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(54) IMPROVEMENTS IN AND RELATING TO ELECTROPHOTOGRAPHIC COPYING MACHINES

(71) We, RICOH COMPANY, LTD., a Japanese Body Corporate of 3-6 1-Chome Naka Magome, Ohta-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to electrophotographic copying machines and to developing units therefor.

According to the invention, there is provided a magnetic brush developing unit for an electrophotographic machine having a photoconductive drum, the unit comprising a housing, a magnet supported within the housing by a shaft a rotary magnetic brush forming a sleeve surrounding the magnet, and being rotatable about the shaft axis, the shaft having opposite ends projecting from the housing, first and second locating members arranged to be located at opposite axial ends of the shaft, each locating member having means for aligning a first predetermined location on the locating member with the axis of a photoconductive drum, and an aperture at a second predetermined location on the member for receiving a corresponding end portion of the shaft whereby to enable accurate relative positioning between the photoconductive drum and the sleeve.

According to the invention, there is further provided an electrophotographic copying machine comprising a frame supporting the shaft of a photoconductive drum and the shaft of a magnetic brush developing unit for relative movement towards and away from one another, the developing unit shaft supporting a housing, a magnet located within the housing and magnetic brush carrying sleeve extending about the magnet, the magnet and housing being locked against rotation relative to the frame whereas the sleeve is rotatable about the axis of the developing unit shaft, and a pair of locating

members, each locating member being arranged to locate the adjacent ends of the shafts relative to each other and to the frame whereby to establish a predetermined spacing between the axes of the two shafts.

An electrophotographic machine, embodying the invention will now be described by way of example, with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a longitudinal section through a developing unit of the machine;

Figure 2 is an end elevation of a locating member of the unit of Figure 1;

Figure 3 is a fragmentary section of the unit of Figure 1 to an enlarged scale;

Figure 4 is a fragmentary perspective view of the unit of Figure 1;

Figure 5 is a longitudinal section through another developing unit for use in the machine in place of the unit of Figure 1; and

Figure 6 is a fragmentary perspective view of the unit of Figure 5.

An electrophotographic machine has a photoconductive drum 16 arranged to produce electrostatic images and has a developing unit 1 for developing the images. The developing unit 1 shown in Figure 1 includes a housing 10 having a pair of opposite side plates 10a, 10b, between which a magnet 11 on a shaft 12 is supported for rotation about the axis of the shaft 12. The magnet 11 is surrounded by a sleeve 13, which is rotatable with respect to the magnet 11. At the right-hand end, the sleeve 13 has a hollow shaft 13a carrying a gear 14. The gear 14 is arranged to transmit a rotary drive force from a drive means (not shown) to the sleeve. The magnet 11 is locked against rotation by a locking device 15. In operation as the sleeve 13 rotates, a magnetic brush is formed on its outer circumferential surface. The opposite end portions 12a, 12b of the shaft project from the side plates 10a, 10b of the casing 10 and are supported by respective locating or

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positioning members to be described later. The end portions 12a and 12b are tapered. The developer unit is slidably mounted on the base plate 17 so that it can be withdrawn from the machine by moving it to the left, as viewed in Figure 1.

The end portion 12a of the shaft 12 engages a support aperture 19a in a first locating member 19 which is secured to the side plate 18 of the copying machine. The other end portion 12b engages a support aperture 27a in a second locating member 20 shown in Figure 2. The second locating member 20 has a body 21 and two locating arms 25 and 26 each having an opening 25a and 26a for engagement with a corresponding one of two locating pins 23 and 24 (see Fig. 4) mounted on the side plate 22. The member 20 also has a support arm 27 having the support aperture 27a for receiving the end portion 12b, means for mounting the member 20 for rotation about the central shaft 28 of the drum 16, and a support member 30 for the mounting means 29. The aperture 27a has a bevelled edge 27b. As shown in more detail in Figure 3, the mounting means 29 includes a stub shaft 31 for engaging the support member 30 and having an inner end portion 31a which is screw-threaded for screw-threaded engagement with a screw-threaded bore 28a in the shaft 28. A knob 32 is secured to the outer end of the stub shaft, and a compression spring 33 extends about the stub shaft to engage at one axial end a spring abutment 34 and at the other axial end a shoe 35. The support member 30 is secured to the body 21 by means of a set screw 30a. Both the drum 16 and the developing unit 1 can be moved into and out of the copying machine through a window 22a in the side plate 22 of the machine frame, as shown in Figure 4.

