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(54) A PROCESS OF STRIPPING DEVELOPING
 A PHOTSENSITIVE MATERIAL
 AND APPARATUS THEREFOR

(71) We, FUJI PHOTO FILM CO., LTD., a Japanese Company, of No. 210, Nakanuma, Minami Ashigara-Shi, Kanagawa, Japan, 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 a process of developing a photosensitive material, and apparatus therefor wherein an image on a photosensitive material consisting of a cover sheet laminated onto a photosensitive layer which has been coated on a support member is developed into a visible resist image by stripping the cover sheet from the support member.

The photosensitive material is of the type which consists of a support member (such as an aluminum plate), a photosensitive layer containing a photo-hardenable material, and a cover sheet which is transparent to light (such as a polyethylene terephthalate film), and after imagewise exposure the areas of the photosensitive layer exposed to light are cured and adhere to the support and unexposed areas thereof adhere to the cover sheet; this photosensitive material is developed to give a resist image on the support member, by stripping the cover sheet from the photosensitive material. The reverse type of adhesion is also possible, whereby the image obtained is reversed.

One prior specific method for carrying out such development is by sticking an adhesive tape to the surface of the cover sheet and pulling the adhesive tape to strip the cover sheet from the support member. Such a device, however, requires extra material, i.e. the adhesive tape, and also an adhesive tape

feed mechanism, resulting in increased manufacturing and running costs. Furthermore, such a device does not always perform satisfactorily due to insufficient adhesion of the adhesive tape to the cover sheet.

Another prior development method uses a roller provided with suction holes in its peripheral surface, so that the cover sheet is stripped under suction. This process requires a vacuum pump and an air control mechanism, resulting in an increased size of the device itself, and hence an increased cost.

It is an object of the present invention to provide a stripping and developing process having advantages over these known methods.

There is provided according to the present invention a process of stripping developing an imagewise exposed photosensitive sheet material to form a relief image, the material consisting of a support coated with a photosensitive photo-hardenable layer on which is adhered a transparent cover sheet through which the material has been imagewise exposed, the process comprising the following steps:

(a) friction means is moved in a first direction while in rubbing contact with one edge (the leading edge) of the cover sheet of the material so that that edge of the cover sheet is stripped from the support by friction;

(b) the stripped edge is gently replaced, by friction means moving in the reverse direction, in its original position but with a lesser adhesion than originally; and

(c) the leading edge of the cover sheet is held by a stripping means and the entire cover sheet is stripped from the leading to the trailing end by relative movement of said stripping means and the material, where-

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upon the exposed areas of the photosensitive layer remain adhered to the support and the unexposed areas remain adhered to the cover sheet or support so as to provide a relief image on the support.

There is also provided apparatus for carrying out this process, which comprises:

(i) friction means capable of stripping the leading edge of the cover sheet of the photosensitive material;

(ii) means for transporting said material so that the leading edge of the cover sheet contacts the friction means;

(iii) means for moving said friction means relative to said cover sheet so as to strip said leading edge thereof;

(iv) means for moving the aforesaid friction means, or a second friction means, in a reverse relative movement to the aforesaid movement so as to gently replace said leading edge; and

(v) means for holding the replaced leading edge of the cover sheet and for stripping the entire cover sheet from the support.

Hitherto, failure of stripping of a cover sheet from a support has occurred due to the misalignment of the leading end of the cover sheet which has become partly separated from the support, which misalignment results from the turning-up of the leading end of the cover sheet during the transportation of the photosensitive material from a preliminary stripping step to the final stripping developing step, or due to formation of a gap between the cover sheet surface and the suction surface where a suction system is adopted as a stripping and developing means and the suction is inadequate. To avoid this, according to the process of the present invention, the leading end of a cover sheet (a) is pre-stripped from the support and (b) is gently replaced in its original position on its support, so that the photosensitive material may be transported with the cover sheet in a condition wherein it is readily separable, because of the reduced adhesion, to (c) the final stripping developing step which is then easily carried out.

The process is advantageously carried out on imagewise exposed material which is continuously fed by feed rolls or the like through a development apparatus.

