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(54) Charger having charging blade, image forming apparatus having same and process cartridge having same.

(57) A charging device includes a charging blade contactable to a member to be charged ; a voltage applying device for applying an oscillating voltage between the charging blade and the member to be charged ; and an urging spring for urging the charging blade and the member to be charged toward and away from each other.

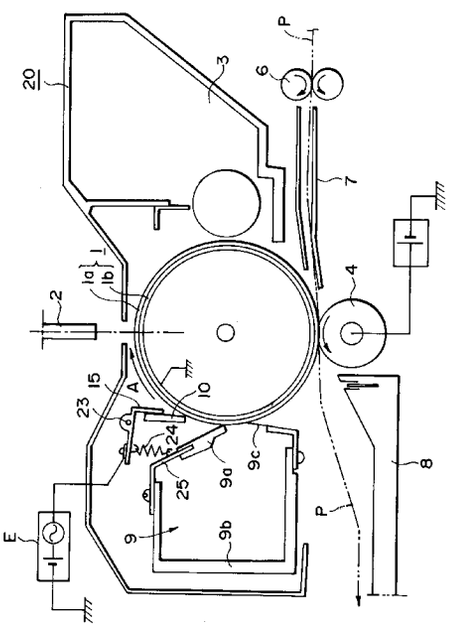


FIG. 1

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FIELD OF THE INVENTION AND RELATED ART

The present invention relates to a charging device having a charging member to be contacted to a member to be charged such as a photosensitive member or the like to electrically charge or discharge it, to an image forming apparatus having such a charging device and to a process cartridge having such a charging device and detachably mountable to an image forming apparatus.

Conventionally, as the means for uniformly charging an image bearing member in the form of a photosensitive member or a dielectric member (a member to be charged) in an image forming apparatus such as a copying or recording machines, a corona discharger in the form of a corotron or scorotron, having a wire electrode and a shield electrode, are widely used since they provide uniform charging property.

However, the corona discharger involves the defects that it requires an expensive high voltage source, that it requires a relatively large space for the discharger itself, the high voltage source and the shielding space, that a relatively large amount of corona products such as ozone or the like results so that additional means for mechanism is required to dispose of the corona products and that the additional means or mechanism results in bulkiness and high cost of the apparatus.

Recently, a contact type charging device is considered in place of the corona discharger. In the contact type charging system, a contact charging member (conductive member) is contacted to a surface of the image bearing member (the member to be charged), and the contact charging member is supplied with a voltage, by which the surface of the image bearing member is charged to a predetermined potential. It includes a roller charging type (Japanese Laid-Open Patent Application No. 91253/1981), a blade type (Japanese Laid-Open Patent Application No. 194349/1981 and Japanese Laid-Open Patent Application No. 147756/1985), a charging-cleaning type (Japanese Laid-Open Patent Application No. 165166/1981).

As for the voltage applied to the charging member, there are a type in which only a DC voltage (1 - 2 KV) is applied and a type in which an oscillating voltage such as an AC biased DC voltage is applied, as disclosed in Japanese Laid-Open Patent Application No. 149669/1988.

The contact charging using only the DC voltage is advantageous in that the level of the applied voltage is low and that the voltage source is simple and inexpensive. However, it involves defects that non-uniform charging spots are easily produced, that the charging performance is easily influenced by contamination of the charging member and that the tolerable range for the uniform charging is narrow.

With the contact charging using the oscillating voltage, the spotty non-uniformity can be removed significantly, and the tolerable range for the uniform charging performance is large despite the voltage source is a little complicated and expensive than those in the contact charging with the use of DC voltage only. The oscillating voltage, as disclosed in Japanese Laid-Open Patent Application No. 149669/1988, is desirably a DC voltage biased with an AC voltage having a peak-to-peak voltage which is not less than twice the charge starting voltage for the member to be charged.

However, in the case of the contact type charging using the oscillating voltage, the charging member vibrates because of the oscillating component of the applied voltage with the result of the vibration of the member to be charged to which the charging member is press-contacted (so-called "charging noise").

The charging noise has a frequency which is twice the frequency of the AC component in the voltage applied to the charging member, for example. If the frequency of the applied voltage is low, for example, 200 Hz or lower, the noise is not harsh. However, with the increase of the frequency, it becomes a harsh noise. From this standpoint, the frequency is desirably 200 Hz or lower.

However, if the frequency is too low, a so-called pitch non-uniformity occurs in a halftone image in the case of the image forming apparatus. The non-uniformity has the pitch:

(process speed (mm/sec))/(frequency (Hz)) mm

If the pitch is about 0.1 mm, the non-uniformity is not conspicuous, but if it is 0.15 or larger mm, it becomes conspicuous, and therefore, the image quality is degraded.

In consideration of the above, the process speed is required to be not more than 30 mm/sec in order that the pitch non-uniformity is not conspicuous and that the charging noise is not harsh (not more than 200 Hz). Actually however, most of the electrophotographic machines have the process speeds which is greater than 30 mm/sec. In such actual image forming machines, if the contact type charging with the use of the oscillating voltage is used, it is desired that the charging noise is reduced or is not harsh.

The charging noise varies depending on the configuration and the material of the charging member. When the charging member is in the form of a blade (charging blade) fixed to the member to be charged, the charging noise is greater than in the case of the charging member is in the form of a roller rolling on the member to be charged.

Referring to Figure 5, there is shown a prior art contact type charging device using a charging blade for the charging member. Designated by a reference numeral 1 is a member to be charged. In this example, the

member to be charged is a photosensitive drum of an electrophotographic machine. It is rotated in the clockwise direction A (arrow) at a predetermined process speed (peripheral speed).

The charging blade is designated by a reference numeral 10 as being made of electrically conductive rubber having a controlled resistance, for example. The charging blade 10 is mounted on a blade supporting metal plate 16, the free end of the blade is contacted on the surface of the photosensitive drum 1 (the member to be charged) at a predetermined contact pressure, by properly fixing the blade supporting metal plate 16 on a stationary member 50.

In this example, the charging blade 10 is counterdirectionally contacted to the surface of the photosensitive drum 1 at a position of angle $\alpha°$ from the horizontal position with a contact angle of $\theta°$ with respect to the tangential line O. A back electrode 21 of the charging blade 10 is electrically connected to the conductive blade supporting metal plate 16 through a conductive paint. A predetermined oscillating voltage is applied from a voltage source E to the blade supporting metal plate 16, by which the charging blade 10 is supplied with electric voltage so that the surface of the rotating photosensitive drum 1 is electrically charged. Designated by a reference character L is a free length of the blade from the edge a of the blade supporting plate 16 to the free end of the charging blade.

