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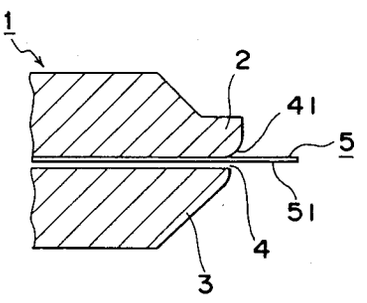
(54) **METHOD AND DEVICE FOR APPLYING LIOUID.**

(57) A method and device for applying liquid, in which, for applying liquid onto the base film by the use of an extrusion type applying head, a flexible body is outwardly extended from the slit opening on the downstream side of the liquid flowing slit of the extrusion type applying head so as to be in contact with the surface of a base film moving continuously, whereby liquid emitted from the liquid flowing-out slit and to be applied onto the base film is evenly applied while being smoothed by the flexible body without causing uneven thickness or streaks of liquid even over a wide range of application conditions.

Fig. 1



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TECHNICAL FIELD

The present invention relates to a method for applying liquid with extrusion type applying head and an apparatus therefor and more particularly to the method for applying the liquid to a base film in a uniform thickness and without forming stripes on the surface of the applied liquid in a wide range of liquid applying condition.

BACKGROUND ART

Indirect applying methods such as gravure method, reverse roll method, and kiss coating method are widely used as a method for applying, to a base film which is moving, a water solution, resin liquid or liquids consisting of various kinds of powders dispersedly mixed with each other in a dispersing medium such as water or an organic solvent.

However, these indirect applying methods have disadvantages in applying liquid which is likely to change in its property and condition because it is exposed to air. A magnetic liquid prepared by dispersedly mixing magnetic powders with a binding resin has this tendency in particular, i.e., the magnetic liquid is likely to change its property and condition as a result of the exposure to air. Thus, a film of the magnetic liquid is likely to degrade in its quality.

In order to solve this problem, instead of these indirect applying methods, direct applying methods such as extrusion method are adopted in recent years (Japanese Patent Laid-Open Publication No. 57-84771, Japanese Patent Laid-Open Publication No. 58-104666, and Japanese Patent Laid-Open Publication No. 60-238179.)

However, in the direct applying method such as extrusion method, since liquid is completely sealed until the liquid is applied to a base film, it is possible to considerably prevent the change of the property and condition of the liquid and easy to carry out a high speed liquid applying process. But an appliable amount of liquid is small and the range of the handleable viscosity thereof is narrow. Therefore, stripes are likely to be formed with the advance of technology of applying liquid at a higher speed. In addition, since the liquid is applied to the base film with the outlet of the liquid discharge slit of an applying head pressed against the base film, one edge of the outlet of the applying head on its downstream side referring to the film moving direction acts as a doctor edge. Thus, the downstream side edge of the outlet of the applying head is worn and the configuration thereof changes. Consequently, the thickness of the applied liquid is ununiform as a result of the repeated use of the applying head. Thus, the quality of the film degrades. In particular, when liquid containing abrasive particles, for example, magnetic liquid is used, the outlet of the applying head on the downstream side thereof is worn to a great extent. As such, it is difficult to maintain the quality of the film consisting of the liquid.

DISCLOSURE OF THE INVENTION

In view of the above-described situation, the present invention has been made as a result of researches. That is, in applying liquid to a moving base film with an extrusion type applying head, a flexible member is extended outward from a downstream side end of an outlet of a liquid discharge slit of the extrusion type applying head; and the flexible member is brought into contact with the surface of the moving base film; and the liquid discharged from the liquid flow slit is applied to the base film in a wide range of liquid applying condition with the liquid being smoothed by the flexible member so that the liquid is applied to the base film without forming nonuniformity in the thickness of the applied layer and stripes on the surface thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of the leading end portion of an extrusion type applying head shown as an example of an applying head of the present invention; and

Fig. 2 is a schematic illustration showing the applying process to be carried out by the applying head.

EMBODIMENT

An embodiment of the present invention is described below with reference to an apparatus for applying liquid to be used in the present invention.

