying paper is carried below the roller pair 20, 21 to a charging chamber 22 which contains spray wires 23 connected to high voltage.

On leaving the chamber 22, the sheet of copying paper is gripped by a pair of conveyor rollers 24, 25 which conveys the sheet to the exposure station consisting of a vertical guide plate 26 and a light permeable contact pressure plate 27. The sheet of copying paper leaving the exposure station is carried by a pair of conveyor rollers 28, 29 to an electrophotographic developing device arranged in a housing 30 having an inlet slot 31 and an outlet slot 32 for the copying paper and forming a unit to be more fully described further down.

After passing through the developing device and leaving the housing 30 through the outlet gap 32, the sheet of copying paper reaches a receiver 33 arranged below the inlet and outlet slots 3, 7 for the original in the end wall 2.

The housing 1 further contains a preferably tubular source of light 34 and a reflector 35 for illuminating the original passing through the illumination station 4, 5 and a deflecting mirror 36 and an objective 37 which

makes a stripwise, non-reversed copy of the original passing through the illumination station on to the copying paper passing through the exposure station 26, 27.

The shafts of the above mentioned conveyor rollers situated in the path of the original and of the copying paper are rotatably mounted in side plates (not shown) and are driven together and at the same peripheral speed by electric motors (also not shown) by way of suitable drive means, e.g., chains or V-belt drives.

FIGS. 2 and 3 show in more detail a developing device 30 which can be replaced as a whole by opening a flap 38 in the housing 1. This developing device operates on a principle based on the different wetting, depending on the charge, of a charge image produced on the photoconductive layer of the copying paper, by a preferably aqueous dyestuff solution.

The opposite side walls 39, 40 of the housing 30 are in the form of side plates on which the individual parts of the developing device are mounted. Below the inlet slot 31 of the housing 30, two guide plates 41, 42 with vertical slots are arranged through which the spring operated probing lever 43 of a microswitch 44 extends. Situated below the guide plates 41, 42 is a pair of conveyor rollers 45, 46 the shafts 47, 48 of which are rotatably mounted in recesses of the side walls 39, 40 of the housing 30, and a curved guide plate 49 and, adjacent thereto, conveyor bands for the copying paper. These conveyor bands enclose three grooved rollers 50, 51, 52 which have several parallel endless conveyor belts 53, 54 inserted in the grooves.

A container 56 provided with an inlet connection (not shown) and containing the developer fluid formed by a dye-stuff solution is mounted on a plate 55 of the housing 30. The developer solution is delivered by an electrically driven pump 57 and a pipe 58 into a developer trough 59 in which an overflow tube 60 connected to the container 56 keeps the liquid level constant.

In addition, an outflow tube 61 of smaller cross-section is provided for emptying the developer trough 59 when the pump 57 is inoperative. An application roller 62 which is in frictional connection with the developer roller proper 63 arranged along the path of the copying paper between the conveyor rollers 45, 46 and the guide plate 49 or which is driven by the shaft 64 by way of a pair of gear wheels dips into the developer liquid in the trough 59. The shafts 64, 65 of the rollers 62, 63 together with their bearings, of which only the bearing 66 of the shaft 65 is shown in FIG. 3, project through the recesses in the side walls 39, 40 of the housing 30. A squeezing roller 67 having its rotary shaft 68 mounted in two lateral levers 69 bears against the developer roller 63. The levers 69 are rotatable about the shaft 70 which is fixed to the housing and they are under the action of tension springs 71.

Opposite the developer rollers 63 is a contact pressure roller 72 whose shaft 73 together with its bearings 74 is displaceable in horizontal slots 75 of the side walls 39, 40 of the housing 30. On both sides of the contact pressure roller 72, slides 76 connected together through a web 77 are rotatably mounted on the shaft 73. The slides 76 are provided with pins 78 which are also displaceable in horizontal slots 79 in the side walls 39, 40 of the housing 30.

