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(54) **Rubber member for paper feeding device.**

(57) A rubber member which stabilizes the friction coefficient, which produces less abnormal sound and which exhibits less swelling when it is in contact with a paper feed roller of Polynorbornene type rubber is provided, whereby paper sheets can be smoothly transferred one by one in a paper feeding device, such as a copying machine or a printer.

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to a rubber member for a paper feeding device and more particularly it relates to improvements in misfeed-preventive rubber pad or rubber roller used in a paper feeding device, such as a copying machine, facsimile device or printer.

Prior Art

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In a paper feeding device, such as a copying machine, facsimile device or printer, a member 2, such as a misfeed-preventive rubber pad or rubber roller, is disposed in opposed relation to a feed roller 1, as shown in Fig. 1, to feed a number of paper sheets one by one. In addition, Fig. 1 shows a rubber pad as a misfeed-preventive rubber member 2.

15 As said misfeed-preventive rubber member 2, it has been common practice to use urethane, which is wear-resistant, a combination of urethane and cork, natural rubber, chloroprene or the like.

In order to feed a number of paper sheets 3 set in a cassette or the like smoothly one by one by using said paper feed roller 1 and misfeed-preventive rubber member 3, as shown in Fig. 1, the friction coefficient between the members has to satisfy the following formula 1.

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$$\mu_F > \mu_R > \mu_p \dots \text{formula 1}$$

In the formula, μ_F is the friction coefficient between the paper feed roller 1 and the paper sheet 3; μ_R is the friction coefficient between the misfeed-preventive rubber member 2 and the paper sheet 3; and μ_p is the friction coefficient between the paper sheets 3.

25 And the above relation has to be maintained during the period of time at least a hundred thousand paper sheets are passed.

Thus, μ_F and μ_p for the currently used members were measured and it was found that μ_p was 0.3 - 0.6, μ_F was 1.5 - 2.5; therefore, it is desirable that μ_R be 0.7 - 1.2. Further, in the case of an OHP (overhead projector) film, since μ_p is 0.3 - 1.5 and μ_F is 2.5 - 3.0, it is desirable that μ_R be 1.7 - 2.4.

30 However, the conventional misfeed-preventive rubber member 2 made of urethane, combination of urethane and cork, natural rubber, chloroprene or the like presents the following problems.

- (1) The friction coefficient decreases because of the adhesion of paper powder produced during the feeding of ordinary paper sheets;
- (2) The friction coefficient is so high in the initial period (it takes a proper value after 5000 - 10000 sheets have been passed) that films for OHP are particularly difficult to feed;
- 35 (3) An abnormal sound referred to as a creak is produced when coated paper sheets or OHP films are fed;
- (4) The paper feed roller 1 used in opposed relation is made frequently of Polynorborene type rubber, which contains 100 - 250 parts by weight of process oil based on 100 parts by weight of polymer; therefore, when a mechanism designed to be permanently contacted with this paper feed roller 1, deformation due to swelling or increase in friction coefficient becomes a problem

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SUMMARY OF THE INVENTION

45 The present invention has been accomplished as a result of studies of the troubles described above and its object is to provide a rubber member for a paper feeding device, wherein the friction coefficient remains unchanged for a long period of time, there is no abnormal sound produced during the feeding of paper sheets and less swelling takes place during contact with a paper feed roller.

Concerning the above problem (1), a rubber composition comprising a metal oxide and acrylic acid and vulcanized has been found as a rubber composition less liable to attract paper powder.

50 Although the above rubber composition is less liable to attract paper powder and provides a friction coefficient which remains unchanged for a long period of time, the initial friction coefficient is high and undergoes a great change, as shown in Fig. 2. Therefore, it is suitable for a paper feeding device only on the condition that paper sheets which provide a high friction coefficient with respect to rubber, such as OHP films, are not used; however, when OHP films have to be fed, the relation (1) is not maintained, making it impossible to attain smooth feeding. Thus, according to the present invention, concerning the above problem (2), it has been found

55 from the experimental result that the initial friction coefficient can be decreased by adding short fibers to said rubber composition and that the effect of decreasing the friction coefficient can be limited to the initial period by selecting a thickness and length for the short fibers which cause the latter to gradually wear as the feeding of paper sheets proceeds (see experimental data in Figs. 3 through 14). The thickness of the short fibers is

desirably not more than 15 deniers. If it exceeds 15 deniers, the fibers form a member which hardly wears and which provides an excessively low friction coefficient. Further, it is desirable that the length of the short fibers be not more than 5 mm. If it exceeds 5 mm, the fibers form a member which hardly wears and which provides an excessively low friction coefficient. The material of the short fibers is not particularly restricted; however, since they are heated to 140 - 190°C during vulcanization reaction, they are required to have a melting point above the reaction temperature. The optimum amount of short fibers to be added is 0.5 - 5 parts by weight with respect to 100 parts by weight of polymer. The reason for restricting the amount of short fibers to 0.5 - 5 parts by weight with respect to 100 parts by weight of polymer is that if it exceeds 5 parts by weight, wearing proceeds so slowly that the friction coefficient does not become stable but that if it is less than 9.5 parts by weight, the decreases in the initial friction coefficient is so small that the friction coefficient does not become stable, either. By adding 0.5 - 5 parts by weight of short fibers to 100 parts by weight of polymer, a rubber member for a paper feeding device which stabilizes the friction coefficient for a long period of time, as shown in Fig. 15.

In this manner, a rubber member for a paper feeding device which provides a stable friction coefficient is obtained, but it has to be adjusted to provide an optimum friction coefficient according to the type and design (load, and method of installation) of the paper feeding device. If the friction coefficient is too high, OHP films and coated paper sheets creak, while if it is too low, misfeed takes place. Thus, in the present invention it has been found that the friction coefficient can be adjusted by adding short fibers as required. That is, short fibers are exposed on the surface and these exposed short fibers provide a suitable friction coefficient to prevent the creaking and misfeed of OHP films and coated paper sheets.