The step (a) of stripping the leading end of the cover sheet from the support may be carried out by a friction means operated in a direction opposite to the advancing direction of the photosensitive material. The friction means may have a surface which is finely roughened, such as a file, or of tough upright filaments (a brush). The configuration of the friction means has no particular limitation, but preferably it is in the form of a flat body or in the form of a roller or belt. The step (b) of replacing the separated leading end of the cover sheet onto the support may be

achieved by rotating the friction means in a direction reverse to that used in step (a), at a speed higher than the speed of movement of the photosensitive material, or by providing a separate friction means separately from the aforesaid friction means.

The invention will be described with reference to the accompanying drawings, wherein:

Figs. 1 to 6 are side views of means (i) to (iv) of various forms of apparatus for carrying out the preliminary steps (a) and (b) of the process of the present invention;

Figs. 7 to 14 and 16 are side views of forms of the means (v) of apparatus for carrying out the final stripping step (c) of the process; and

Fig. 15 is a side view of a complete stripping developing apparatus for effecting the entire process of the present invention.

In Figs. 1 to 6, the exposed photosensitive material to be developed is shown at P, and is to be advanced in the direction A along the line between the feed rollers 1. Figs. 1 to 3 show the use of a single friction means for carrying out both steps (a) and (b); the friction means being of different configurations. In Fig. 1 the friction means 2 is a flat plate having a surface arranged to contact the cover sheet of the material and movable on its own plane; a pressure plate 4 is fixed opposite to this means 2. Fig. 2 shows a friction means in the form of a roller 2, the peripheral surface of which is molded in the form of a brush or bears a tape on which are numerous projecting filaments of hard material; opposite the roller 2 are idle rollers 4a. Fig. 3 shows a friction means in the form of an endless belt 2 having thereon numerous filaments of hard material. In using each of these embodiments, the friction means are operated (a) in the direction of arrow B to strip the cover sheet at the leading end thereof from the support member, and then (b) operated in the direction of arrow C to gently restore the cover sheet to its original position, in register with the support, but with a reduced adhesion than originally.

Figs. 4 to 6 show further embodiments in which a second friction means (iv) is provided, separately from a first friction means (i), for restoration of the leading end portion of the cover sheet with that of the support. In Fig. 4, first brush rollers 2a arranged side by side are rotated, as a friction means, in the direction of arrow B, and second brush rollers 2b are arranged side by side so that one brush roller of the latter group is interposed between the neighboring brush rollers of the first group and rotated in the direction of arrow C as a restoration means. Fig. 5 includes a diametrically large brush roller 2a serving as a friction means, and a diametrically small brush 2b roller serving as a restoration means and spaced apart from

the diametrically large brush roller. In this embodiment, the friction means is rotated in the direction of arrow B independently of the restoration means which in turn is rotated in the direction of arrow C. In Fig. 6, a group of endless belts 2a arranged in side by side relation and having a number of filaments of hard material on the surfaces thereof are rotated, as a friction means, in the direction of arrow B, and another group of endless belts 2b arranged in side by side relation in a manner that one belt element thereof is between the neighboring belt elements of the former group of endless belts and having a number of filaments of hard material are rotated as a restoration means in the direction of arrow C.

The final stripping step (c) is for stripping the whole of the cover sheet from the support member first from the leading end portion and continuing to the trailing end, the leading end portion of the cover sheet having been subjected to the preliminary stripping and brought back into registration with the support member in the preliminary stripping step. In this final stripping step, the cover sheet is stripped from the support member first from the leading end and continuing to the trailing end, thus the cover sheet is separated from the support member completely. There may be employed in this step a stripping means serving as a separating means as well, or the combination of a stripping means and a separating means. The stripping means may utilize any of suction, air-blowing, separating blade and friction. The separating means may be a transporting roller, transporting belt, a reciprocating link mechanism with a means for clamping the leading end of the cover sheet, or a means for pulling the cover sheet by arresting the leading end or side edge of the cover sheet by a needle or pawl.

In Fig. 7, there is employed a stripping means consisting of a suction roller and a nip roller. In this embodiment, the leading end of the cover sheet subjected to the preliminary stripping, when it reaches a suction port of the suction roller, is attracted under suction due to decreased pressure to the peripheral surface of the suction roller, then pulled downwards with the rotation of the suction roller, and inserted between the nip roller and the suction roller. At this instant, suction due to decreased pressure is relieved, and the cover sheet is wholly separated from the support member by the rotation of the suction roller and the nip roller, as shown in Fig. 8.

