

PATENT SPECIFICATION

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(54) APPARATUS FOR FEEDING SHEETS INDIVIDUALLY FROM A STACK

(71) We, AGFA-GEVAERT AKTIEN-GESELLSCHAFT, a body corporate recognised under German Law of Leverkusen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for feeding sheets individually from a stack, and especially to such apparatus for use in electrostatic copying machines, the sheets then being copy supports.

According to previous proposals, sheet-feeding apparatus may comprise an intermittently driven feed roller arranged frictionally to engage the uppermost sheet of a stack and advance it to transport rollers, separating members being provided for separating the advancing top sheet from the remainder of the stack. To produce the necessary frictional engagement, the feed roller has a resilient outer covering having a high frictional resistance.

In such previously proposed apparatus, the feed roller is driven by means of a free-wheel in the first transport phase. After the leading edge of the sheet has been engaged by the transport rollers, the moving sheet drives the feed roller along with it in the free-wheel direction until its trailing edge has passed the position at which the feed roller bears on the stack. As a result of the deformation of the resilient roller covering which occurs in the vicinity of the bearing position, there is contact, shortly before the feed roller comes to a standstill, between the roller and the next sheet which is to be picked up, and that sheet is therefore carried along for a short distance while the feed roller continues to move. That next sheet is thereby pushed against the separating members which may comprise, for example, the known corner stops, and generally suffers a permanent deformation, which detracts from the smooth transportation of the sheet through the apparatus.

The present invention provides apparatus for feeding sheets individually from a stack, which comprises a feed roller arranged frictionally to engage the uppermost sheet of a stack and advance it to transport rollers, means for preventing all but the topmost sheet of the stack from being advanced by the feed roller, and free-wheel drive means for intermittently rotating the feed roller to effect the said advancement, the feed roller being provided with a resilient covering having high frictional resistance and with a member arranged on the periphery of the feed roller to provide a region thereon of relatively low frictional resistance, the said member being so disposed that, in operation, it comes into contact with the stack after the topmost sheet has been engaged by the transport rollers and renders the area of contact between the said resilient covering and the moving topmost sheet insufficient for the movement of the latter to be transmitted to the feed roller, the turning moment deriving from friction between the said member and the stack being insufficient to rotate the feed roller. It will of course be appreciated that when the free-wheel drive means is inoperative, the feed roller is free to rotate in the direction in which it moves when driven.

The said member advantageously comprises an auxiliary roller which projects beyond the surface of the feed roller and which is preferably mounted so as to be freely rotatable.

By providing a member on the periphery of the feed roller in accordance with the invention, continued rotation of the feed roller during the final transport phase is prevented and/or since the said member does not itself have a covering of high frictional resistance, it does not carry along the next sheet on the stack.

Advantageously, the auxiliary roller is so arranged and is of such dimensions that the connecting line between its axis and the axis of the feed roller at the moment of

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lift-off (that is to say, when the auxiliary roller contacts the stack or immediately thereafter) encloses with the direction of the pressure force engaging with the roller axis an angle α , measured in the direction of advancement of the feed roller, which fulfills the condition:

$$\sin \alpha \geq \frac{1}{P'_A} \left(\frac{M_G \cos \alpha}{r_G} - \frac{M_A}{r_L} \right)$$

wherein M_G indicates the frictional resistance moment of the auxiliary roller, M_A the friction resistance moment of the feed roller, P'_A the counter-pressure force arising from the action of the feed roller on the stack, r_G the radius of the auxiliary roller, and r_L the distance between the two roller axes.

The co-rotating moment of the auxiliary roller is then opposed by a back-rotating moment caused by the counter-pressure force, so that even a free-running feed roller will certainly come to a standstill. The relation between the various turning moments will be explained fully hereinafter with reference to the accompanying drawings.

Preferably, on the periphery of the feed roller there are provided two auxiliary rollers which are off-set with respect to one another by the angle 2α , the front auxiliary roller in the direction of the rotation of the feed roller being hard to rotate and the rear roller being easily rotatable. Due to its relatively high friction resistance (stemming from its resistance to rotation), the firm auxiliary roller can transmit to the feed roller the movement of the top sheet of the stack. The feed roller is thereby rotated as far as the position in which both rollers rest on the sheet and the perpendicular bisecting the connecting line between the roller axes coincides with the direction of action of the pressure force. Further rotation of the feed roller is prevented by selection of the angle α between the said perpendicular and the line connecting the axis of the second auxiliary roller with the axis of the feed roller, to comply with the condition stated hereinbefore. If this angle is appropriately selected, the result is merely a considerable reduction in the bearing force exerted by the firm auxiliary roller and thus of the friction resistance which is exerts on the copy support. Since both rollers come to bear, no significant idle stroke occurs, after the intermittent drive of the feed roller has re-started before the resilient covering comes to bear again and the next sheet is conveyed.