As for the problems (3), it may be contemplated to make the polymer oil-resistant. However, the higher the oil-resistance of the polymer, the more frequently the creaking of the problem (3) takes place; thus, such an oil-resistant rubber as reduces the creaking has to be selected to reconcile the two incompatible properties: the oil resistance and the reduced creaking. Thus, it has been found from the experimental result that an oil resistance which does not spoil the performance of the misfeed-preventive rubber member can be obtained if the volumetric increase of a specimen immersed in oil which is added to polynorbornene often used in paper feed rollers is not more than 10%, said increase being caused by swelling. Further, in consideration of the problem (3), it has been found that acrylonitrile butadiene rubber (hereinafter referred to as NBR), which, of all oil-resistant rubbers, is the least liable to creak and has a high degree of freedom of composition, is suitable. Various grades of NBR are marketed; however, in order to solve the problems (3) and (4), it is necessary to select a single NB, a mixture of NBRs whose acrylonitrile contents differ, or a mixture of NBR and diene type rubber in which the bound acrylonitrile content of the polymer is 10 - 35%. The diene type rubber mentioned herein refers to NR (natural rubber), IR (isoprene rubber), SBR (styrene-butadiene), BR (butadiene rubber), IIR (butyl rubber), CR (chloroprene), or NBR. The reason for restricting the bound acrylonitrile content to 10 - 35% is that if it is below 10%, the requirement for oil resistance cannot be satisfied and that if it exceeds 35%, the glass transition point increases to cause creaking. To make the bound acrylonitrile content equal to 10 - 34%, a single NBR, a mixture of NBRs, or a mixture of NBR and diene type rubber which provides the required bound acrylonitrile content will be selected. In the case where ozone resistance is required in the case of some machine type, EPDM (ethylene propylene rubber), which is superior in ozone resistance, may be added.

According to the present invention, some of the short fibers exposed on the rubber member surface suitably decrease the excessive surface friction coefficient which appears in the initial period of the paper feeding operation and gradually wear as paper sheets are passed, whereby the friction coefficient is maintained at a suitable value. It is possible to impart a better oil resistance to the oil-resistant rubber so as to decrease the amount of swelling from the paper feed roller. Further, by adding cork, it is possible to adjust the friction coefficient to provide a suitable surface friction resistance. Further, since the oil-resistant rubber contains diene type rubber or a single NBR whose bound acrylonitrile content is 10 - 35%, it is possible to decrease creaking while providing oil resistance. Further, by the combination of acrylic acid and a metal oxide, it is possible to make the paper powder less sticky. It goes without saying that the present roller member may be utilized to form a roller and use it as a separating roller for paper delivery and paper feed between the rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view showing the outline of a paper feeding device;

Fig. 2 is a diagram showing changes in friction coefficient in a rubber composition comprising a metal compound and acrylic acid;

Fig. 3 is a diagram showing the relation between the friction coefficient of ordinary paper and the acrylonitrile content in the initial period of paper feeding in various rubber compositions containing short fibers having a length of 3 mm and thicknesses of 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 4 is a diagram showing the relation between the friction coefficient of ordinary paper and the acrylonitrile content in the initial period of paper feeding in various rubber compositions containing short fibers having a length of 5 mm and thicknesses of 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 5 is a diagram showing the relation between the friction coefficient of an OHP film and the acrylonitrile content in the initial period of paper feeding in various rubber compositions containing short fibers having a length of 2 mm and thicknesses of 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 6 is a diagram showing the relation between the friction coefficient of an OHP film and the acrylonitrile content in the initial period of paper feeding in various rubber compositions containing short fibers having a length of 5 mm and thicknesses of 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 7 is a diagram showing changes in the friction coefficient of ordinary paper in rubber compositions having a short fiber content of 0.3 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 8 is a diagram showing changes in the friction coefficient of ordinary paper in rubber compositions having a short fiber content of 0.5 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 9 is a diagram showing changes in the friction coefficient of ordinary paper in rubber compositions having a short fiber content of 3 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 10 is a diagram showing changes in the friction coefficient of ordinary paper in rubber compositions having a short fiber content of 5 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 11 is a diagram showing changes in the friction coefficient of an OHP film in rubber compositions having a short fiber content of 0.3 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 12 is a diagram showing changes in the friction coefficient of an OHP film in rubber compositions having a short fiber content of 0.5 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 13 is a diagram showing changes in the friction coefficient of an OHP film in rubber compositions having a short fiber content of 3 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers;

Fig. 14 is a diagram showing changes in the friction coefficient of an OHP film in rubber compositions having a short fiber content of 5 phr and containing short fibers having a length of 5 mm and thicknesses 2 deniers, 7 deniers, 15 deniers, and 20 deniers; and

Fig. 15 is a diagram showing changes in friction coefficient in the rubber member of the present invention for a paper feeding device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the invention will now be described.

Rubber compositions obtained by combinations in embodiments A - X shown in Table 1 below were used to form misfeed-preventive rubber members and friction coefficients which appeared in the initial period, the second period which started at the end of passage of 1000 paper sheets, and the third period which started at the end of passage of a hundred thousand paper sheets were measured. The result is shown also in Table 1.

Document in which chemical formulas, etc. are written

Specification
Table 1

Acrylonitrile content, ² 6-nylon 2d-3 mm, ³ particle diameter 0.5-0.84 mm		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Specification																									
NBR (15% ¹)				25	25	25																			
NBR (20% ¹)		50	50																						
NBR (26% ¹)		50	50	50	75	75	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	
NBR (35% ¹)														75	75	75							75	75	75
EPDM											10	10	10												
BR														25	25	25									
NR							10	10	10																
IR																	10	10	10						
IIR																					10	10	10		
SBR																									
Fibers ²		3	3		3	3		3	3		3	3		3	3		3	3		3	3		3	3	3
Corks ³			20			20				20			20			20						20			20
Acrylonitrile (%)		23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Oil resistance (%)		5.1	5.0	4.2	4.5	4.4	4.0	5.2	5.1	4.3	5.6	5.5	5.0	5.2	5.2	4.9	5.3	5.3	5.0	5.1	5.0	4.8	5.5	5.5	4.9
Friction coefficient	(1)	1.6	1.7	1.7	1.8	1.5	1.8	1.5	1.7	1.5	1.7	1.5	1.7	1.5	1.7	1.5	1.8	1.6	1.7	1.5	1.7	1.5	1.9	1.6	1.9
	(2)	1.2	1.3	1.3	1.5	1.4	1.5	1.4	1.5	1.3	1.5	1.3	1.5	1.3	1.5	1.3	1.6	1.6	1.5	1.3	1.5	1.3	1.6	1.3	1.6
	(3)	1.1	1.2	1.2	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.6	1.6	1.5	1.3	1.5	1.3	1.6	1.3	1.6
	(4)	2.4	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.7	2.7	2.6	2.6	2.6	2.8	2.8	2.8	2.8
	(5)	2.2	2.3	2.3	2.5	2.5	2.5	2.5	2.5	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.4	2.4	2.4	2.4
	(6)	2.1	2.1	2.1	2.3	2.3	2.3	2.3	2.3	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2	2.2	2.1	2.1	2.1	2.3	2.3	2.3	2.3