Fig. 1 shows the leading end portion of an extrusion type applying head to be used in the present

invention. In an extrusion type applying head 1, a liquid discharge slit 4 is provided between the downstream side end 2 of the applying head 1 and the upstream side end thereof. A flexible member 5 is mounted in the slit 4 of the applying head 1 on the side of the downstream side end 2 thereof and extended outward from the downstream side end of the outlet 41 of the slit 4.

Fig. 2 shows a process of applying the liquid to a base film by discharging it from the slit 4 of the applying head 1. An extended portion 51 of the flexible member 5 extended outward from the downstream side end of the outlet 41 of the slit 4 is bent toward the film moving direction at the downstream side end 2 so as to bring the extended portion 51 into contact with a base film 6 which moves continuously. The liquid 7 discharged from the slit 4 is applied to the base film 6 with the extended portion 51 of the flexible member 5 smoothing the liquid 7.

Thus, the liquid 7 discharged from the slit 4 is smoothed by the extended portion 51 of the flexible member 5 and applied to the base film 6 without nonuniformity occurring in the thickness of the applied liquid 7 or stripe-like marks formed. Notwithstanding the change of the liquid application condition such as a viscosity, an application speed, and an application amount, the liquid is smoothed by the extended portion 51 of the flexible member 5. The liquid 7 is preferably applied to the base film 6 in a wide range of application condition. Further, since the downstream side end of the outlet 41 of the slit 4 does not act as a doctor edge, the downstream side end of the outlet 41 is not worn and as such the configuration thereof is not changed. Even though the liquid 7 contains abrasive particles such as magnetic powders, the liquid 7 can be repeatedly applied to the base film 6 in the same condition and the quality of the film of the liquid 7 does not degrade.

The flexible member 5 extending in the width of 500mm outward from the downstream side end of the outlet 41 of the slit 4 is likely to be crimped and becomes ununiform widthwise in a long cycle in the thickness of the applied liquid 7 while the liquid 7 is being applied if the flexural rigidity $E \cdot I$ (E: modulus of longitudinal elasticity, I: modulus of section) of the flexible member 5 is smaller than $0.01 kg \cdot mm^2$. Therefore, preferably, the flexural rigidity of the flexible member 5 is greater than $0.01 kg \cdot mm^2$. However, if the flexural rigidity of the flexible member 5 is greater than $15 kg \cdot mm^2$, the flexible member 5 is incapable of smoothing the liquid 7 favorably and displays doctor effect beyond the necessary degree, thus scraping the applied liquid 7. Since the flexural rigidity of the flexible member 5 is great, it is necessary to press the applying head 1 against the base film in a great force. Therefore, the surface of the base film 6 may be injured in applying the liquid 7 to the thin base film 6. Therefore, favorably, the flexural rigidity of the flexible member 5 is in the range from $0.01 kg \cdot mm^2$ to $15 kg \cdot mm^2$ and more favorably, from $0.1 kg \cdot mm^2$ to $10 kg \cdot mm^2$. If the length of the extended portion 51 extended outward from the downstream side end of the outlet 41 of the slit 4 is shorter than 3mm, a desired effect cannot be obtained and if longer than 30mm, the surface of the film consisting of the applied liquid 7 is rough. Therefore, it is preferable that the length of the extended portion 51 extended outward from the downstream side end of the outlet 41 of the slit 4 is in the range from 3mm to 30mm.

Preferably, film-shaped flexible materials 5 are used. For example, polyester films such as polyethylene terephthalate, polyethylene 2,6-naphthalate; polyolephin films such as polyethylene, polyolephin; plastic films such as derivatives of cellulose, polycarbonate, polyimide, and polyamideimide; and foils of aluminum or some alloys.

Since the flexible member 5 is mounted on the downstream side end 2 of the outlet 41 of the slit 4 and extended outward therefrom, the pressure of the liquid 7, the flexural rigidity of the flexible material 5, and the pressing force of the applying head 1 against the base film 6 favorably balance with the rigidity and tension of the base film 6 during the movement of the base film 6. Consequently, the liquid 7 is smoothed favorably and applied uniformly to the base film 6 without ununiform thickness or stripe-like marks formed.

The embodiments of the present invention is described below.