The charging noise tends to increase with increase of (phantom) sinking amount of the charging blade into the photosensitive member and with increase of a nip width w with the photosensitive member. When the charging blade is press-contacted to the photosensitive member (the member to be charged), a certain degree of pressure is required. At least 0.3 mm of the sinking amount is desired, in consideration of the variation of the amount, 0.7 mm will be possible. In this case, the charging noise is significant. Here, the sinking amount is a distance from the surface of the member to be charged to the free edge of the blade when the member to be charged is removed.

SUMMARY OF THE INVENTION

Accordingly, it is a principal object of the present invention to provide a charging device, a process cartridge and an image forming apparatus in which the charging noise is reduced.

It is another object of the present invention to provide a charging device, a process cartridge and an image forming apparatus in which the contact of the charging member to the member to be charged is stabilized.

It is a further object of the present invention to provide a charging device, a process cartridge and an image forming apparatus in which the uniform charging of the member to be charged can be stabilized.

These and other objects, features and advantages of the present invention will become more apparent upon a consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of a major part of an image forming apparatus using a contact type charging device according to an embodiment of the present invention.

Figure 2 is an enlarged view of the contact type charging device shown in Figure 1.

Figure 3 is a sectional view of a major part of a device according to a second embodiment of the present invention.

Figure 4 is a sectional view of a major part of a device according to a third embodiment of the present invention.

Figure 5 is a sectional view of a conventional contact type charging device.

Figure 6 is a graph showing a relation between a rubber hardness of a charging blade and a permanent deformation rate.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(1) Image Forming Apparatus

Figure 1 is a sectional view of a major part of an image forming apparatus using a contact type charging device, according to an embodiment of the present invention.

The image forming apparatus comprises an image bearing member in the form of a rotatable photosensitive drum, which is an electrophotographic photosensitive member having an aluminum conductive drum base 1b and an OPC photosensitive layer 1a having a thickness of 25 microns and a dielectric constant of approximately 3, in this embodiment. It is rotated in the clockwise direction A at a predetermined process speed. In this em-

bodiment, the image bearing member 1 is in the form of a drum, but it may be a rotatable belt or the like. In either case, it may be a seamless type, or may have a seam. In the latter case, the copying process steps are executed with synchronizing signals.

The image forming apparatus further comprises an array 2 of short focus lenses as an exposure means for forming a latent image on the photosensitive drum 1, developing means 3 for developing the latent image with toner, transfer means 4 in the form of a transfer roller, timing rollers (registration rollers) 6 for feeding a transfer material P fed in seriatim from an unshown sheet feeding station to between the photosensitive drum 1 and the transfer roller 4 (transfer station) in synchronism with the rotation of the photosensitive drum 1, and a transfer guide disposed between the timing rollers 6 and the transfer roller 4 to guide the transfer material P.

Conveying means 8 for guiding the transfer material P having received the image between the photosensitive drum 1 and the transfer roller 4 to an unshown fixing means. The apparatus further comprises cleaning means 9 for removing residual toner or the like from the photosensitive drum 1 after the image transfer, a cleaning blade 9a for scraping off the residual toner, a container 9b for receiving the residual toner removed by the cleaning device 9a, a charging member in the form of a blade contactable to the photosensitive drum 1 at the position after the cleaning means to uniformly charge the photosensitive drum 1. The charging blade 10 will be described in detail hereinafter.

In the image forming apparatus of this embodiment, the four process means, i.e., the photosensitive drum 1, the developing device 3, the cleaning device 9 and the charging blade 4, are included in the process cartridge 20 at a predetermined positional relations among them. The process cartridge 20 may be inserted into the main assembly of the image forming apparatus along supporting rail (not shown) in the direction perpendicular to the sheet of the drawing. It may be retracted out of the main assembly. When the process cartridge 20 is sufficiently inserted into the main assembly, the mechanical and electrical couplings between the main assembly and the process cartridge 20 are established to enable the image forming apparatus. In the present invention, the process cartridge comprises at least the photosensitive drum 1 and the charging blade 10.

(2) Charging Blade 10

Figure 2 is an enlarged view of the charging blade. The charging blade 10 is fixed to and supported on one of arm plates of a blade supporting metal plate 15 which is swingable about a shaft 23. A charging blade urging spring 24 is stretched between the other arm plate of the metal plate 15 and a stationary cleaning blade supporting plate 25, so that the blade supporting plate 15 is normally urged in the counterclockwise direction B about the supporting shaft 23, by which the free end of the charging blade 10 is press-contacted to the surface of the photosensitive drum 1.

In the normal operating position, the charging blade 10 in this embodiment is contacted to the photosensitive drum 1 (the member to be charged) counterdirectionally (with acute contact angle) with respect to the rotation of the photosensitive drum at a position of an angle $\alpha 0$ from the horizontal direction with a contact angle $\theta 0$ with respect to the tangential direction of the photosensitive drum 1 at the position a degree. here, the contact angle is an angle, at the contact point between the drum and the blade, between the blade and such a portion of the tangential line as is downstream of the contact point with respect to the movement direction of the drum surface.

The position angle α degree is properly selected depending on the locations of various process means and the diameter of the photosensitive drum. The contact angle θ degree of the charging blade 10 is preferably not more than 30 degrees from the standpoint of the charging stability. The counterdirectional contact is not inevitable. However, the counterdirectional contact is preferable in that even if the toner or other residual matter reaches the blade edge portion, they are blocked by the blade edge so that the amount of the residual matter reaching the downstream of the edge portion is reduced, and therefore, the charging of the photosensitive drum is more uniform than with a co-directional contact.

On the backside of the charging blade 10 (the side remote from the photosensitive drum 1), a back electrode 21 is mounted and is electrically connected with the charging blade 10. The voltage from a voltage source E is applied to the charging blade 10 through the conductive blade supporting metal plate 15, an electrically conductive print 22 electrically connected with the back electrode 21, and the back electrode 21.

The pressure of contact between the charging blade 10 and the photosensitive drum 1 is adjustable by changing a spring constant of the pressing spring 24. The line pressure thereof is preferably 5 - 40 g/cm. If it is less than 5 g/cm, non-uniformity of contact along the longitudinal direction tends to occur although it depends on the edge accuracy or the waving of the edge of the charging blade 10. If this occurs, spotty non-uniformity of the charging occurs in a halftone image at the portions where the contact is sufficient. If the line pressure is larger than 40 g/cm, the charging noise becomes harsh, and the friction between the photosensitive drum 1 and the charging blade 10 is so large that the wearing of the photosensitive drum 1 increases together with

the increase of the driving torque required.

The charging blade 10 comprises two layers, i.e., an intermediate resistance layer 10a and a coating layer 10b. The voltage applied to the back electrode 21 forms an electric field sufficient for the charging across a fine space between the charging blade 10 and the member to be charged (photosensitive drum 1), through the intermediate layer 10a and the coating layer 10b of the charging blade 10.