Fig. 9 shows a stripping means having a clamping and pulling pawl, wherein the clamping pawl has a wire brush in the tip portion thereof and closes while it rubs the leading end of the cover sheet subjected to the preliminary stripping, and are shifted

downwards, with the leading end of the cover sheet clamped between the tips thereof, thereby separating the cover sheet from the support member, in the manner shown in Fig. 10.

In Fig. 11, a suction roller incorporating a clamping pawl is provided as a stripping means. In this embodiment, the leading end of the cover sheet subjected to the preliminary stripping is led under suction into a suction hole in the suction roller, then a pawl facing the suction hole is caused to slide to a position shown in Fig. 12, and the suction roller is rotated to separate the cover sheet from the support member.

Fig. 13 shows another arrangement of the final stripping step in which a stripping roller 26 and a nip roller 27 are provided below guide plates. As clearly seen in Fig. 14, stripping roller 26 is constructed by prefabricating an integral core metal roller consisting of diametrically large portions 31, diametrically small portions 32 and grooves or recesses 33, diametrically large portions alternating with the diametrically small portions and separated by the grooves. Subsequently, a rubber sheet 35 having a number of projections on the surface thereof is attached to the peripheral surfaces of respective diametrically small portions 32 of the roller, thereby providing separating roller portions, and a tape of cloth 36 embedded with a number of tip-bent plastic filaments is attached to the peripheral surfaces of respective diametrically large portions 31, thereby forming brush roller portions.

When the leading end of photosensitive material P being transported comes into contact with brush roller portions of stripping roller 26 which is rotating in the direction opposite to the direction of transportation of the photosensitive material, then cover sheet F is stripped at the leading end thereof from support member, and the leading end of cover sheet F thus stripped is transported with the rotation of brush roller portions. When the leading end of the cover sheet contacts nip rollers 27, the leading end thereof enters, through the rotation of the nip rollers, between the nip rollers and separating rollers which are similar to the nip rollers and in contact therewith, and cover sheet F is delivered downwards, under the guidance of stripping rib 29B as well as separating rib 29A which are provided at the exit portion between both rollers, without the risk of clinging to stripping roller 26 and to nip roller 27.

A device for carrying out both the preliminary stripping step and the final stripping and developing step is shown in Fig. 15, which is convenient for embodying the present invention. Referring more specifically to Fig. 15, photosensitive material P is shifted from the left to the right as viewed in the

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drawing by a pair of transporting rollers 1 with its cover sheet directed downwards. When the leading end of photosensitive material P is detected by detectors 23, then preliminary stripping brush 2 and restoration brush 3 start rotating in the counterclockwise direction and in the clockwise direction, respectively. By the time at which photosensitive material P is shifted to a point at which the leading end thereof contacts preliminary stripping brush roller 2, and cover sheet F is stripped at the leading end from the support member, then the rotation in the counterclockwise direction, of preliminary stripping brush roller 2 is reversed (namely, in the clockwise direction) under control of a counter (not shown) which has counted from the time at which the leading end of photosensitive material P has been detected by detectors 23. Cover sheet F separated in the leading end portion thereof from the support member is brought into registration with the support member by the rotation, in the clockwise direction, of preliminary stripping brush roller 2 and restoration brush roller 3. When photosensitive material P is shifted further towards the right, and the leading end thereof is detected by detectors 24, then a final stripping brush roller 5 starts rotating in the counterclockwise direction at a high speed, to thereby separate cover sheet F from the support member which has been in registration therewith following the preliminary stripping, and the leading end of cover sheet F is caused to enter between a separating roller 6 rotating in the same direction as that of the final stripping brush roller 5 coaxially therewith and a diametrically small nip roller 7 adjacent thereto. Then, final stripping brush roller 5 and separating roller 6 are rotated in the clockwise direction through a given angle under control of another counter (not shown) which has counted from the initiation of the operation of detectors 24, while separating roller 6 is in contact with nip roller 7 which is also in contact with a press roller 17. As a result, final stripping brush roller 5 and separating roller 6 are displaced downwards from the path of the transport of the photosensitive material (the horizontal direction from the left to the right in the drawing), so that these rollers no longer contact the surface of the support member from which cover sheet F has been stripped, and hence the support member surface has no likelihood of being damaged by these rollers.