Stability of friction
coefficient is goodStability of friction
coefficient is bad

- (1) Initial period
 (2) After passage of 1000 paper sheets
 (3) After passage of a hundred thousand paper sheets
 (4) Initial period
 (5) After passage of 1000 paper sheets
 (6) After passage of a hundred thousand paper sheets

As has so far been described, the rubber member of the present invention stabilizes the friction coefficient for a long time, eliminates abnormal sounds and is superior in oil resistance; therefore, less welling occurs even if it contact a paper feed roller of Polynorbornene type rubber at all times. Therefore, a reliable, high quality practical rubber member for a paper feeding device can be provided.

5 The following information is relevant to Figure 15.

(1) It contains short fibers. As the short fibers wear, the friction coefficient increases. It is premised that no sticking of paper takes places.

(2) It contains short fibers. The increase in friction coefficient due to the wear of short fibers is cancelled by the decrease in the sticking of paper powder; thus, stability is attained.

10 (3) It contains no short fibers. Paper powder sticks to it, so that friction coefficient decreases.

Claims

15 1. A rubber member for a paper feeding device, characterized in that 0.5 - 5 parts by weight of short fibers having a thickness of not more than 15 deniers and a length of not more than 5 mm are added to 100 parts by weight of polymer and some of said short fibers are exposed on the surface of the rubber member.

20 2. A rubber member for a paper feeding device as set forth in Claim 1, characterized in that said polymer comprises oil-resistant rubber.

3. A rubber member for a paper feeding device as set forth in Claims 1 and 2, characterized in that cork is added to said polymer.

25 4. A rubber member for a paper feeding device as set forth in Claim 2, characterized in that said oil-resistant rubber comprises acrylonitrile butadiene copolymer rubber or a mixture thereof with a predetermined rubber, the bound acrylonitrile content being 10 - 35%.

30 5. A rubber member for a paper feeding device as set forth in Claim 4, characterized in that acrylic acid and a metal oxide are added to said oil-resistant rubber whose bound acrylonitrile content is 10 - 35%.