The intermediate resistance layer 10a is of epichlorohydrin rubber or EPDM or the like added with conductive material powder such as carbon black powder, metal oxide (zinc oxide, titanium oxide) powder so as to provide a volume resistivity of $1x10^6$ - $1x10^9$ Ωcm. The thickness thereof is preferably 1 - 3 mm.

The coating layer 10b is usable if the surface resistance thereof is not less than $5x10^7$ Ω/□, and the thickness thereof is 3 - 100 microns. From the standpoint of the coating stability, it is preferably not less than 10 microns in consideration of the variation of the thickness of the coating layer, because if the thickness is not more than 5 microns, there may occur no coated portion due to the coating variation. The material of the coating layer 10b preferably has a flexibility, good surface properties, low friction coefficient and anti-wearing property.

In this embodiment, the intermediate resistance layer 10a was prepared by dispersing zinc oxide in epichlorohydrin rubber material so as to provide a volume resistivity of $1x10^8$ Ωcm (under application of 1000 Vdc). The coating layer 10b was prepared by dispersing carbon in PTFE dispersion paint (Emraron 345, available from Nihon Achison) so as to provide $1.7x10^8$ Ω/□ (1.0 KV). The coating layer was applied in 30 microns thick by dipping.

The coating layer 10b has far lower friction coefficient than the epichlorohydrin rubber of the intermediate resistance layer 10a, and therefore, the sliding property is remarkably improved. Therefore, so-called "turn-up" of the blade edge which tends to occur at the initial stage of the photosensitive drum 1 rotation, can be effectively prevented. In addition, the required torque and the wearing can be remarkably reduced.

In this embodiment, the charging blade 10 has a two layer structure. However, the surface resistance of the intermediate resistance layer 10a is not less than $5x10^7$ Ω/□. If the friction coefficient thereof is low enough not to turn up, the coating layer 10b is not inevitable, and therefore, a single structure charging blade is satisfactory.

The investigations have been made as to the charging noise and the imaging property for the charging device of the embodiments (Figures 1 and 2) and for the prior art charging device of Figure 5 under the same contact conditions except for the contact pressure and the sinking amount.

Common contact conditions:

α = 35 degrees
θ = 10 degrees
Thickness of the charging blade 10 = 1.5 mm
Free portion length L of the blade 10 = 6.5 mm

Common image forming conditions:

Process speed = 72 mm/sec
Photosensitive drum diameter = 30 mm
Applied bias voltage: AC + DC
AC = 500 Hz, 1800 Vpp
DC = -750 V

Pre-exposure (exposure of the drum after image transfer and before charging): No Image potentials:

Dark potential Vd = -700 V
Light potential V1 = -230 V
Halftone potential Vh = -400 V

The unevenness of the image was evaluated on halftone images produced through a regular development both at the initial stage of the operation and after 3000 prints were produced.

The results of the tests are show in Table 1 below.

Table 1

		CONTACT PRESS. (g/cm)	NOISE LEVEL	INITIAL NON-UNIFORMITY	NON-UNIFORMITY AFTER DURABILITY TEST
EMBODIMENT	1	5	E	E	G
	2	10	E	E	E
	3	30	E	E	E
	4	40	G	E	E
PRIOR ART	1	Sink 0.2 mm	E	F	NG
	2	0.3 mm	E	E	NG
	3	0.5 mm	G	E	G
	4	0.8 mm	NG	E	E

Charging noise:

E: substantially nothing (substantially no difference from corona discharger, 47 - 48 dB)
G: slight (49 - 53 dB)
NG: noisy (not less than 54 dB)

The charging noise was measured by a noise meter ("NL-02", available from RION Kabushiki Kaisha) placed 1 m away from the front side of the apparatus.

Image unevenness (non-uniformity):

E: substantially no
G: slight at times (2 - 3 stripes)
F: slight
NG: unsatisfactory (not less than 10 stripes on a halftone image, and some stripes on solid black image)

The image unevenness were evaluated on the basis of stripes appearing on the image and extending in the direction of the transfer material movement.

From Table 1, it will be understood that in order to reduce sufficiently the charging noise, it is desirable that the sink amount is not more than 0.5, and that in order to maintain the evenness of the image after the durability test run, the sink amount is desirably not less than 0.5. In order to satisfy both of them, the sink amount is limited within a very narrow range about 0.5.

The cause for the increased unevenness of the image after the durability test run, is considered as being the reduction of the contact pressure due to the wearing of the charging blade which leads to the unevenness of the contact. In this embodiment, charging noise is at the satisfactory level if the contact pressure is not more than 40 g/cm, and the image evenness is satisfactory after the durability test run if the contact pressure is not less than 5 g/cm. Accordingly, the contact pressure is selectable in a very wide range.

The reason why the image evenness is maintained even after the durability test run is considered as being that even if the charging blade 10 is worn, the contact pressure is assured by the spring 24 so that the even contact pressure is maintained. In the case of charging blade, the electric resistance thereof is desirably intermediate, and in order to provide the electric conductivity, the addition of conductive powder is desired. Since the usable resistance width is narrow, and therefore, the property of the rubber material can not be significantly

changed. For these reasons, any remarkable improvement in the creep property in an attempt to reduce the wearing of the charging blade 10, is difficult. In consideration of the above, it is possible that the rubber material can be modified mainly in consideration only of the electric properties of the charging blade.

The waveform of the oscillating voltage component may be a sine wave, a rectangular wave, a triangular wave or the like. The oscillating voltage may be provided by periodically turning on and off the DC voltage source (rectangular waveform). The oscillating voltage applied between the photosensitive drum 1 and the charging blade 10 desirably has a peak-to-peak voltage which is not less than twice the charge starting voltage between the charging blade 10 and the drum 1.

The description will be made as to a charging blade 10 comprising epichlorohydrin rubber in which carbon black is dispersed as the conductive powder, so that the volume resistivity thereof is $1x10^6$ Ωcm. The contact angle between the charging blade 10 and the drum 1 (θ) was 20 degrees. The contact pressure therebetween was 20 g/cm (line pressure) (initial setting). The free portion length L of the blade between the free end of the charging blade 10 and the edge of the supporting member 15, was 7 mm.

In this embodiment, the contact pressure between the charging blade 10 and the drum 1 was initially 20 g/cm. However, with the creep of the rubber material of the charging blade 10 with the result of permanent deformation with elapse of time, the contact pressure gradually decreases. Generally, the term of guarantee of the process cartridge detachably mountable to the image forming apparatus, is two years. In view of this term of guarantee, it is required that the contact pressure of 5 g/cm approximately is maintained to assure proper charging even after two years.

Experiment 1

The charging blades of a variety of hardness made of epichlorohydrin rubber which carbon black is dispersed are pressed at the initial contact pressure of 20 g/cm, and are kept on the shelf under 45 °C condition for five days (this corresponds to keeping on the shelf under the normal temperature of 23 °C for two years). Figure 6 is a graph showing a relation between the rubber hardness of the blade and the permanent deformation rate when they were kept on the shelf for five days.