In operation, the end portion 12a of the shaft 12 engages the support aperture 19a in the first locating member 19 that is secured to the side plate 18. At this time, the housing 10 of the developing unit 1 bears against the base plate 17 at three points A1, A2 and B (see Fig.4). Then the second locating member 20 is mounted in place, with the locating pins 23 and 24 engaging respective openings 25a and 26a, and with the end portion 12b engaging the support aperture 27a and of the locating arm 27. When the knob 32 is then turned to engage the screw-threaded portion 31a (see Fig.3) of the drum shaft 28 the point B of the housing 10 is raised, and the developing unit 1 is supported by the shaft 12 and the points A1 and A2. Simultaneously, a relative movement in the axial direction between the drum 16 and the developing unit 1 is constrained. With the described arrangement, the spacing between the drum and the magnetic brush or more specifically the sleeve 13 on which a brush is

to be formed can be maintained constant, thus allowing the developing unit to be readily changed with another similar developing unit. Since a constant spacing is obtained by merely securing the locating members in place, the need for a complex adjustment which has heretofore been experienced during the maintenance and inspection of the copying machine is avoided, permitting a simple dismounting and assembly of the drum and the developing unit for repair and inspection purposes.

Where it is desired to increase the copying rate of a copying machine the described developing unit may not be able to cope. Accordingly the described development unit should be replaced by one having a plurality of magnetic brushes. Such a developing unit is referred to as a multiple brush developing unit. When a multiple brush developing unit is used, a mere increase in the number of support apertures formed in the locating members does not achieve the intended purpose. In particular, when a plurality of magnetic brushes are provided, it is a relatively simple matter to form an increased number of apertures with good accuracy, but the mounting of the corresponding magnetic brush sleeves must be achieved with high accuracy. Otherwise, an impediment will occur in the rotation of the individual magnetic brushes, resulting in poor copy quality. In addition, when a uniform accuracy is to be achieved for all of the developing brushes, an increase in the cost results. If however the mounting position of the individual sleeves varies from brush to brush, the interchangeability of the developing units between copying machines is lost.

In the developer unit shown in Figures 5 and 6, parts similar to those in Figures 1 to 4 are similarly referenced.

The developing unit shown in Figure 5 has a plurality of generally similar magnetic brushes but only one of these magnetic brushes is shown. The magnetic brush shown has a shaft 12 supported on the housing by means of two bearings 37 and 38 which are mounted in respective ones of the two side plates 10a and 10b. These bearings 37,38 are formed of elastic members such as rubber or rubber-like materials. One of the bearings 37, supports the end portion 12b of the shaft while the other bearing 38 supports the hollow shaft 13a of the sleeve 13 through a roller bearing 39. In this manner, the magnetic brush to be formed on the sleeve is radially displaceable by supporting the shaft 12.

A second locating member 36 generally similar to the second locating member 20 of Figures 1 to 4, includes mounting means 29 and two locating openings 25a and 26a. The two openings 25a and 26a act to prevent rotation of the locating member about the shaft 28. However, the member 36 differs

from the locating member 20 of Figures 1 to 4 in that it includes a plurality of the locating arms 36A and 36B (see Fig.6) each of the locating arms having a respective support aperture 36a and 36b for supporting the shafts of the corresponding magnetic brushes. Each of the support apertures 36a, 36b has a bevelled edge 36c (see Fig.5) adjacent the corresponding magnetic brush. The shaft 12 of each magnetic brush is locked against rotation by means, not shown. The removal and insertion of the developing unit out of and into the copying machine are similar to those described in connection with the developing unit of Figures 1 to 4.