The or each auxiliary roller is preferably mounted on an excision in the periphery of the feed roller, which excision preferably runs in the direction of a secant. The angle α (on which the back-rotating moment depends) may then be made relatively large

without contact between the sheet and the resilient covering of the feed roller occurring between the bearing points of the auxiliary rollers.

If the feed roller is not formed with an excision when only one auxiliary roller is provided, the auxiliary roller must project considerably beyond the circular periphery of the feed roller for a given angle α . This in turn increases the eccentricity of the feed roller/auxiliary roller combination, and the increased eccentricity impedes the succeeding rotation of the combination for the purpose of conveying the next sheet to the transport rollers.

Two forms of feed rollers in accordance with the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Fig. 1 shows a copy support being pulled through beneath a feed roller of known type;

Fig. 2 shows a side elevation of the first form of feed roller;

Fig. 3 shows a similar view of the second form of feed roller; and

Fig. 4 shows, in side elevation, a particular rotation position of the second form of feed roller.

Referring to Fig. 1, a feed roller 3 having a resilient, high friction covering rests on the topmost sheet 2 of a stack 1 under the action of a bearing force P_A . The force P_A is produced in a known manner by the action of gravity or by means of spring forces acting on the feed roller 3 or the stack 1. Fig. 1 shows the moment at which the trailing edge 2a of the sheet passes through the position at which the roller 3 bears on the stack 1. Due to the deformation of the resilient covering of the feed roller 3, the covering is already in contact not only with the sheet 2 which has been pulled away but also with the next sheet in the stack. This next sheet is therefore pushed for at least a short distance in the direction of the arrow C during the remaining rotation of the feed roller 3 in the direction of the arrow A. The result is undesirable deformation of the lower sheet.

Referring to Fig. 2, the periphery of the feed roller 3 is formed with an excision 3a which extends in the direction of a secant. Attached to the side walls of the feed roller 3 is a spindle 4 on which is supported a freely rotatable auxiliary roller 5 which may, for example, be formed of polished steel. When the topmost sheet 2 is pulled away in the direction of the arrow C beneath such a feed roller, the feed roller 3 is driven along in the direction of the arrow A until both the edge K bordering the excision 3a and the auxiliary roller 5 rest on the sheet 2 (as in Fig. 2). If there were no excision 3a, the roller 5 would have to project con-

siderably beyond the circular periphery of the feed roller for a given angle α , thereby undesirably increasing the eccentricity of the feed roller auxiliary roller combination. Also, the point of contact K between the stack and the feed roller in its rest position would be closer to the auxiliary roller 5, thereby decreasing the stability of the feed roller in the rest position.

For further rotation of the feed roller 3 beyond the position shown in Fig. 2, the edge K would have to lift away from the copy support 2, and this can only happen if the turning moment transmitted by means of the auxiliary roller 5 is sufficient for this purpose. The following force relationships apply:

The turning moment acting on the feed roller 3 in the direction of the arrow A results from the bearing force P_L which acts by way of the lever arm

$$r_L \cdot \cos \alpha$$

and the maximum of which depends on the friction moment M_G of the auxiliary roller 5 and on its radius r_G . The following applies:

$$(1) \quad P_L = \frac{M_G}{r_G}$$

From this arises for the maximum forward turning moment M_V :

$$(2) \quad M_V = \frac{M_G \cdot r_L \cdot \cos \alpha}{r_G}$$

The backward turning moment M_R depends on the counter-pressure force P'_A acting by way of the lever arm

$$r_L \cdot \sin \alpha \cdot M_R$$

is given by the equation:

$$(3) \quad M_R = P'_A \cdot r_L \cdot \sin \alpha$$

In addition, the friction moment M_A of the feed roller itself must be overcome. The condition for the standstill of the feed roller is accordingly:

$$(4) \quad M_A \geq \frac{M_G \cdot r_L \cdot \cos \alpha}{r_G} - P'_A \cdot r_L \cdot \sin \alpha$$

The condition may instead be expressed as:

$$(5) \quad \sin \alpha \geq \frac{1}{P'_A} \left(\frac{M_G \cdot \cos \alpha}{r_G} - \frac{M_A}{r_L} \right)$$

By appropriate selection of the angle α , which depends on r_L and r_G , it is therefore possible for further rotation of the feed roller 3 to be prevented with certainty. The top sheet 2 then only moves the auxiliary roller 5 which, owing to its limited deformability and also to the relatively low friction coefficient of its surface, cannot carry the next sheet along with it. It is also possible to make the angle α of such a value that co-rotation is in fact only just prevented but the bearing pressure of the edge K is already considerably reduced. In this way, the abrasion of this edge may be restricted. In the form of feed roller shown in Fig. 3, abrasion of the edge K is prevented completely. Referring to Figure 3, the side wall of the feed roller 3 carries two spindles 4 and 8 on which are supported two auxiliary rollers 5 and 7, respectively. The auxiliary roller 5 is mounted so as to be easily rotatable, but the auxiliary roller 7 is either hard to rotate or is non-rotatably connected to its spindle 8. The centre lines of the spindles 4, 6 and 8 together form the angle 2α , which when both rollers rest on the sheet 2 is bisected by the direction of the bearing force P_A .