The permanent deformation (rate) is determined as follows: The blade is kept on the shelf at 45°C for five days while the edge thereof is kept deformed by 1 mm by pressure. Thereafter, the pressure is removed, and the deformation of the blade is measured within 1 minute after the release. If 0.1 mm deformation remains, the permanent deformation (rate) is 10 %. If 0.5 mm deformation remains, it is 50 %. If 1 mm deformation remains, it is 100 %. From Figure 6, it will be understood that the permanent deformation of the blade 10 increases with increase of the rubber hardness, and increases with decrease of the rubber hardness.

As described hereinbefore, the minimum pressure for the desired stabilization of the blade contact is 5 g/cm, and therefore, in order to maintain the 5 g/cm contact pressure even after the charging blade is kept pressed with the initial setting of 20 g/cm at 45 °C for five days, it is required that the permanent deformation is not more than 75 %.

From the standpoint of the permanent deformation in consideration of maintaining the proper contact pressure, the rubber hardness is not less than 55 degrees.

Experiment 2

In order to lower the rubber hardness, a larger amount of the oil is contained. Generally, the oil tends to seep out under high temperature, high humidity and pressed conditions in the case of the low hardness rubber, and the conductive powder containing rubber (for the purpose of low resistance) is not easily kneaded, and therefore, even a larger amount of oil is contained. This further increase the oil seeping tendency. Table 2 below shows the results of experiments investigating the relation between the rubber hardness and the oil seeping.

Table 2

RUBBER HARDNESS (deg. JIS A)	50	55	60	65	69	74	80	83
OIL SEEPAGE	NG	G	G	G	G	G	G	G

(35 °C, 90 %, 1 week on the shelf)

G: Good images (without seeped oil)

NG: Improper images (with seeped oil)

In this experiments, the contact conditions between the charging blade 10 and the drum 1 are maintained. Process cartridges 20 in which the charging blades 10 are press-contacted to the drums 1 were placed under 35°C and 90 % humidity conditions for one week, and thereafter, the images were formed, and the image qualities were evaluated.

It will be understood that with the rubber hardness of 50 degrees, the oil seeps out onto the drum 1 with the result of improper images. If, however, the hardness is not less than 55 degrees, the oil does not seep out and therefore, the produced images were good. From the standpoint of preventing the oil seep, the rubber hardness is desirably not less than 55 degrees.

Experiment 3

Process cartridges which the charging blades are rest under the same conditions and are kept under the condition of 15 °C temperature and 10 % humidity (low temperature and low humidity). These conditions are difficult conditions in that the resistance of the rubber increases, that the followability to the vibrational movement is worsened, therefore, that the charging performance is worsened very much. With these conditions, the image quality evaluation tests were carried out in terms of the relation between the rubber hardness and the charging property. The results are given in Table 3 below.

Table 3

CHARGING PROPERTY	AC VOLT Vpp (KV)					
RUBBER HARDNESS (deg. JIS A)	1.4	1.6	1.8	2.0	2.2	2.4
50	E	E	E	E	E	E
55	E	E	E	E	E	E
60	E	E	E	E	E	E
65	E	E	E	E	E	G
69	E	E	E	E	G	NG
74	E	E	E	E	G	NG
80	E	E	E	G	NG	NG
83	E	E	G	NG	NG	NG

E: Excellent (no improper charging)

G: Improper charging occurs at times

NG: Improper charging occurs

In Experiment 3, the charging blade 10 was supplied with DC voltage of -700 V biased with an AC voltage of 1.4 KV - 2.4 KV. The charging performance was evaluated on the basis of the image quality. The rubber hardness was changed in the range of 55 - 83 degrees (8 points).

The AC voltage was selected as being not less than 1.4 KV, because if it is lower than that, the uniforming effect of the AC voltage decreases with the result of roughened images. In consideration of variations in the individual transformers, ±10 % margin is preferably provided.

Looking at the results of Experiment 3 in consideration of the above, the preferable rubber hardness is 50 - 80 degrees.

The reason why the improper charging occurs when the AC voltage is high is as follows. The instable contact of the charging blade which is originally in stick and slip contact, is increased by the large AC voltage, and the increase of the rubber hardness deteriorates the followability relative to the rotation of the surface of the drum, and therefore, the tolerable range for the charging performance is narrowered.

From the above-described Experiments 1 - 3, it will be understood that the rubber hardness is preferably 55 - 80 degrees to provide stabilized images for a long term.

The electric resistance of the blades having the different hardness are maintained constant by ajusting the content of the conductive powder. Here, the used rubber was only epichlorohydrin rubber, and the conductive powder is added to provide the electrically conductive rubber. The reason for this is that the resistance of the epichlorohydron rubber is relatively low as compared with the other rubber materials. Because of the low resistance nature of this rubber, the required amount of the conductive powder to provide the same electric resistance may be smaller, and therefore, the influence to the rubber property can be minimized.

The permanent deformation nature of the epichlorohydron rubber is slightly poor, and therefore, it is effective to add urethane rubber, EPD (tercopolymer of ethylenepropylenediene) to improve the permanent deformation nature or the like. It is a possible alternative that the surface of the epichlorohydron rubber is coated with a resistance layer of urethane resin containing dispersed titanium oxide or another electrically conductive

powder so as to provide,a resistivity of $1x10^9$ Ω/□ and having a thickness of approximately 30 microns. The resistance layer is contacted to the photosensitive drum 1.

The provision of the resistance layer is effective to stabilize the charging property even in case where the surface of the photosensitive drum 1 is damaged for one reason or another to produce a low durable voltage portion, a pin hole or holes are produced. With such a damage or pin hole, the electric current may be concentrated on the damage portion or the pin hole without the resistance layer.

With the case of the resistance layer provided, the natures of the blade are similar to those described above. The relations between the permanent deformation rate or the charging performance and the rubber hardness are the same even if the thin resistance layer is applied or bonded only at an end portion of the blade 10. In other words, such natures are dependent on the base layer, that is, the epichlorohydron rubber hardness.

Referring to Figure 3, the second embodiment of the present invention will be described.

Embodiment is different from Figure 2 embodiment only in the pressing means for the charging blade 10. In the Embodiment 1, the urging means is in the form of a tension coil spring only for the purpose of urging the charging blade 10. Therefore, electrode for applying the voltage to the charging blade 10 and contact for receiving electric power from the main assembly of the image forming apparatus, are required.