Embodiment 1

Co-coated γ-Fe_2O_3 (major axial diameter: 0.4μm, minor axial diameter: 0.05μm, coercive force: 600 oersteds)	500 parts by weight
nitrocellulose	50 parts by weight
Pandex T - 5250 ® (manufactured by Nippon Ink Chemical Industry Co., Ltd., polyurethane resin)	30 parts by weight
Coronate L ® (manufactured by Nippon Polyurethane Industry Co., Ltd., trifunctional isocyanate compound of low molecular weight)	20 parts by weight
Morgal L ® (manufactured by Cabot Corp., carbon black)	10 parts by weight
myristic acid	3 parts by weight
butyl stearate	2 parts by weight
methyl isobutyl ketone	720 parts by weight
toluene	720 parts by weight

A compound consisting of the above substances were dispersedly mixed with each other by a ball mill for 72 hours to prepare magnetic paint having a viscosity of 0.18p at a temperature of 25 ° C and a shear rate of $10^4 S^{-1}$. The flexible member 5 made of polyethylene terephthalate and having a thickness of 36μm and a width of 520mm was mounted on the downstream side end of the slit 4 of a SUS 304 extrusion type applying head 1. The magnetic paint was supplied to the applying head 1. The flexural rigidity of the flexible member 5 is 1.2kg•mm^2 when the length and width of the extended portion 51 of the flexible member 5 are 20mm and 500mm, respectively.

The magnetic paint was applied to the moving polyester film 6 of 15μm thick and 508mm wide at an application speed of 150m/min and in an application width of 480mm, then, the applied paint was dried to form a magnetic layer on the polyester film 6 having an amount of 28cc/m^2 of paint and a thickness of 4.0μm.

Embodiment 2

Except that the amount of methyl isobutyl ketone was altered from 720 parts by weight to 650 parts by weight and the amount of toluene was altered from 720 parts by weight to 650 parts by weight, magnetic paint having a viscosity of 0.30p at a temperature of 25 ° C and a shear rate of $10^4 S^{-1}$ was prepared to form a magnetic layer having an amount of 22cc/m^2 of paint and a thickness of 4.0μm similarly to the embodiment 1.

Embodiment 3

Except that the amount of methyl isobutyl ketone was altered from 720 parts by weight to 580 parts by weight and the amount of toluene was altered from 720 parts by weight to 580 parts by weight, magnetic paint having a viscosity of 0.64p at a temperature of 25 ° C and a shear rate of $10^4 S^{-1}$ was prepared to form a magnetic layer having an amount of 20cc/m^2 of paint and a thickness of 4.0μm similarly to the embodiment 1.

Embodiment 4

Similarly to embodiment 1, the magnetic paint was applied to the base film 6 to form a magnetic layer having an amount of 28cc/m^2 of paint and a thickness of 4.0μm. Instead of the flexible member 5 used in embodiment 1, the thickness and width of the flexible member 5 used in this embodiment were 36μm and 520mm, respectively and made of polyethylene terephthalate, however, the flexural rigidity thereof was 3.3kg•mm^2 when the thickness and width of the extended portion 51 thereof were 36μm and 520mm, respectively. The flexible member 5 was mounted on the downstream side end of the slit 4 of the SUS 304 extrusion type applying head 1.

Embodiment 5

Similarly to embodiment 2, the magnetic paint was applied to the base film 6 to form a magnetic layer having an amount of 22cc/m^2 of paint and a thickness of 4.0μm. Instead of the flexible member 5 used in embodiment 2, the flexible member 5 made of polyethylene terephthalate was used. The flexural rigidity of the flexible member 5 used in this embodiment was 3.3kg•mm^2 when the thickness and width thereof was

36μm and 520mm, respectively and the length and width of the extended portion 51 were 20mm and 500mm, respectively. The flexible member 5 was mounted on the downstream side end of the slit 4 of the SUS 304 extrusion type applying head 1.

Embodiment 6

Similarly to embodiment 3, the magnetic paint was applied to the base film 6 to form a magnetic layer having an amount of 20cc/m^2 of paint and a thickness of 4.0μm. Instead of the flexible member 5 used in embodiment 3, the flexible member 5 made of polyethylene terephthalate was used. The flexural rigidity of the flexible member 5 used in this embodiment was 3.3kg•mm^2 when the thickness and width thereof was 36μm and 520mm, respectively and the length and width of the extended portion 51 were 20mm and 500mm, respectively. The flexible member 5 was mounted on the downstream side end of the slit 4 of the SUS 304 extrusion type applying head 1.