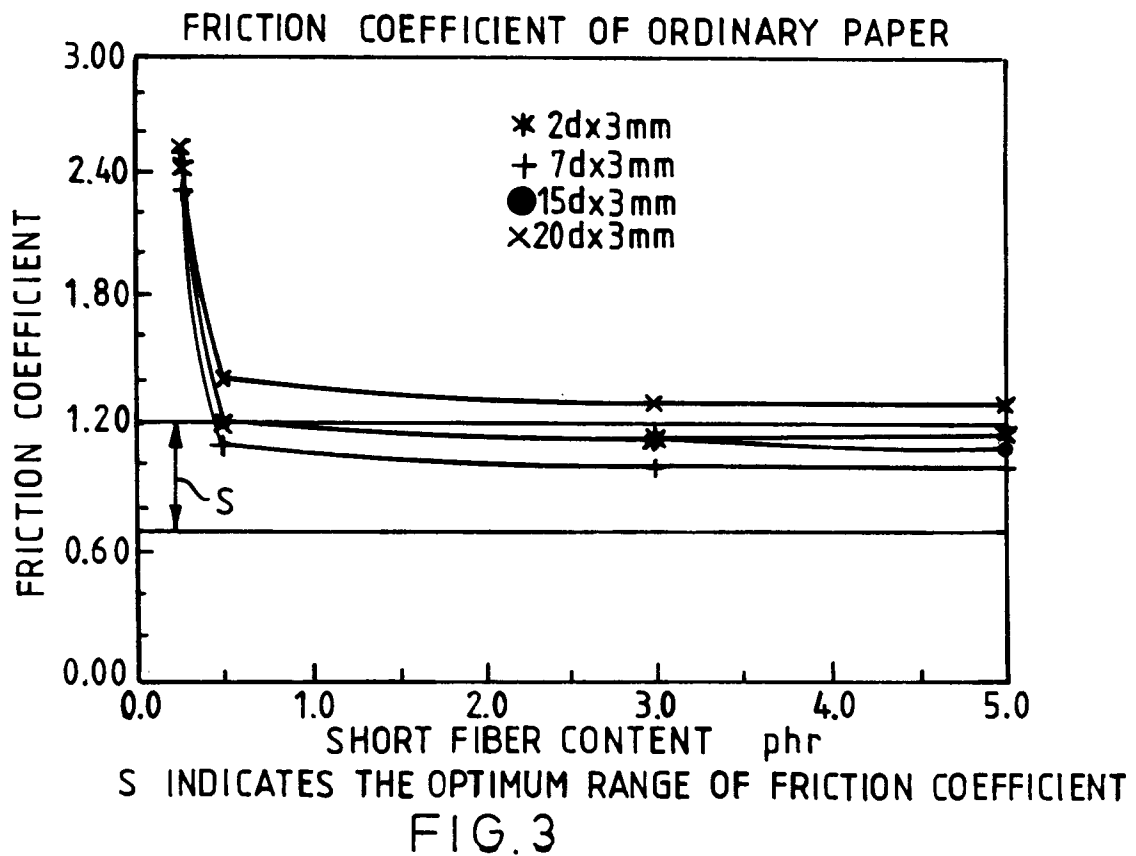
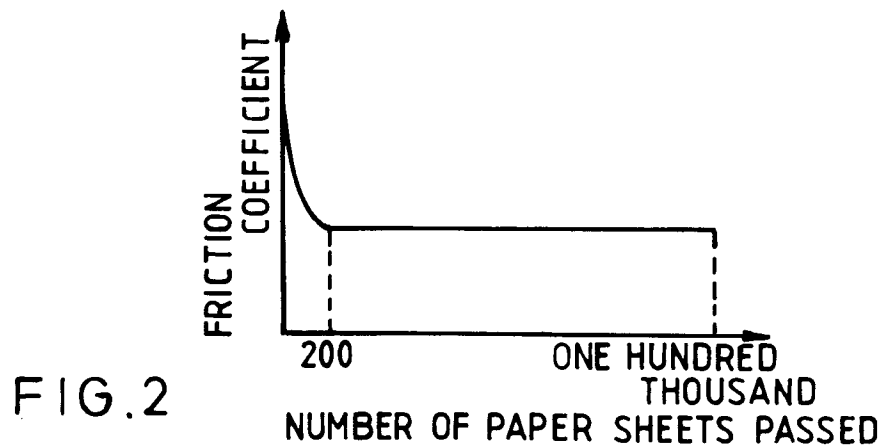
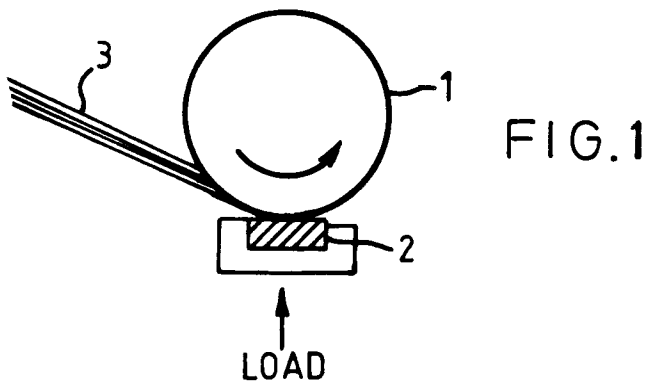
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