In the present embodiment, a primary charging contact 26 for receiving electric power supply from the main assembly of the image forming apparatus is in the form of a leaf spring which is fixed on a cartridge frame 28. The leaf spring is partly (26a) exposed to function as electric power receiving contact of the process cartridge, and the inside portion thereof is projected as a leaf spring portion 26b (urging means) for rotationally urging the blade supporting metal plate 15. The end of the projected portion is contacted to the supporting plate 15. Thus, the supporting plate 15 is normally urged in the counterclockwise direction B about the shaft 23 to contact the free end of the charging blade 10 with a predetermined pressure. Simultaneously, the voltage required for the charging action is supplied to the charging blade supporting metal plate 15 through the primary charge contact 26a, the leaf spring portion 26b.

By the use of the leaf spring structure fixed on the cartridge frame 28 to provide the primary charge contact 26 electrically contactable with the power source of the image forming apparatus, it becomes possible to provide the pressing means of the charging blade 10 and the power supply means by a single material.

Referring to Figure 4, a charging device according to a third embodiment of the present invention will be described. In this embodiment, the charging blade 10 also functions as a cleaning blade of the cleaning device 9.

The charging blade is disposed in the upper opening of the cleaning device 9. The charging blade 10, the charging blade supporting metal plate 12, the sealing member 31, the cleaner container 9b and the receiving sheet 9c, constitute the cleaning device 9. The charging blade 10 also functions as the cleaning blade to remove the toner remaining on the photosensitive drum 1 after the image transfer.

The charging blade 10 is fixed and supported on one of arm plates of the blade supporting plate 15 which is swingable about a shaft 23. The pressure spring 30 for the charging blade 10 is in the form of an electrically conductive compression spring disposed between the other arm plate of the supporting plate 15 and an electrode plate 32 mounted on the inside surface of the process cartridge frame 28. The spring 30 is effective to normally urge the blade supporting plate 15 about the shaft 23 in the counterclockwise direction B, by which the free end of the charging blade 10 is abutted to the photosensitive drum 1, and the pressure-contact state therebetween is maintained. The voltage from the voltage source E is applied to the charging blade 10 through the electrode plate 32, the conductive compression spring 30, the conductive supporting metal plate 15, electrically conductive paint and a back electrode 21. The sealing member 31 is fixed to the top of the cleaner container 9b and fills the space between the supporting plate 15 and the container 9b to prevent the toner leakage from the cleaning device 9.

In this embodiment, the charging blade 10 also functions to clean the photosensitive drum 1, and therefore, the contact pressure of not less than 20 g/cm is desirable. Because of the dual function of the charging blade 10, there is no need of the cleaning blade upstream of the charging blade 10 with respect to the movement direction of the surface of the drum 1. Therefore, a simpler structure of the process cartridge is enabled. Therefore, the low cost small cartridge can be provided. The cleaning with the blade supplied with the AC voltage is preferable because the toner particles strongly attached to the surface of the photosensitive drum by coulomb force can be electrically discharged or charged to the opposite polarity, and therefore, better cleaning effect can be expected.

As compared with the urethane rubber or the like used for the conventional cleaning blade, the rubber material of the charging blade is relatively easily worn. However, with the structure of this embodiment, the stabilized contact and the stabilized cleaning performance can be maintained with less variation of the contact pressure. From the standpoint of reducing the wearing, the coating layer 10b of the charging blade may be provided only at the edge of the charging blade 10, because most of the materials for the coating layer 10b have

a high hardness as compared with the intermediate resistance layer 10a and do not show the rubber property.

As described in the foregoing, according to the present invention, the contact type charging blade supplied with the oscillating voltage produced less noise and stabilized contact between the charging blade and the member to be charged or discharged in a long term use, thus providing stabilized uniform charging operation.

While the invention has been described with reference to the structures disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

Claims

1. A charging device comprising:
   a charging blade contactable to a member to be charged;
   voltage applying means for applying an oscillating voltage between said charging blade and the member to be charged; and
   urging means for urging said charging blade and the member to be charged toward and away from each other.

2. A device according to Claim 1, wherein said oscillating voltage as a peak-to-peak voltage which is less than twice a charge starting voltage for the member to be charged.

3. A device according to Claim 1 or 2, wherein said oscillating voltage is in the form of an AC biased DC voltage.

4. A device according to Claim 1, wherein said urging means includes a spring.

5. A device according to Claim 1, wherein a pressure between said charging blade and the member to be charged is 5 - 40 g/cm.

6. A device according to Claim 1 or 4, wherein said charging blade includes a rubber layer, and said apparatus further comprises a supporting member for supporting the rubber layer, wherein said supporting member is joined with said urging means.

7. A device according to Claim 1, wherein said charging blade includes a rubber layer and a coating layer outside said rubber layer and contactable to the member to be charged.

8. A device according to Claim 1, wherein said charging blade includes a rubber layer mainly comprising epichlorohydrin rubber having a hardness of 55 - 80 degrees (JIS A).

9. A process cartridge detachably mountable to an image forming apparatus, comprising:
   an image bearing member;
   a charging blade contactable to said image bearing member to electrically charge or discharge said image bearing member, wherein an oscillating voltage is applied between said charging blade and said image bearing member; and
   urging means for urging said charging blade and said image bearing member toward and away from each other.

10. An image forming apparatus, comprising:
    an image bearing member;
    image forming means for forming an image on said image bearing member;
    a charging blade contactable to said image bearing member to electrically charge or discharge said image bearing member;
    voltage applying means for applying an oscillating voltage between said image bearing member and said charging blade; and
    urging means for urging said charging blade and said image bearing member toward and away from each other.

11. An apparatus according to Claim 10, wherein said image bearing member includes a photosensitive member.

12. An apparatus according to Claim 10, wherein said charging blade also functions to clean said image bearing member.

13. An apparatus according to Claim 10, further comprising a cleaning member for cleaning said image bearing member, and wherein said urging means urges the cleaning member and said image bearing member toward each other.

14. An apparatus according to Claim 10, wherein said urging means is in the form of an electrode for applying the oscillating voltage to said charging member from said voltage applying means.