Comparison 1

Except that instead of the extrusion type applying head used in embodiment 1, a flexible member was not provided and the SUS 304 extrusion type applying head having a 1s finish in the surface roughness of the leading end portion thereof was used, attempts were made for application of magnetic paint similarly to embodiment 1. The result was that the magnetic paint could not be applied.

Comparison 2

Except that instead of the extrusion type applying head used in embodiment 2, a flexible member was not provided and the SUS 304 extrusion type applying head having a 1s finish in the surface roughness of the leading end portion thereof was used, similarly to embodiment 2, magnetic paint was applied to the base film 6 to form a magnetic layer having an applied amount of 22cc/m^2 and a thickness of 4.0μm.

Comparison 3

Except that instead of the extrusion type applying head used in embodiment 3, a flexible member was not provided and the SUS 304 extrusion type applying head having a 1s finish in the surface roughness of the leading end portion thereof was used, similarly to embodiment 3, magnetic paint was applied to the base film 6.

In each of the embodiments and comparisons, the condition of the surfaces magnetic layers formed by applying magnetic paint to the base films were visually observed. Evaluations were made by putting (A) for surfaces having no stripe-like marks, (B) for surfaces having stripe-like marks in some extent, and (C) for surfaces having many stripe-like marks. A fluorescence X-ray micrometer (manufactured by Seiko Electronic Industry Co., Ltd.; SFT-156, collimator spot diameter: 0.5mm) was used to measure thickness nonuniformity of each magnetic layer in the widthwise direction. Deviations with respect to the average film thickness are shown in percentage in Table 1 below.

Table 1

	surface condition of magnetic layer	thickness nonuniformity of magnetic layer

embodiment 1	A	2.1
embodiment 2	A	2.4
embodiment 3	B	3.0
embodiment 4	B	2.9
embodiment 5	A	2.1
embodiment 6	A	2.3
comparison 1	-	-
comparison 2	C	15.1
comparison 3	C	12.5

Effect of the invention

As apparent from the above-described embodiments and comparisons, the method and apparatus of the present invention makes it possible to apply, to a base film, paint which cannot be applied thereto by the use of only an applying head due to its high viscosity. As clear from Table 1, each magnetic layer (embodiment 1 through embodiment 6) has a more favorable appearance and condition and a smaller degree of thickness nonuniformity than the magnetic layers (comparisons 2 and 3) formed by the conventional method. This indicates that according to the method and apparatus of the present invention, even though applying condition is varied in a wide range by using paint of different viscosities to a base film, the paint can be applied thereto without forming stripe-like marks in the surface of the applied paint and nonuniformity in the thickness thereof and thus a favorable finish of paint can be obtained and a high-dignity film can be obtained, thus contributing to the improvement of productivity.

REFERENTIAL NUMERALS IN DRAWINGS

1 An extrusion type applying head
2 A downstream side end of head
3 An upstream side end of head
4 A slit
5 A flexible member
6 A base film
7 An applying liquid
41 A down stream side end of outlet
51 An extended porsion

Claims

1. A method, for applying liquid (7) to a moving base film (6) with an extrusion type applying head (1), comprising the steps of:

preparing a flexible member (5) which extends outward from a downstream side end of an outlet (41) of said extrusion type applying head;

bringing said flexible member (5) into contact with a surface of said moving base film (6); and

applying said liquid (7) discharged from said liquid discharge slit (4) to said base film (6) with said liquid (7) being smoothed by said flexible member(5).

2. A method for applying liquid as defined in claim 1, wherein said flexible member (5) has a flexural rigidity of 0.01kg•mm^2 ~ 15kg•mm^2 when the width of said flexible member (5) is 500mm.

3. A method for applying liquid as defined in claim 1, wherein said flexible member (5) is extended outward in the range from 3mm to 30mm from said downstream side end of said outlet (41) of said liquid discharge slit (4) of said applying head (1).