Cover sheet F thus separated is guided, through a passage between the assembly of a back-up roller 8 which supports nip roller 7 and an auxiliary roller 9 coaxial with the back-up roller and rotating in the clockwise direction independently of the back-up roller and the separating roller 6, and past a passage between two transporting belts 10,

11, towards a transporting belt 15 onto which air is blown from a fan 18 positioned to the right of the belt 15 so as to dry the attached areas of the photohardened layer, and then transported downwards along the transporting belt 15. Cover sheet F then enters between a press roller 19 and a take-up roll 20 urged against press roller 19 under the force of a spring 21. Since cover sheet F is moved downwards with its adhesive surface directed to the right, the cover sheet can adhere to the periphery of take-up roll 20 by virtue of the adhesion of the cover sheet itself and the action of press roller 19, thereby being continuously taken up onto the roll 20.

Brush roller 2 used in the preliminary stripping step in the embodiment shown needs to be comparatively high in stiffness when contacting the cover sheet. The length of the brush element may be longer for a stiff resilient material, but preferably is short for a soft resilient material. The brush material, whether it is a natural material or an artificial material, may be in the form of a bundle of metallic or plastic filaments, or in the form of a brush. As an alternative, a plastic or rubber roller may be used, having a number of fine projections on the surface thereof. The material for nip roller 7 used in the final stripping step preferably is one which has a large coefficient of friction, such as plastic or rubber.

Besides the arrangements so far described, for effecting the final stripping step, the arrangements shown in Fig. 16 may be applicable. In the embodiment of Fig. 16, there is used the stripping roller consisting of separating roller portions 6 and brush roller portions 5 larger in diameter than the separating rollers, the former alternating with the latter in side by side relation, as shown in Fig. 14. The stripping roller is rotated in a direction opposite to the direction of travel of a photosensitive material P shown by an arrow A, so that cover sheet F is stripped from the support member, first from the leading end thereof and continuing to the trailing end by the brush roller portions 5. Cover sheet F thus separated is pulled downwards by the separating roller portions and nip roller 7 in pressure contact therewith. Back-up rollers 8 rotating in contact with nip roller 7 are fixedly mounted on a shaft 8a, and auxiliary rollers 9 arranged in side by side relation in a manner to alternate with back-up rollers 8 are journaled with ball bearings on shaft 8a. Thus, back-up rollers 8 are all rotated at the same speed by nip roller 7, and auxiliary rollers 9 are rotated in contact with brush roller portions 5 in a direction reverse to the direction of rotation of back-up rollers 8, namely in a direction of pulling the cover sheet downwards. Cover sheet F therefore is delivered in the direction of arrow D by the combination of the brush

roller portions 5 and auxiliary rollers 9, without clinging to the periphery of nip roller 7.

5 The stripping developing process according to the present invention enables the positive separation of the cover sheet from the support member by a mechanism simple in construction, dispensing with any extra material such as an adhesive tape and without causing any damage to the support member surface. If the leading end portion of photosensitive material which is to be subjected to the preliminary stripping is exposed to light beforehand, then adhesion of the cover sheet in the area exposed to light to the photosensitive layer becomes lowered, resulting in a difference in adhesion between the exposed area and the unexposed area of photosensitive material. This facilitates, in 20 the preliminary stripping step, the positive separation of the cover sheet only in the leading end portion exposed to light.

WHAT WE CLAIM IS:—

25 1. A process of stripping developing an imagewise exposed photosensitive sheet material to form a relief image, the material consisting of a support coated with a photosensitive photohardenable layer on which is 30 adhered a transparent cover sheet through which the material has been imagewise exposed, the process comprising the following steps:

35 (a) friction means is moved in a first direction while in rubbing contact with one edge (the leading edge) of the cover sheet of the material so that the edge of the cover sheet is stripped from the support by friction;

40 (b) the stripped edge is gently replaced, by friction means moving in the reverse direction, in its original position but with a lesser adhesion than originally; and

45 (c) the leading edge of the cover sheet is held by a stripping means and the entire cover sheet is stripped from the leading to the trailing end by relative movement of said stripping means and the material, whereupon the exposed areas of the photosensitive layer remain adhered to the support and the unexposed areas remain adhered to the cover sheet or support so as to provide a relief image on the support.