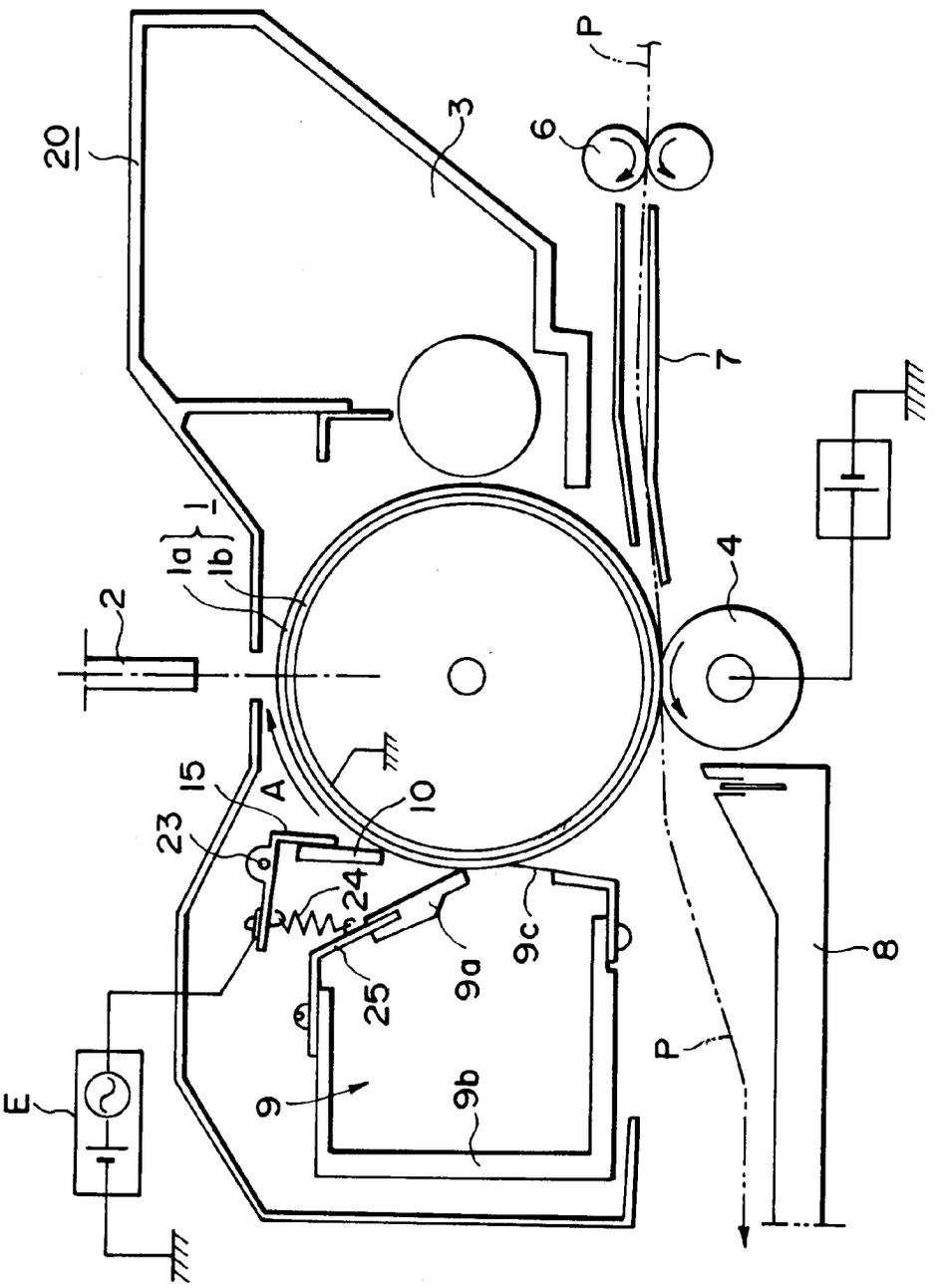


FIG. 1

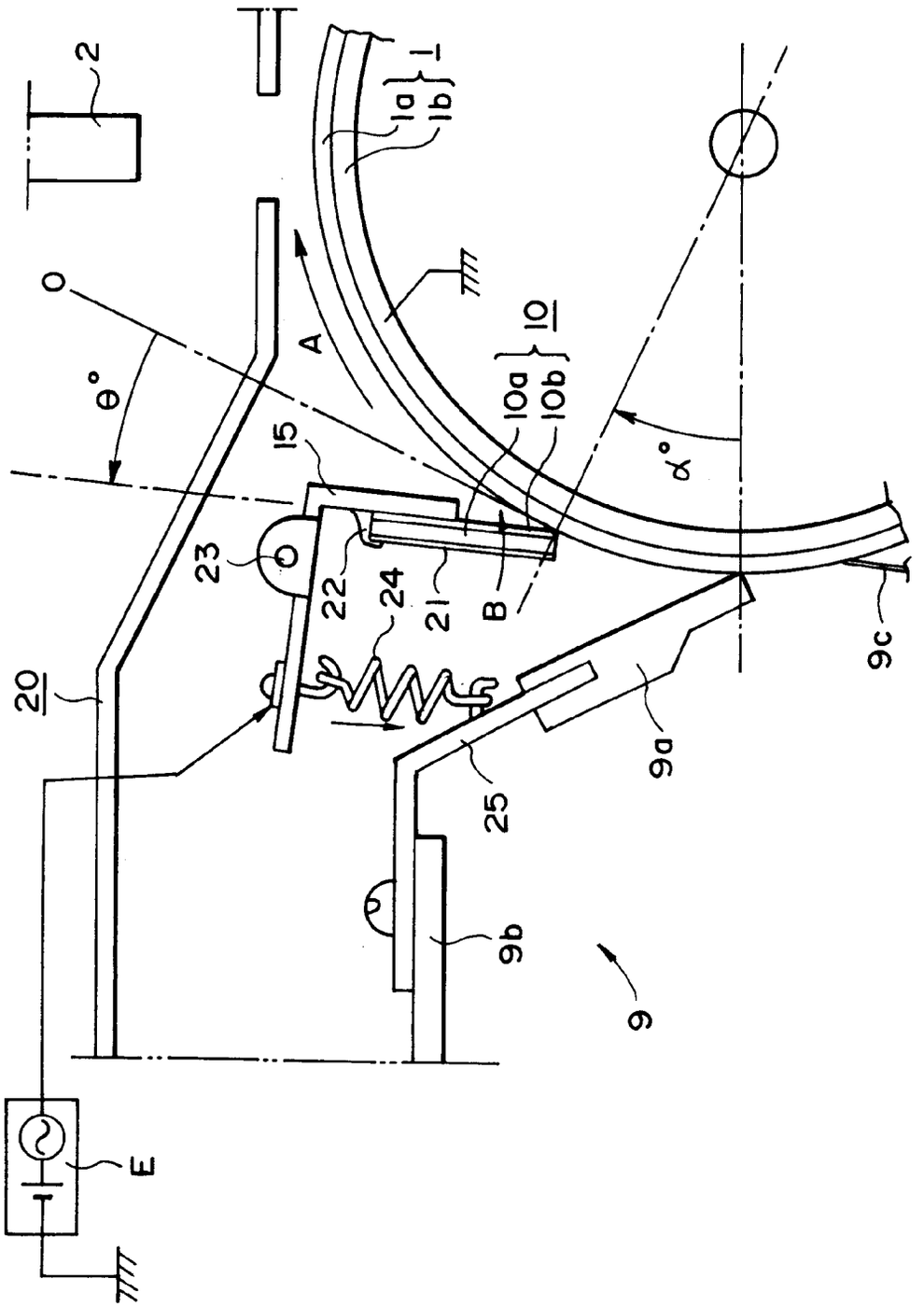


FIG. 2

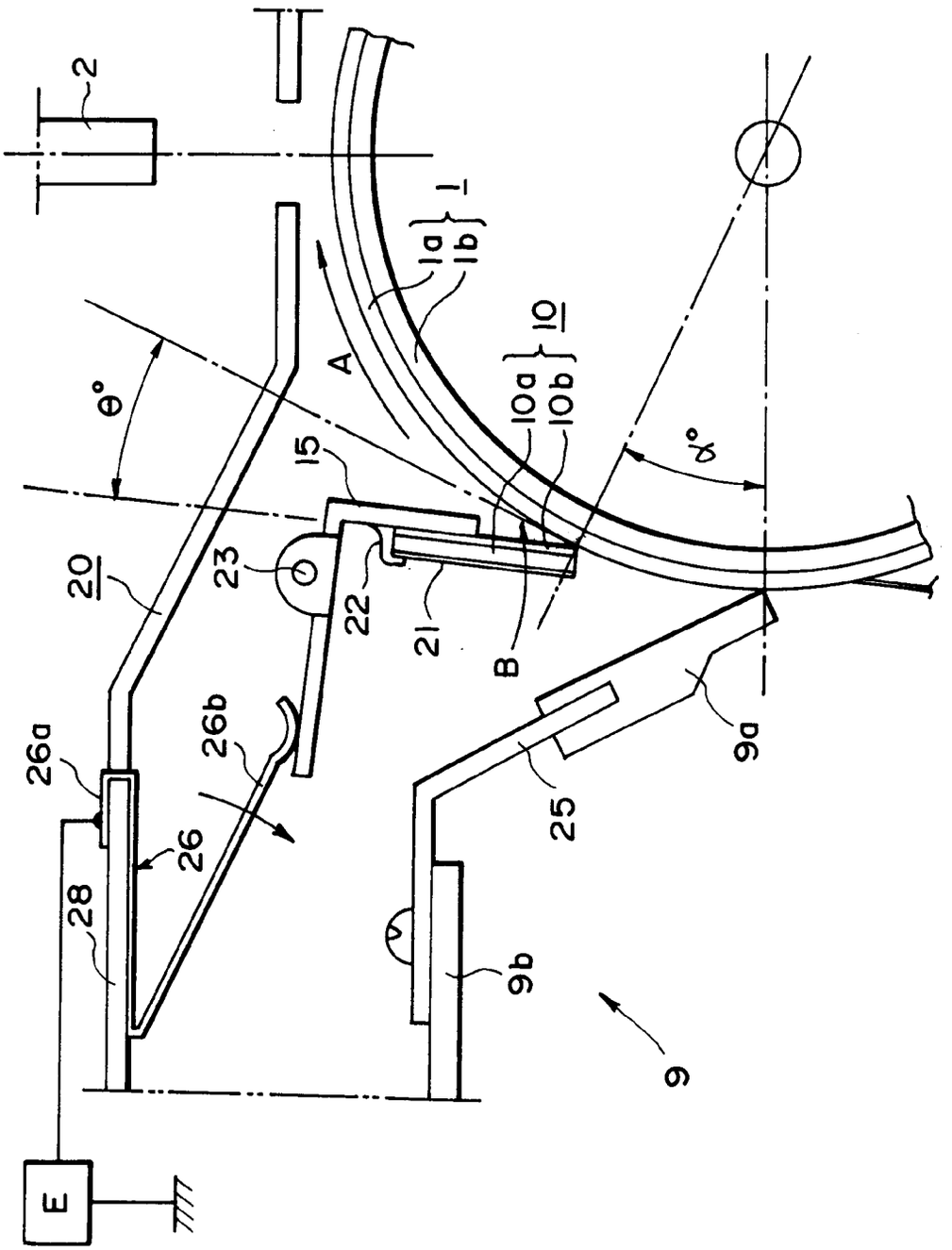