When the opposite ends of each shaft 12 engage the first and second locating members 19, 36, the magnetic brush which is supported on the housing 10 by elastic members will assume a radical position which is determined by the support apertures 19a, 36a and 36b in the individual locating members. Thus, the position of the shafts 12 of the individual magnetic brushes is not constrained by the bearings through which it is mounted on the housing, but is determined by both positioning members, thus avoiding any loading upon rotation of the sleeve 13.

As shown in Figure 5, an elastic member lies between the shaft 12 and the side plate of the housing to permit a radial movement of the magnetic brush. However, such elastic member may be omitted and the shaft 12 allowed to be directly supported by a bore in the side plate of the casing which serves as a bearing. It will be appreciated however, that the shaft 12 is radially movable within the bore.

#### WHAT WE CLAIM IS:

1. A magnetic brush developing unit for an electrophotographic machine having a photoconductive drum, the unit comprising a housing, a magnet supported within the housing by a shaft, a rotary magnetic brush forming a sleeve surrounding the magnet and being rotatable about the shaft axis, the shaft having opposite ends projecting from the housing, first and second locating members arranged to be located at opposite axial ends of the shaft, each locating member having means for aligning a first predetermined location on the locating member with the axis of a photoconductive drum, and an aperture at a second predetermined location on the member for receiving a corresponding end portion of the shaft whereby to enable accurate relative positioning between the photoconductive drum and the sleeve.

2. A unit according to claim 1, wherein each end portion of the shaft is tapered to facilitate entry into a corresponding aperture.

3. A unit according to claim 1 or claim 2, wherein the second locating member includes means for locking the locating

member to the shaft of the drum.

4. A unit according to claim 1, wherein the shaft is movable radially of its axis relative to the housing.

5. A unit according to any preceding claim, including at least one further magnet supported by a further shaft within the housing and carrying a further magnetic sleeve, the said further shaft being engageable with a further aperture in said first and second locating members to locate the further sleeve with respect to the photoconductive drum.

6. A unit according to any preceding claim, including a bearing located in the aperture in the first locating member for receiving a corresponding end of the shaft.

7. A unit according to any one of claims 1 to 5, including a bearing located in the aperture in the second locating member for receiving a corresponding end of the shaft.

8. A unit according to claim 6 or claim 7, wherein the opening in the bearing member is bevelled to facilitate the entry of a corresponding end portion of the shaft.

9. A unit according to any preceding claim, wherein the aligning means of the second locating member comprises a screw-threaded member for screw-threadedly engaging the photoconductive drum and a knob rigid with the screw-threaded member for rotating the screw-threaded member relative to the locating member to effect a screw-threaded coupling with the drum.

10. A unit according to any preceding claim, wherein each locating member includes an opening for receiving a pin rigid with a frame of a photoelectric copying machine incorporating said photoconductive drum.

11. A unit according to any preceding claim, wherein the shaft and sleeve are supported by the housing through at least one elastic member which allows limited radial movement of the shaft and sleeve relative to the housing.

12. An electrophotographic copying machine including a developing unit according to any preceding claim.

13. An electrophotographic copying machine comprising a frame supporting the shaft of a photoconductive drum and the shaft of a magnetic brush developing unit for relative movement towards and away from one another, the developing unit shaft supporting a housing, a magnet located within the housing the magnetic brush carrying sleeve extending about the magnet, the magnet and housing being locked against rotation relative to the frame whereas the sleeve is rotatable about the axis of the developing unit shaft, and a pair of locating members each locating member being arranged to locate the adjacent ends of the shafts relative to each other and to the frame whereby to establish a predetermined spacing between

the axes of the two shafts.