At the level of the contact pressure roller 72 are two cam plates 80 mounted on a common shaft 81. This shaft projects through horizontal slots 82 of the slides 76 and is rotatable in bearings 83 of the side walls 39, 40 of the housing 30. The cams 84 of the cam plates 80 cooperate with plates 85 which are fixed to the pins 78 of the slides 76.

Two armed levers 86 which are rotatable about the spindle 87 fixed to the housing and are under the action of tension springs 88 act on the bearings 74 of the shaft 73 of the contact pressure roller 72. These springs tend to press the roller 72 against the developer roller 63.

The driving arrangement of the developing device comprises a drive shaft 89 which is positively connected to the electric motor supplying the whole apparatus and which carries two gear wheels 90, 91. While the gear wheel 90 meshes with a gear wheel 92 arranged on the shaft 64 of the application roller 62, the gear wheel 91 meshes with a gear wheel 93 mounted on a shaft 94. A gear wheel 95 driving the pair of conveyor rollers 45, 46 is rigidly mounted on the shaft 94 and a further gear wheel 96 is mounted to be loosely rotatable on this shaft. The gear wheel 96 may be positively connected to the shaft 94 through a magnetic clutch 97, which is known and only shown diagrammatically, the clutch plates of which receive voltage through slip rings (not shown). A gear wheel 98 which is fixed to the shaft 81 of the cam plates 80 meshes with the gear wheel 96.

The spring loaded probing lever 99 of a microswitch 100 lies in contact with the plate 85 of one of the slides 76. The microswitches 44, 100 are connected in parallel into the circuit of the magnetic clutch 97.

The shaft 89 may also be used for driving the conveyor bands 53, 54. In addition, a drying apparatus may be arranged above the conveyor band 54.

The apparatus according to the invention, which is shown in FIGS. 2 and 3 in the starting position with the switches 44, 100 open, operates as follows:

The driving motor of the apparatus is switched on by closing a main switch so that the conveyor rollers as well as the application roller 62 with the developer roller 63 and the squeezing roller 67 begin to rotate while the magnetic clutch 97 is without current. When an original to be copied is introduced into the inlet slot 3, the paper delivery device 15 is switched on by a microswitch (not shown) arranged in the inlet duct to execute a working stroke so that the uppermost sheet of the stack 14 of copying paper is carried to the inlet slot 16 and from there to the charging station 22 and the exposure station 26, 27. By exposure of the uniformly charged copying paper in the exposure station, a charge image is produced which corresponds to the image of the original passing through the illumination station 4, 5.

The conveyor rollers 28, 29 carry the exposed sheet 101 of copying paper (FIG. 2) into the inlet slot 31 of the developing device 30. In this process, the sheet 101 of copying paper passes between the guide plates 41, 42 and its front edge pushes the probing lever 43 of the microswitch 44 aside by swinging in the anticlockwise sense, whereby the microswitch 44 is closed, the magnetic clutch 97 comes into operation and the cam plates 80 begin to rotate in the clockwise sense. The rear edges of the cams 84 leave the plates 85 of the slides 76 at the precise moment when the front edge of the sheet of copying paper 101, which is gripped between the conveyor rollers 45, 46, has reached the developer roller 63. Due to the movement of the cam 84 away from the plates 85, the slides 76 shift to the right under the action of the tension springs 88 until the contact pressure roller 72 lies against the rear surface of the sheet 101 of copying paper and presses the front surface of this sheet against the developer roller 63. As the sheet 101 moves further between the developer roller 63 and the pressure roller 72, developer liquid from the trough 59 is applied to the front surface of the sheet, the surface of the paper being thereby wetted in a distribution corresponding to the charge image, the image being thereby developed.

As the contact pressure roller 72 is moved from its inoperative into its operative position in which the roller 72 presses the copying paper against the developer roller 63, the spring loaded probing lever 99 of the microswitch 100, which bears against the plate 85, is also displaced in a clockwise direction and thus closes the switch 100, so that the magnetic clutch 97 remains energised even when the rear edge of the sheet 101 of copying paper has passed the probing lever 43 of the microswitch 44 and the latter returns to its starting position.