FIG. 3

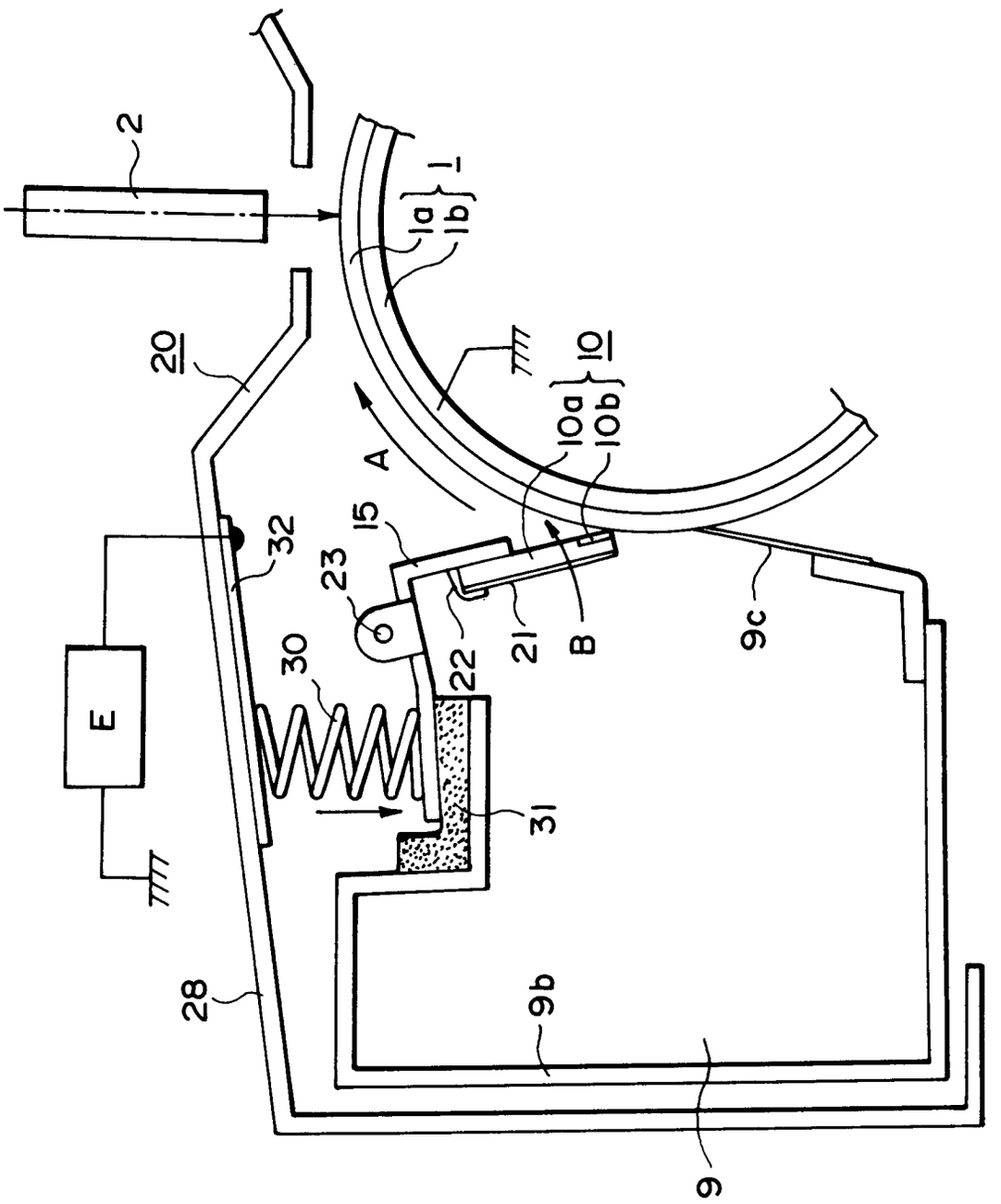


FIG. 4

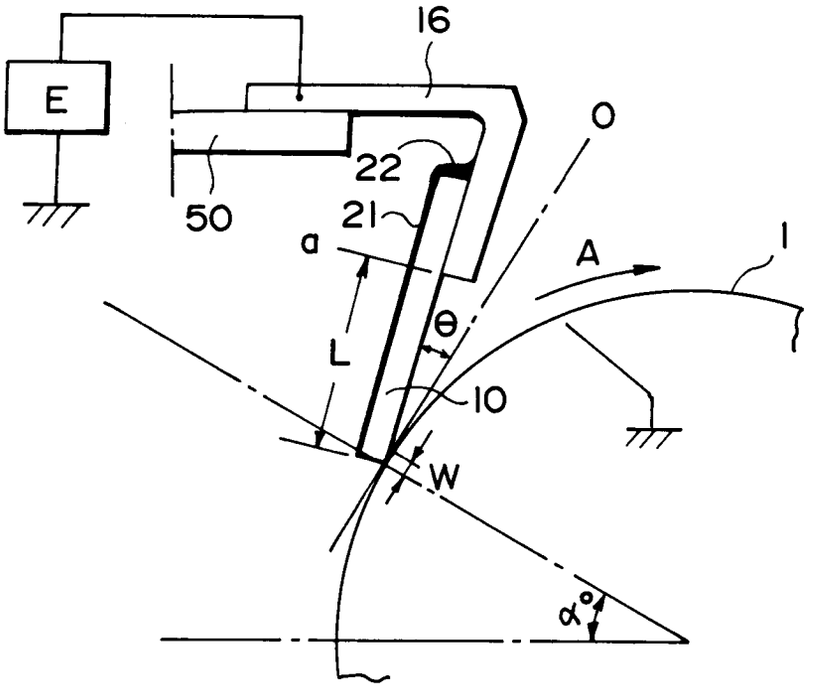


FIG. 5

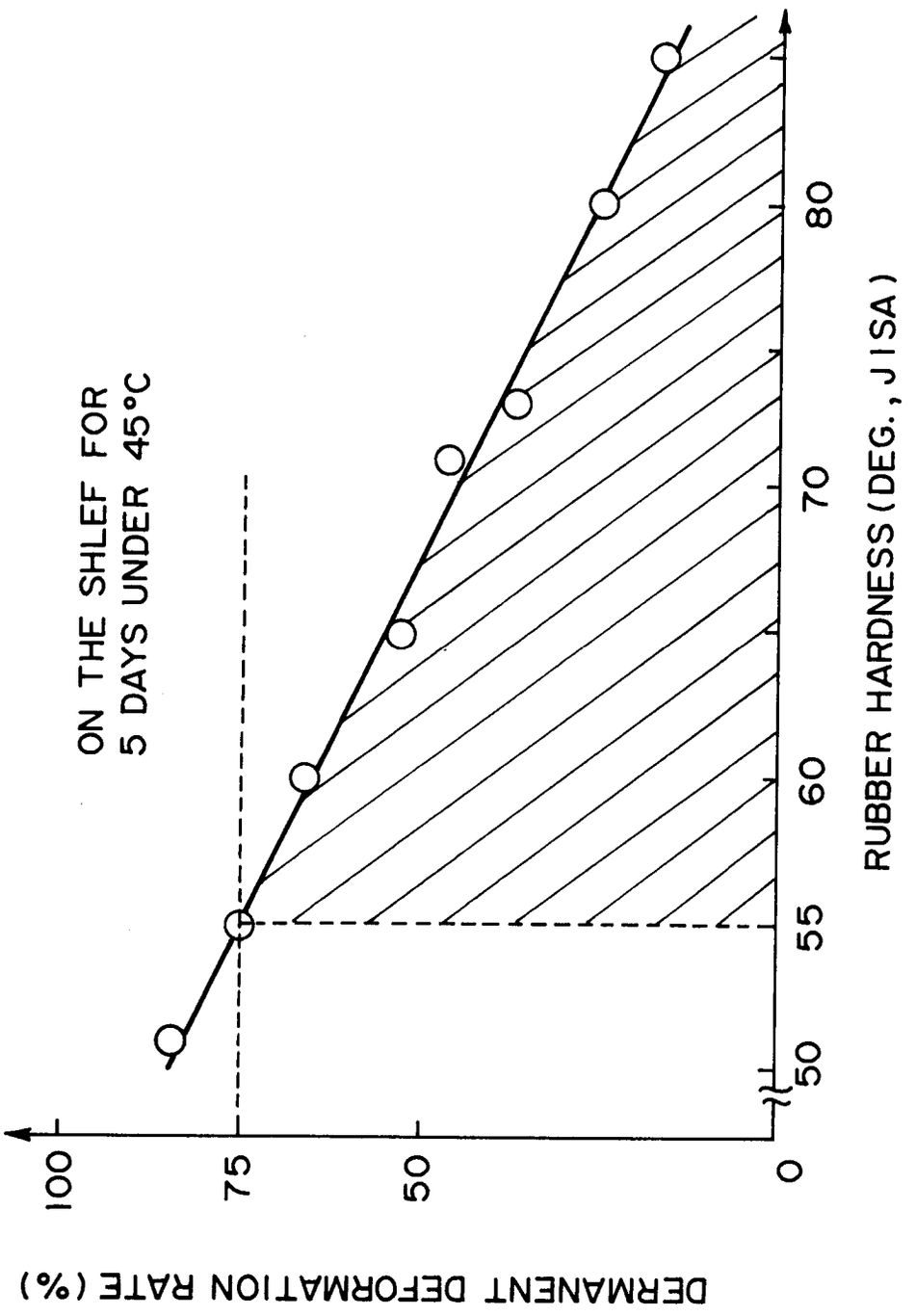

PERMANENT DEFORMATION RATE (%)
100
75
50
0
50
55
60
70
80
RUBBER HARDNESS (DEG., JISA)
ON THE SHLEF FOR
5 DAYS UNDER 45°C

FIG. 6