14. An electrophotographic copying machine substantially as hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings.

15. An electrophotographic copying machine substantially as hereinbefore described with reference to Figures 5 and 6 of the accompanying drawings.

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FIG. 1

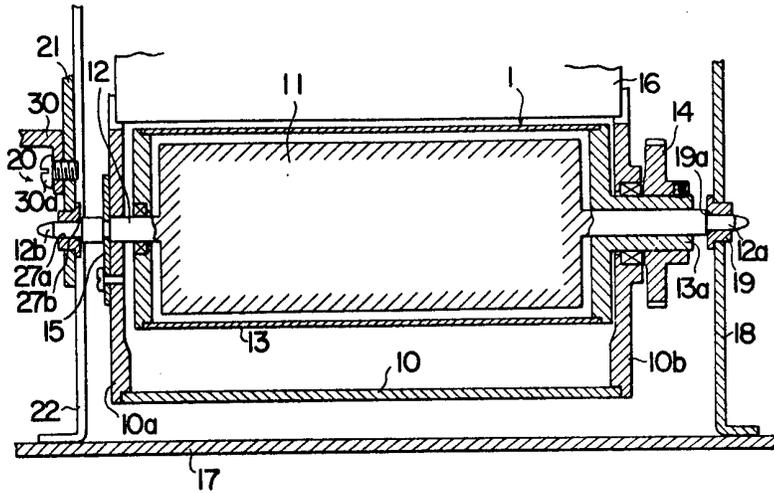


FIG. 5

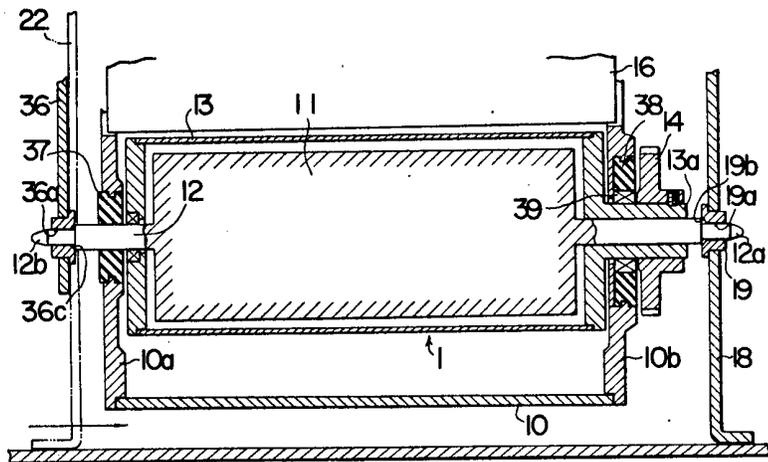


FIG. 2

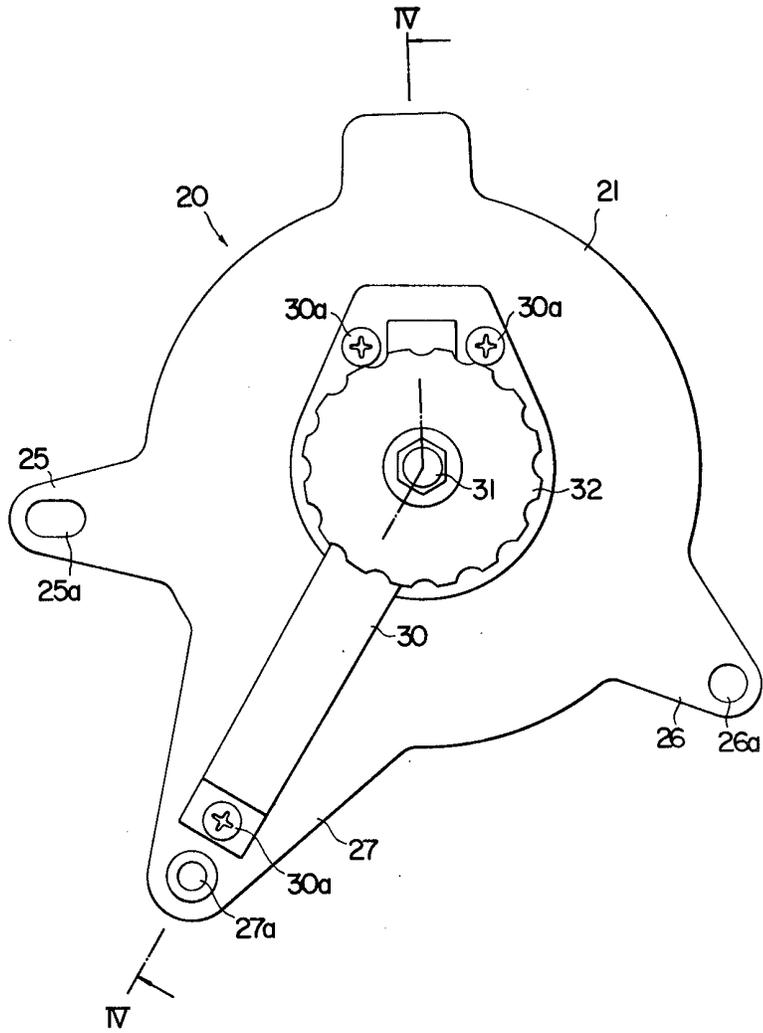


FIG. 3

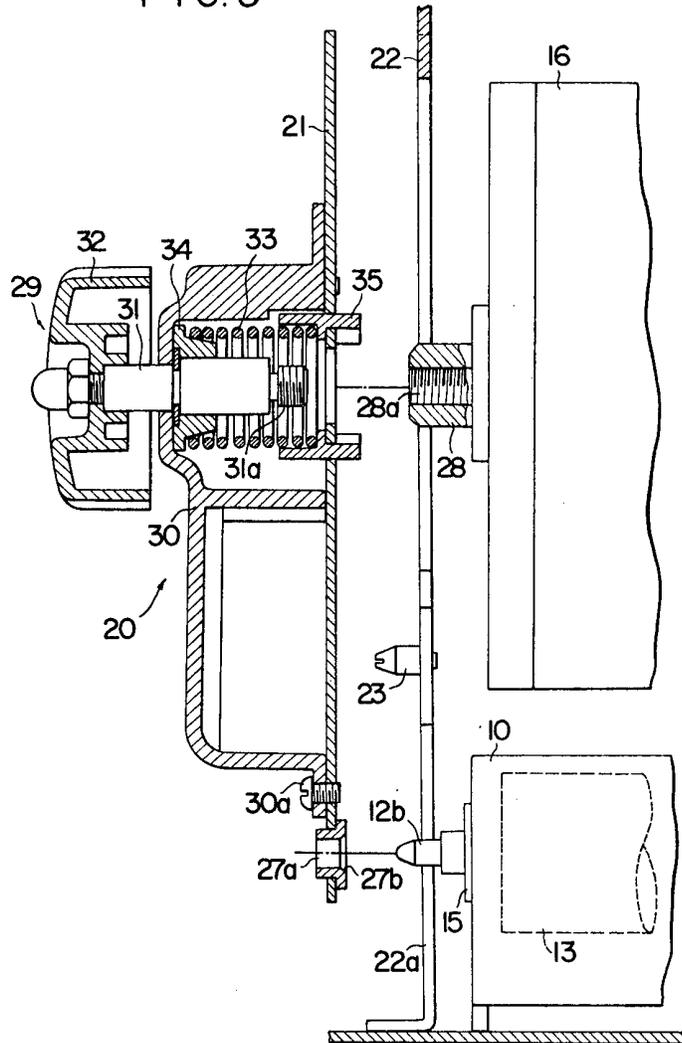


FIG. 4