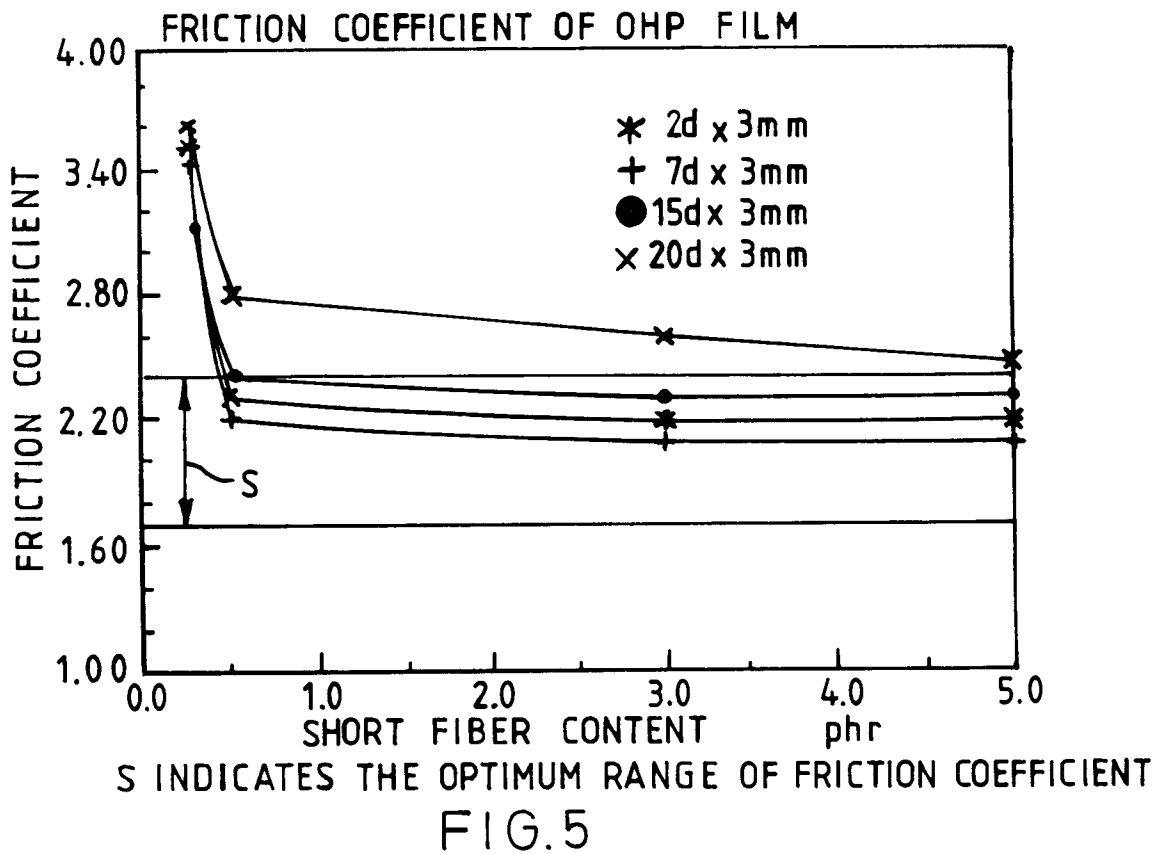
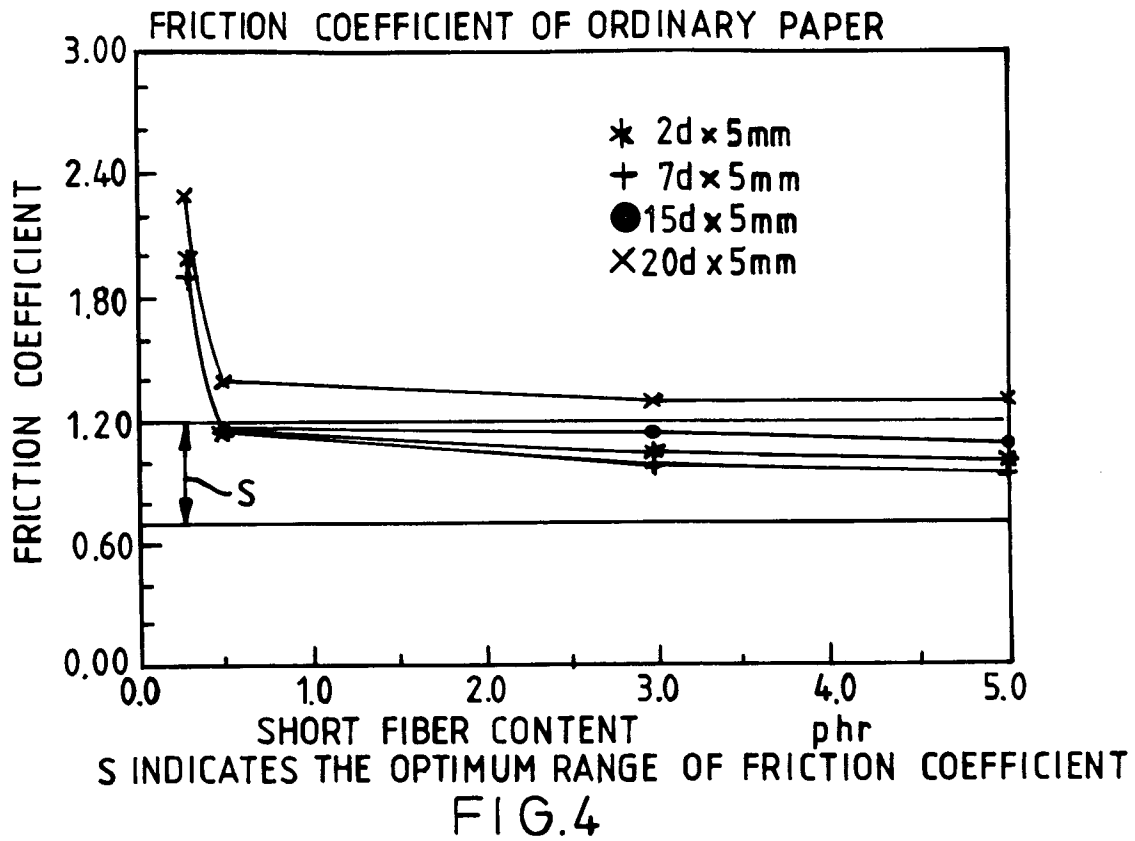
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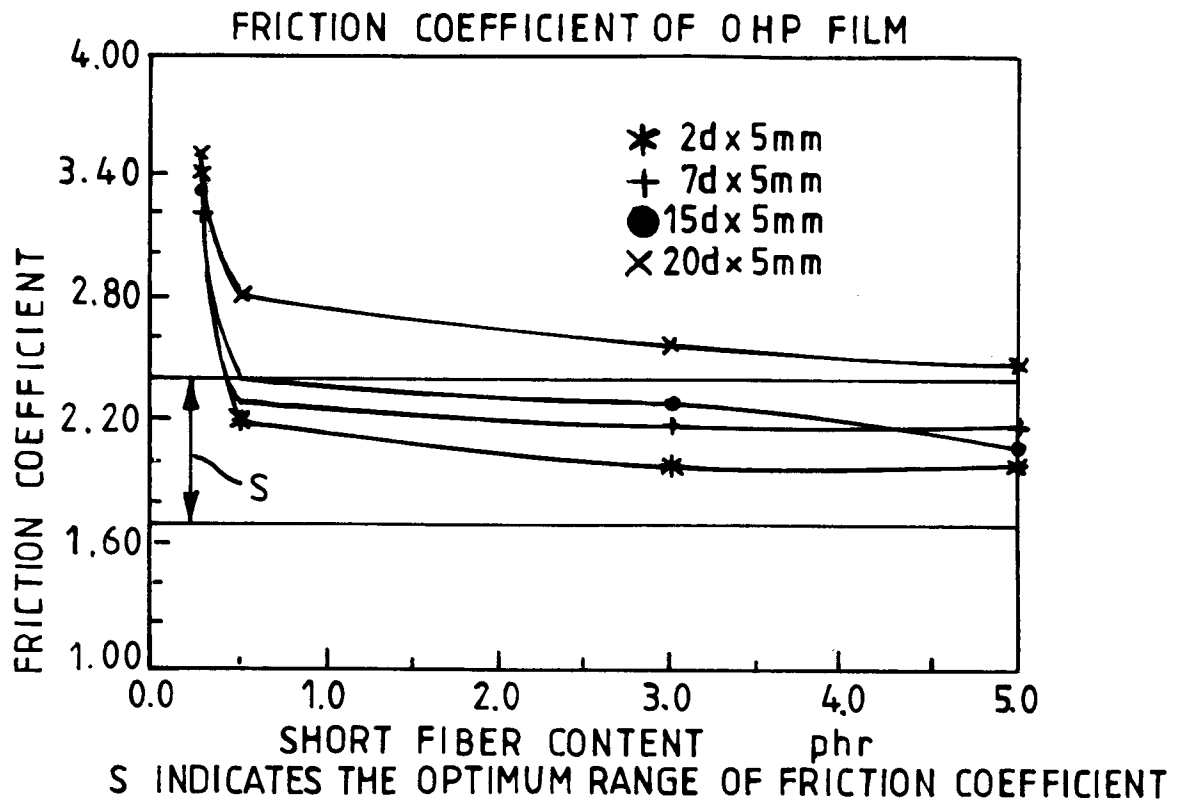