4. An apparatus, for applying liquid to a moving base film (6) with an extrusion type applying head (1), in which a flexible member (5) is extended outward from a downstream side end of an outlet (41) of a liquid discharge slit (4) of said extrusion type applying head (1); said flexible member (5) is brought into contact with a surface of said moving base film (6); and said liquid (7) is discharged from said liquid discharge slit (4) and applied to said base film (6) with said liquid (7) being smoothed by said flexible member (5).

5. A method for applying liquid as defined in claim 4, wherein said flexible member (5) has a flexural rigidity of 0.01kg•mm^2 ~ 15kg•mm^2 when the width of said flexible member (5) is 500mm.

6. A method for applying liquid as defined in claim 4, wherein said flexible member (5) is extended outward in the range from 3mm to 30mm from said downstream side end of said outlet (41) of said liquid discharge slit (4) of said applying head (1).

Fig. 1

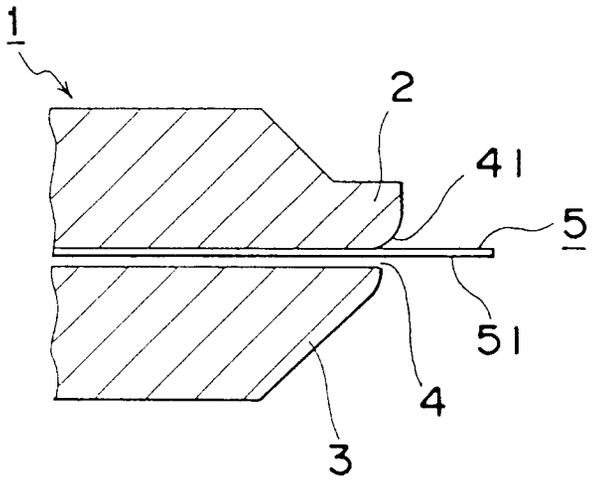
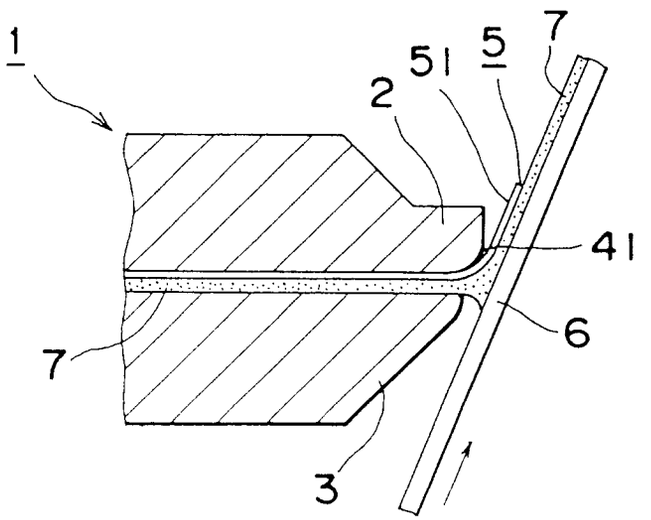


Fig. 2



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP91/00571

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] B05C5/02, B05D1/26

II. FIELDS SEARCHED

Minimum Documentation Searched *

Classification System	Classification Symbols
IPC	B05C5/00-5/02, B05D1/26

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *

Jitsuyo Shinan Koho	1960 - 1991
Kokai Jitsuyo Shinan Koho	1971 - 1991

III. DOCUMENTS CONSIDERED TO BE RELEVANT *

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	JP, A, 57-084771 (Fuji Photo Film Co., Ltd.), May 27, 1982 (27. 05. 82), Claim & US, A, 4424762 & DE, A1, 3144655	1-6
A	JP, A, 58-104666 (Fuji Photo Film Co., Ltd.), June 22, 1983 (22. 06. 83), Claim & US, A, 4480583 & DE, A1, 3246692	1-6
X	JP, A, 59-171654 (Johannes Zimmer), September 28, 1984 (28. 09. 84), Fig. 8 & EP, A2, 108887 & US, A, 4550681	1, 4
X	JP, A, 59-111852 (Johannes Zimmer), June 28, 1984 (28. 06. 84), Fig. 10 & DE, A1, 3335252 & US, A, 4550681	1, 4

* Special categories of cited documents: [10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
July 18, 1991 (18. 07. 91)	August 5, 1991 (05. 08. 91)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	