The speed of rotation of the cam plates **80** and the length of the format of the sheet **101** of copying paper are so adjusted to each other that the cam plates **80** have just completed a full rotation when the rear edge of the sheet **101** reaches the developer roller **63** and the contact pressure roller **72**. At that moment, the cams **84** again make contact with the plates **85** of the slides **76** and push the slides back into the starting position against the action of the springs **88**, the contact pressure roller **72** being then again lifted away from the rear surface of the copying paper. The microswitch **100** is thereby actuated through the probing lever **99**. The clutch **97** is deenergised, the contact pressure roller remains raised in the starting position for the next copy. Thus when the sheet **101** of copying paper drops onto the conveyor band **53** under its own weight and by the guiding action of the guide plate **49** and is conveyed by this conveyor band **53** and by the conveyor band **54** to the drying apparatus, if present, and then to the receiver **33**, the contact pressure roller **72** will not be wetted with developer liquid by the developer roller **63**.

The developing device described in FIGS. 2 and 3 is suitable for apparatus used for treating copying papers of a certain length of format. The cam plates **80** together with the cams **84** and the plates **85** of the slides **76** form a time switch device in which, if the cam plates **80** are made of two parts in the form of double plates displaceable relatively to each other, the switching time can be varied by varying the effective overall width of the cam **84** and can thus be adapted to copying papers of different lengths of format. Instead of the mechanical time switch device, an electrical time switch device of known construction may be used.

In the form of construction of the developing device shown in FIG. 4, copying papers of variable length may be used without the switching time of a time switching device having to be adjusted manually to the different lengths of format in each case. In the form of construction shown there, a major part of the construction of FIGS. 2 and 3 was used unchanged and has therefore not been shown again on these figures with the exception of the rollers **63**, **72**. However, instead of the cam plates **80**, the gear wheels **96**, **98**, the magnetic clutch **97** and the microswitch **100** of the embodiment shown in FIGS. 2 and 3, two levers **102** are used which are combined into a frame and between which a contact pressure roller **72** is arranged, the shaft **73** being rotatably mounted in recesses of the levers **102**. The levers **102** are rotatable about a shaft **103** fixed to the housing and are under the action of tension springs **104** which act on the upper ends of these levers. Further, an electromagnet **105** is provided whose armature **106** is connected by the intermediate member **107** to a rod **108** which is arranged between the lower ends of the levers **102**.

The microswitch **44** is in this case connected into the circuit of the pull magnets **105**.

In the last described embodiment of the developing device, the microswitch **44** applies a voltage to the pull magnets **105** after a brief delay after the probing lever **43** has been actuated by the front edge of the copying paper introduced into the slot **31**, so that the magnet presses the contact pressure roller **72** on to the developer roller **63** against the force of springs **104** at the instant when the front edge of the copying paper continuously carried by the pair of conveyor rollers **45**, **46** is situated between the rollers **63**, **72**. It is not until the rear edge of the sheet of copying paper again releases the probing lever **43** of the microswitch **44** that the pull magnet **105** is switched off again with the same delay, so that the contact pressure roller **72** is lifted off the rear surface of the copying paper at the instant when the rear edge of the paper has reached the developer roller **63**.

In the event of a voltage being applied between the conductive underlay of the electrophotographic paper **101** and the developer liquid during the development, the

rollers **63**, **72** must be insulated from each other. This may most simply be done by making the side walls **39**, **40** of the housing **30** of insulating material. The voltage may suitably be so applied that the contact pressure roller **72** which touches the conductive underlay of the copying paper is earthed while a voltage is applied to the rollers **62**, **63** which are wetted with the developer liquid. A protective resistor must be connected into the voltage supply to limit the current. The contact pressure roller **72** may advantageously be coated with a layer of conductive rubber. The specific resistance of the rubber may be so chosen that the layer of rubber takes over the role of protective resistor. The squeezing roller **67** and the conveyor roller **46** are preferably also rubberised.