FIG.6

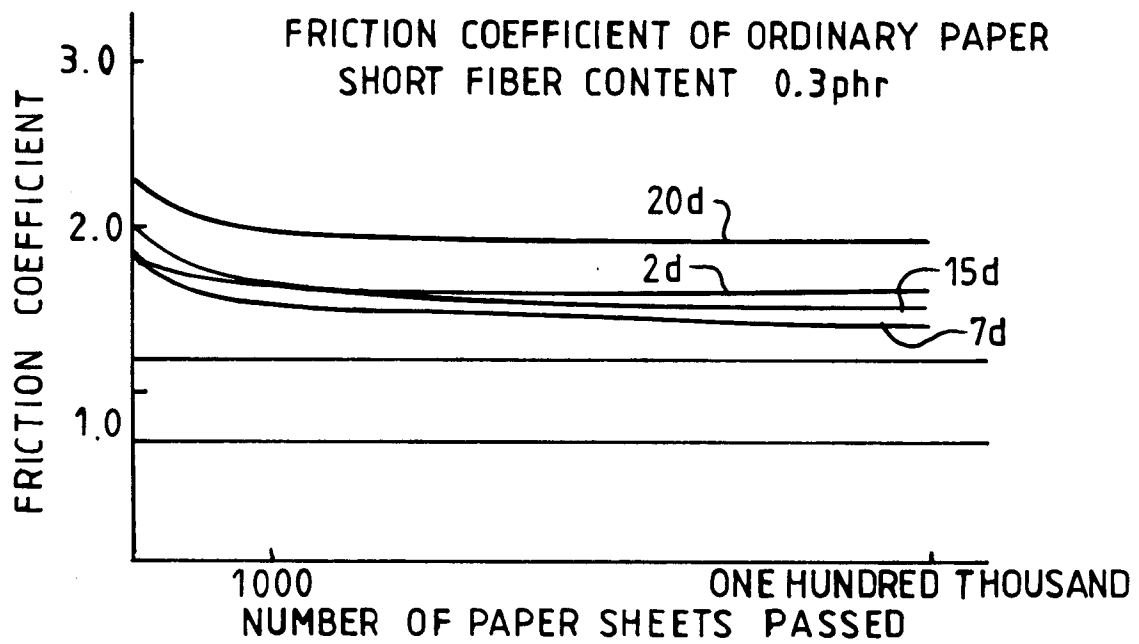


FIG.7

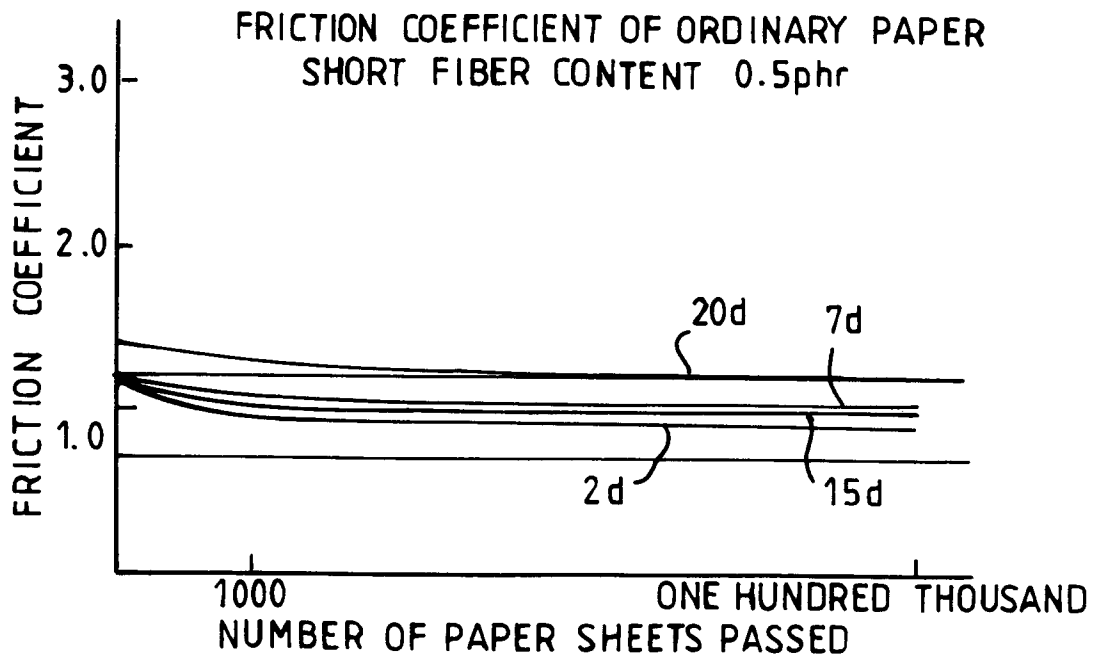


FIG. 8

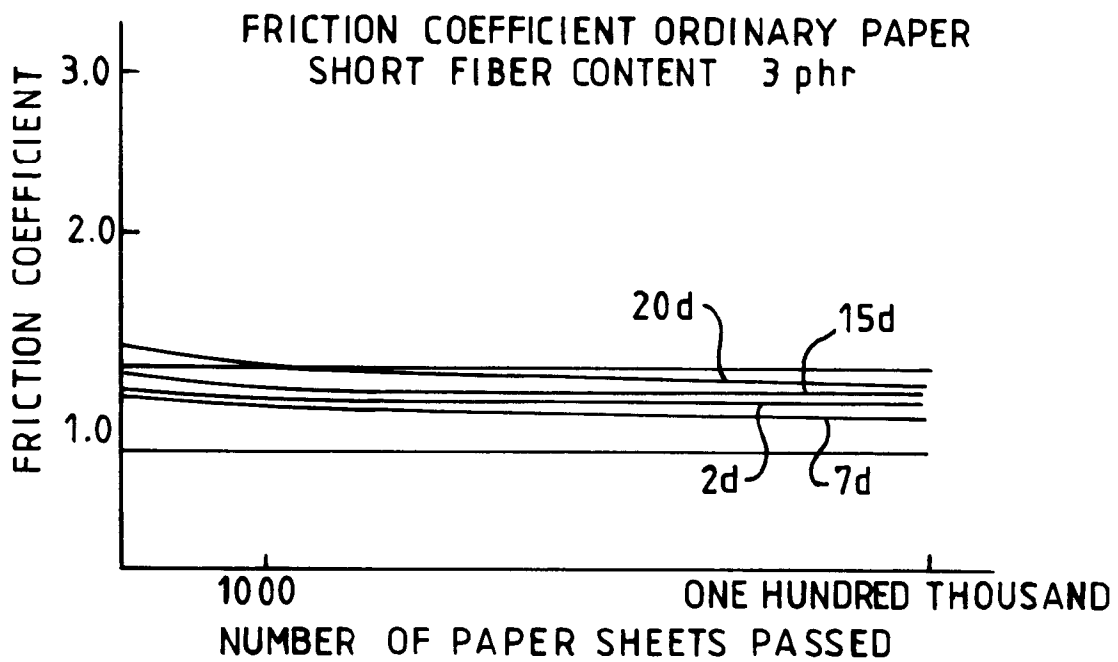


FIG. 9