It is necessary for the roller 7 to be non-rotatable or very stiff to rotate, because the feed roller 3 could not otherwise be driven along by means of the moving sheet 2 beyond the position shown in Fig. 4, in which the edge K is still in contact with the sheet 2. In addition, from the position shown in Fig. 4, a considerable idle stroke in the direction of the arrow A must be executed at the start of the next transport stroke of the feed roller 3 before the edge K' comes into contact with the top sheet and carries it along.

Further rotation of the feed roller 3 out of the position shown in Fig. 3, which is caused by the movement of the sheet 2 in the direction of the arrow c, results in the roller 7 being lifted away from the sheet 2, and the turning moments calculated with reference to Fig. 2 are then produced, as is apparent from the Figure. This means that a forward turning moment is produced by the bearing force P_L acting by way of the lever arm

$$r_L \cdot \cos \alpha$$

a backward turning moment is produced by the counter-pressure force P'_A acting by way of the lever arm

$$r_L \cdot \sin \alpha$$

and the difference between these two moments tends to overcome the friction moment M_A .

It will be appreciated that when the member provided on the periphery of the feed roller in accordance with the invention contacts the stack, the topmost sheet has been engaged by the transport rollers and the drive means for the feed roller is inoperative.

10 WHAT WE CLAIM IS:—

1. Apparatus for feeding sheets individually from a stack, which comprises a feed roller arranged frictionally to engage the uppermost sheet of a stack and advance it to transport rollers, means for preventing all but the topmost sheet of the stack from being advanced by the feed roller, and free-wheel drive means for intermittently rotating the feed roller to effect the said advancement, the feed roller being provided with a resilient covering having high frictional resistance and with a member arranged on the periphery of the feed roller to provide a region thereon of relatively low frictional resistance, the said member being so disposed that, in operation, it comes into contact with the stack after the topmost sheet has been engaged by the transport rollers and renders the area of contact between the said resilient covering and the moving topmost sheet insufficient for the movement of the latter to be transmitted to the feed roller, the turning moment deriving from friction between the said member and the stack being insufficient to rotate the feed roller.

2. Apparatus as claimed in claim 1, wherein the said member comprises an auxiliary roller which projects beyond the surface of the feed roller.

3. Apparatus as claimed in claim 2, wherein the arrangement is such that, when the auxiliary roller contacts the stack, or immediately thereafter, the connecting line between the axis of the auxiliary roller and the axis of the feed roller includes an angle α with the vertical passing through the axis of the feed roller, the angle α being measured from the said connecting line in the direction of rotation of the feed roller and satisfying the following condition:

$$\sin \alpha \geq \frac{1}{P'_A} \left(\frac{M_G \cos \alpha}{r_G} - \frac{M_A}{r_L} \right)$$

in which equation

M_G represents the frictional resistance moment of the auxiliary roller;

M_A represents the frictional resistance moment of the feed roller; 55

P'_A represents the counter-pressure force corresponding to the force with which the feed roller bears on the stack;

r_G represents the radius of the auxiliary roller; and 60

r_L represents the distance between the axes of the rollers.

4. Apparatus as claimed in claim 3, which includes a further auxiliary roller arranged on the periphery of the feed roller and ahead of the first-mentioned auxiliary roller (in the direction of rotation of the feed roller), the front auxiliary roller having high resistance to rotation, the rear auxiliary roller being readily rotatable, and the angle included between the lines connecting the axis of each auxiliary roller with the axis of the feed roller being equal to 2α , where α is as defined in claim 3. 65 70 75

5. Apparatus as claimed in any one of claims 2 to 4, wherein the or each auxiliary roller is mounted along an excision formed in the periphery of the feed roller.

6. Apparatus as claimed in claim 5, wherein the excision extends along a secant. 80

7. Apparatus for feeding sheets individually from a stack, substantially as hereinbefore described with reference to, and as shown in, Fig. 2 or Figs. 3 and 4 of the accompanying drawings. 85

7. Electrostatic copying apparatus incorporating sheet-feeding apparatus as claimed in any one of claims 1 to 7.

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