In principle, it is possible to use a smooth metal roller as developer roller **63**. However, to avoid blurring of small closed letters when copying texts, it is advantageous to use a raster type profiling of the surface of the developer roller **63**. In the form of construction shown in FIG. 3, the cylindrical surface of the developer roller **63** is provided with a winding **109** of thin metal wire. The wire has a thickness of 0.05 to 0.5 mm., preferably 0.2 mm.

Instead of this arrangement, the developer roller **63** may be surface profiled by covering it with a fine mesh (size of mesh between 20 and 200μ) of metal wire or monofilar textile threads or with a layer a few mm. thick or porous material such as felt, finely porous rubber or foam plastic. The surface profiling of the developer roller **63** may further more also be achieved in the form of cording or a threading worked into the surface or small cup-shaped recesses. If, according to the above proposal, a threading is worked into the surface of the developer roller **63**, this may have a pitch of, for example, 0.05 to 0.5 mm., preferably 0.2 mm. and a depth of, for example, 0.37 mm.

Other forms of construction are possible in addition to those shown. Thus, for example, the pull magnet **105** may be used for displacing the slides **76** in FIGS. 2 and 3 instead of the levers **102** in FIG. 4. Similarly, the cam plates **80** of FIGS. 2 and 3 may also be used for controlling the levers **102** of FIG. 4.

The control according to the invention of the contact pressure roller **72** is advantageous also when the development of the latent charge image on the copying paper is effected not by differential wetting determined by the charge but by electrophoretic, electrolytic or other means.

Instead of lifting the contact pressure roller **72** off the developer roller **63**, the roller **63** may be lifted by a roller or plate guiding the copying paper to the development station and may be controlled in dependence upon the passage of the copying paper. This variation of the invention is advantageous particularly when developer is used in the form of powder which is applied to the photoconductive layer of the copying paper by a magnetic roller automatically controlled in dependence upon the passage of the copying paper.

Finally, the principle according to the invention of automatically transferring a developing device from the inoperative to the operative condition and returning it to the inoperative condition in dependence upon the passage of copying paper through it may be successfully applied also when the developer is not applied to the copying paper by rollers but sprayed on to the copying paper. In this case, the switching on and off of the spray nozzles of the developing device may be controlled by the microswitch **44**.

Instead of charging the copying apparatus with a stack of sheets of copying paper, it is possible to use copying material in the form of rolls which are cut to the length of the original by cutters in the copying apparatus before the stages of charging and exposure, and the material may then be supplied sheet by sheet to the various treatment stations of the copying apparatus.

The conveyor bands **53**, **54** together with the drying

apparatus not shown obviously need not necessarily be included in the housing **30** of the developing device. In the last mentioned case, an outlet slot would be provided at the bottom of the housing **30** below the guide plate **46** instead of the outlet slot **32**.

The control according to the invention of the developing device in dependence upon the passage of the copying material through it may be successfully used not only in electrophotographic but also in other apparatus.

We claim:

1. Developing device for applying liquid developer to copying material running through it in sheets, for electrophotographic apparatus, comprising a switch influenced by the copying material, said switch being arranged in the path of conveyance of said copying material in front of the developer station and being connected into the circuit of a magnetic clutch, cam plates being connected to a drive motor through said magnetic clutch, said cam plates controlling slides which are provided with a contact pressure roller arranged opposite a developer roller, said contact pressure roller being mounted so as to be displaceable transversely of the path of conveyance of the copying material by means of said slides, said developing device being returned to the inoperative condition by means controlled by said copying material in dependance upon the length of the format of said copying material.

2. Developing device according to claim **1**, comprising

a second switch, which is controllable by said slides, being connected in parallel with said switch.

3. Developing device according to claim **1**, comprising said contact pressure roller being arranged on rotatably mounted levers.

4. Developing device according to claim **1**, comprising said contact pressure roller being displaceable by an electromagnet the circuit of which contains said switch.

5. Developing device according to claim **1**, comprising said contact pressure roller being coated with a layer of conductive rubber.

6. Developing device according to claim **1**, comprising said developing roller and the device for controlling the contact pressure roller and the paper transporting means of said developing device being connected to a common drive shaft.

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