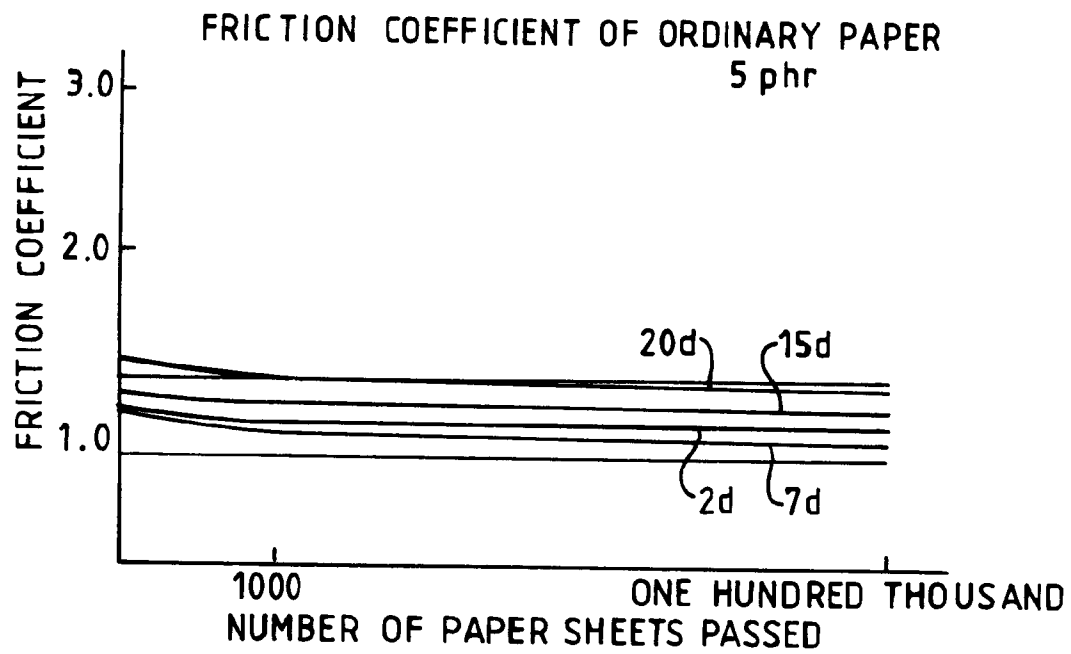


FIG.10

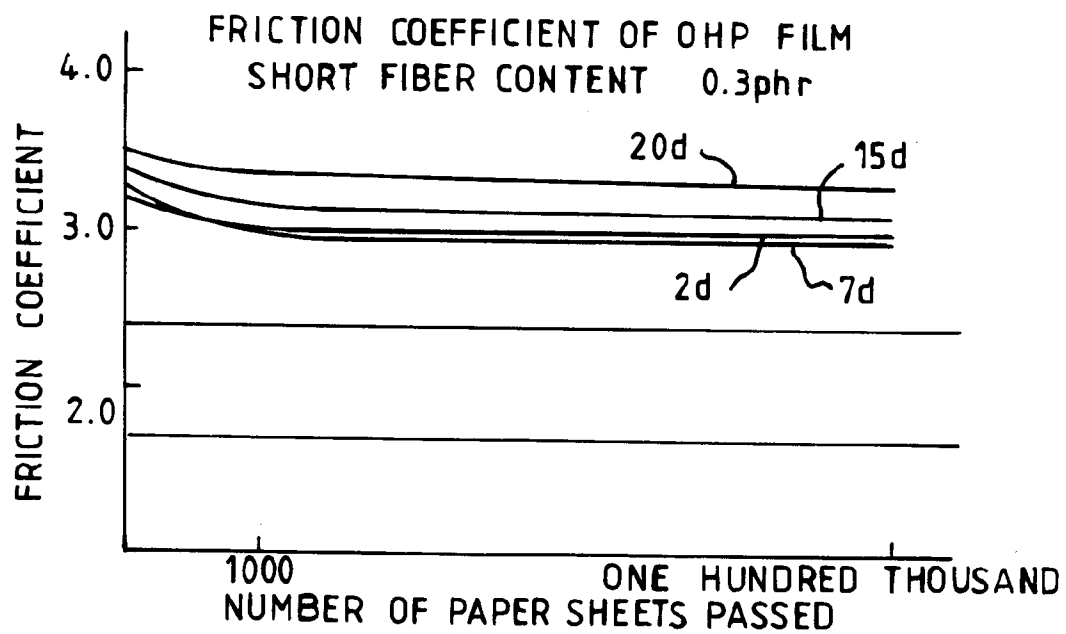
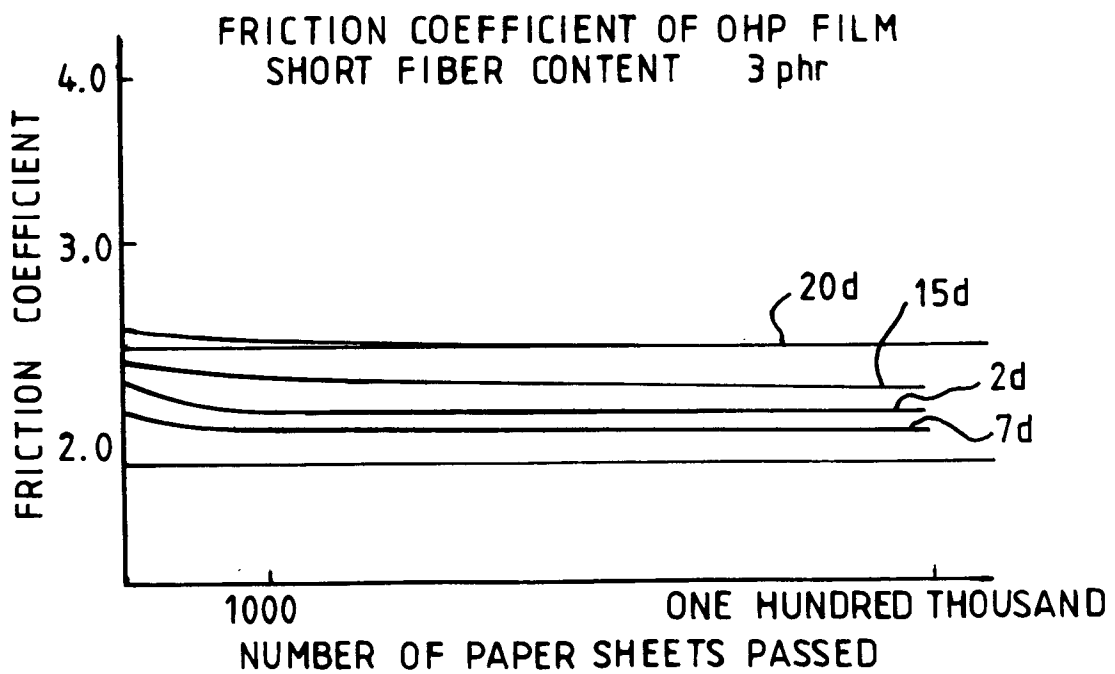
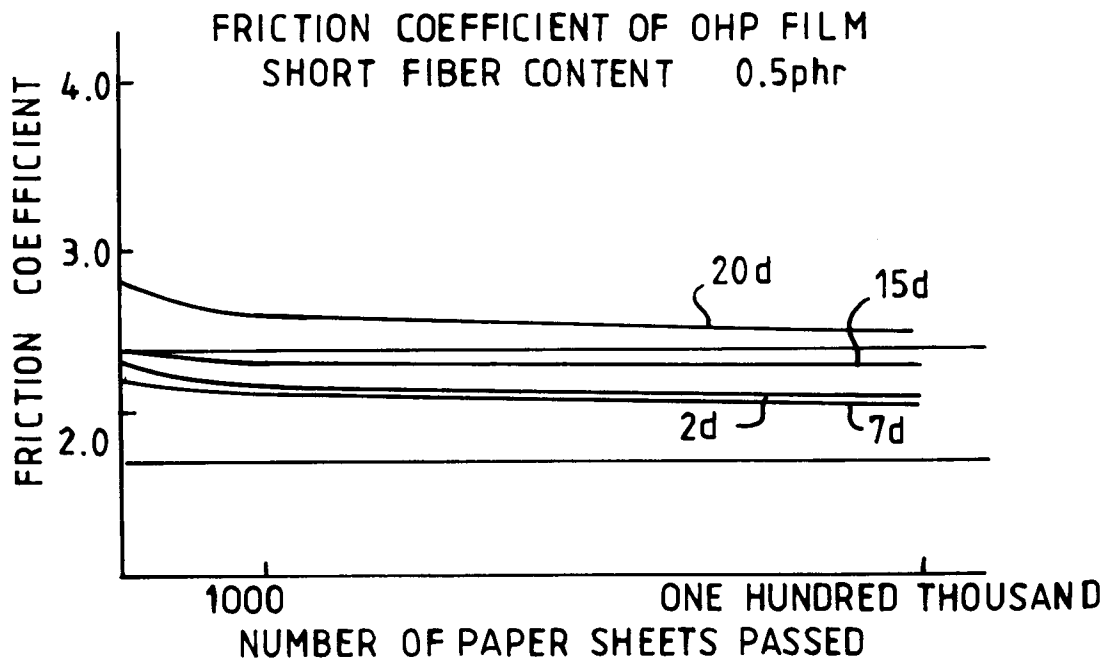