50 2. A process as claimed in Claim 1, wherein the material is rubbed in a first direction by a friction means so as to effect the preliminary stripping (a) and then the relative movement of the friction means is reversed to effect the replacement (b).

55 3. A process as claimed in Claim 1, wherein first friction means effects the preliminary stripping (a) and a second friction means acting in the reverse direction to the first means effects the replacement (b).

60 4. A process as claimed in Claim 1, 2 or 65 3, wherein in steps (a) and (b) the cover sheet

is rubbed by filaments of a hard material mounted on a brush, tape or belt as said friction means.

5. A process as claimed in any preceding claim, wherein steps (a) and (b) are carried out substantially as hereinbefore described with reference to any of Figures 1 to 6 or 17 of the accompanying drawings. 70

6. A process as claimed in any of Claims 1 to 5, wherein the final step (c) is commenced by attaching the leading edge of the cover sheet to a suction roller and/or a pawl which is then pulled away from the support. 75

7. A process as claimed in Claim 6, substantially as hereinbefore described with reference to any of Figures 7 to 12 of the accompanying drawings. 80

8. A process as claimed in any of Claims 1 to 5, wherein the final step (c) is commenced by the pulling of the leading edge of the cover sheet by hard filaments mounted on a roller rotating against said edge, and the detached cover sheet is led through the nip between said roller and a second rotating roller and thence away from the support as the exposed material is advanced over said first roller. 85 90

9. A process as claimed in Claim 8, substantially as hereinbefore described with reference to Figures 13 and 14 or 16 and 14 of the accompanying drawings. 95

10. A process as claimed in Claims 3 and 4, substantially as hereinbefore described with reference to Figure 15 of the accompanying drawings. 100

11. A process as claimed in any preceding claim, wherein the leading edge of the material is overall exposed prior to imagewise exposure. 105

12. Apparatus for carrying out the process of Claim 1, which comprises:

(i) friction means capable of stripping the leading edge of the cover sheet of the photosensitive material;

(ii) means for transporting said material so that the leading edge of the cover sheet contacts the friction means; 110

(iii) means for moving said friction means relative to said cover sheet so as to strip said leading edge thereof; 115

(iv) means for moving the aforesaid friction means, or a second friction means, in a reverse relative movement to the aforesaid movement so as to gently replace said leading edge; and 120

(v) means for holding the replaced leading edge of the cover sheet and for stripping the entire cover sheet from the support.

13. Apparatus as claimed in Claim 12, wherein said friction means comprises filaments of a hard material mounted on a rotatable brush or on a movable endless belt. 125

14. Apparatus as claimed in Claim 12 or 13, wherein said friction means is substantially as shown in any of Figures 1 to 6 of the 130

accompanying drawings.

15. Apparatus as claimed in Claim 12, 13 or 14, wherein the means (v) for holding the leading edge of the material comprises a suction roller and/or a pawl.

16. Apparatus as claimed in Claim 15, substantially as shown in any of Figures 7 to 12 of the accompanying drawings.

17. Apparatus as claimed in Claim 12, 13 or 14, wherein the means (v) comprises a rotatable roller bearing, at alternate peripheral areas, hard filaments and rubber projections and a second rotatable roller mounted to form a nip with the first roller.