FIG.11



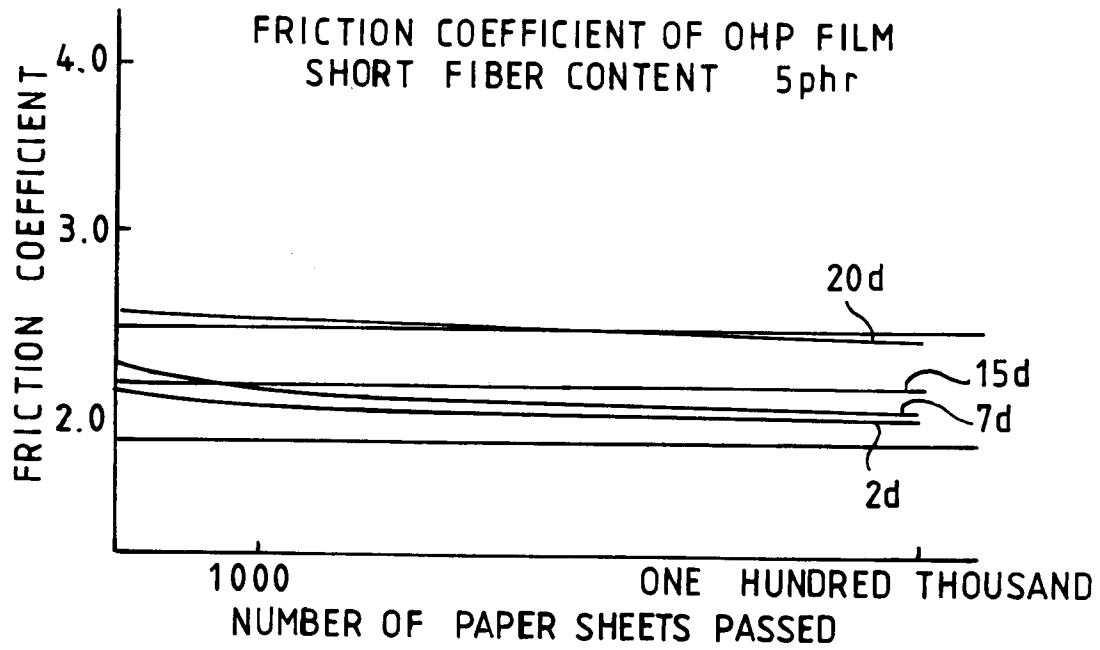


FIG.14

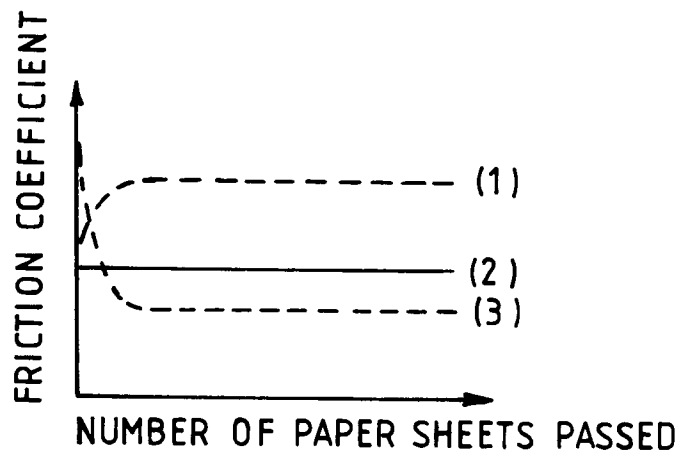


FIG.15