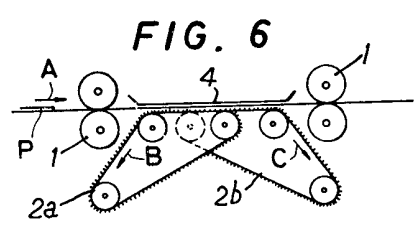
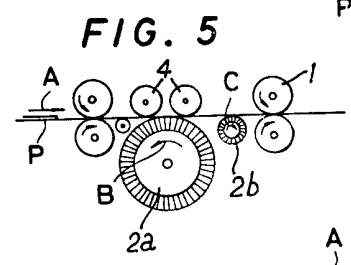
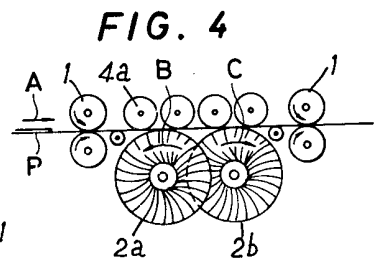
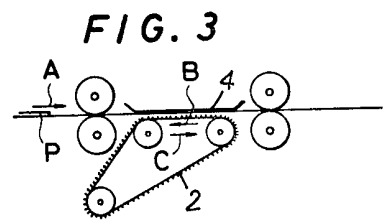
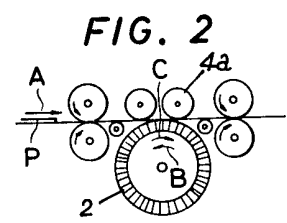
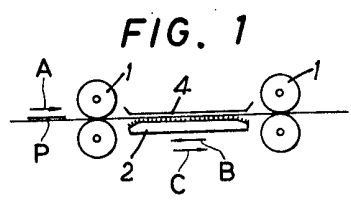
18. Apparatus as claimed in Claim 17, which also includes belts for transporting the separated cover sheet from the nip of the means (v) past a drying station to a take-up roller.

19. Apparatus as claimed in Claim 17 or 18, substantially as shown in Figures 13 or 14 or 16 and 14 or 15 of the accompanying drawings.

20. A cover sheet bearing a relief image when stripped by a process as claimed in any of Claims 1 to 11 or by an apparatus as claimed in any of Claims 12 to 19.

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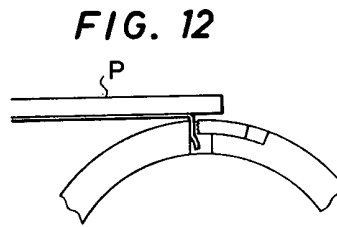
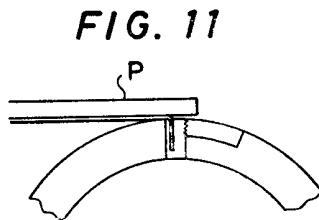
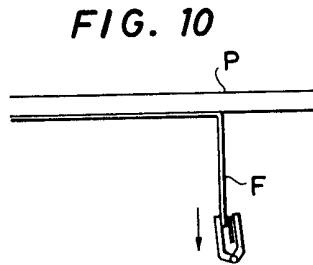
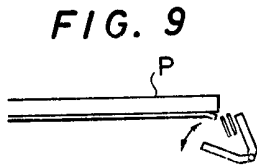
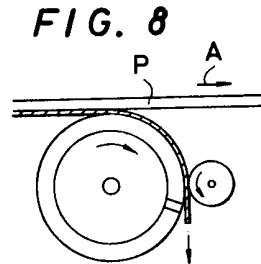
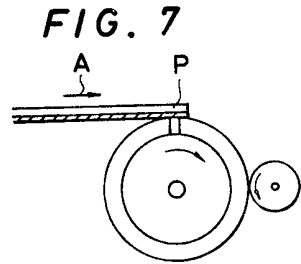


FIG. 13

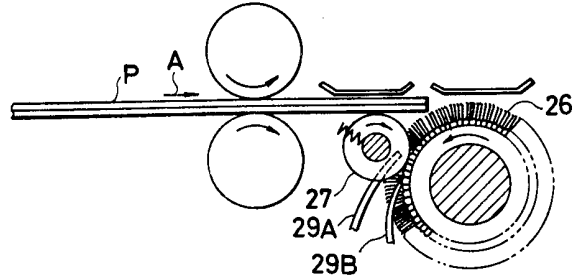


FIG. 14

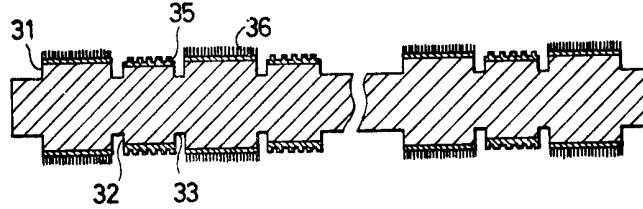


FIG. 16

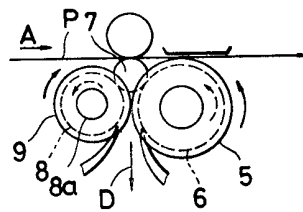


FIG. 15

