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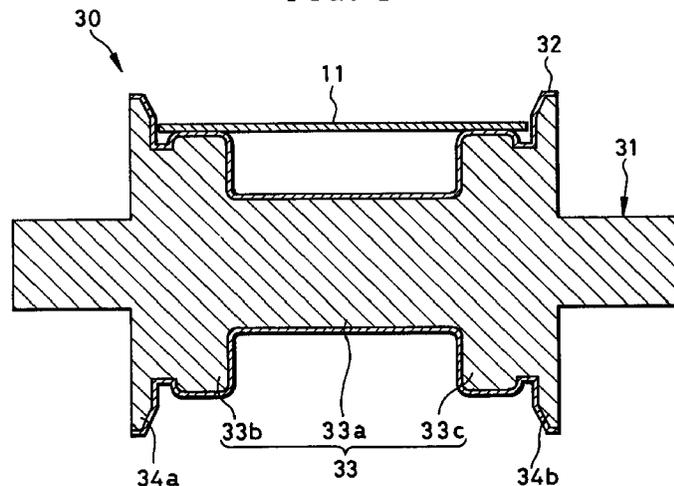
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(54) Conveying roller for photosensitive material and method of producing the same

(57) Continuous photo film (11) includes a support (11a) of resin film having a back surface. A photosensitive layer (11b) of photographic emulsion is disposed on a surface of the support opposite to the back surface. A conveying roller conveys the continuous photo film. The conveying roller includes a roller body (31) of metal. A

hardness reinforcer layer (32) is formed on a surface of the roller body by thermal spraying and from ceramic or cermet, and avoids being scratched or ground by the back surface.

FIG. 4



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a conveying roller for photosensitive material, and a method of producing the same. More particularly, the present invention relates to a conveying roller for photosensitive material, which has high resistance to abrasion and can be produced easily, and a method of producing the same.

2. Description Related to the Prior Art

Photosensitive material, in general, is constituted by a support and a photosensitive layer of photographic emulsion, which is applied as a coating to, or deposited to, the support. According to various kinds of the support, there are plural examples of photosensitive material, including photo film, dry plate, and photographic paper. The photo film has the support produced from film of resin. Types of the photo film includes a roll photo film and a sheet photo film. Examples of the roll photo film include the 8 mm type and the 1,000 mm type. Examples of the sheet photo film include types of 4 x 5 cm, the cabinet size (halfplate), B5, A4, B4, A3 and 10 x 12 inches. As a form of the most widely used photo film, a photo film cassette is well-known, and includes a cassette shell, a spool rotatable inside the cassette shell, and a strip of the photo film whose end is retained on the spool and which is wound about the spool.

The photo film is conveyed by conveying rollers in optical instruments. Conveying rollers for use in the photo film manufacturing apparatus, a photographic printer and a photo film processor are constituted by a roller body formed by cutting and scraping a rod of stainless steel, or by a roller body of metal and hard chromium plating formed on its surfaces. To avoid damaging continuous photo film and photo filmstrip in conveyance, a surface of the roller is finished by polishing, and smoothed for the contact with the photo film.

There is a type of photo filmstrip including a magnetic recording layer, which is a coating of magnetic material applied to the support on the side opposite to the photosensitive layer, so that the photo filmstrip can operate for storing magnetic information written thereto. There is abrasive material or polishing agent, mixed with the magnetic material, for contacting a magnetic head of an information reader/writer, to remove dust or dirt from the magnetic head. When a conveying roller contacts the continuous photo film which will become this type of photo filmstrip, the conveying roller is abraded and deformed by the abrasive material of the photo film, because the conveying roller contacts the magnetic recording layer. It is likely that the continuous photo film or photo filmstrip is fogged by pressure, scratched or damaged. A life of the roller is short, so

that each roller must be replaced with an unused one very frequently.

To solve those problems, JP-A 8-262680 (corresponding to U.S. Pat. No. 5,520,601) discloses a use of such ceramics for a conveying roller as yttria-alloyed tetragonal polycrystalline zirconia, which is zirconium oxide and yttria mixed therewith at 3-5 mole %. Ceramics characteristically have a higher hardness than stainless steel and hard chromium plating, and have higher resistance to abrasion. However it is difficult to cut or scrape a ceramic product into a complicated shape due to the considerable hardness of the ceramics. Ceramics are unsuitable for shaping the roller which includes a roller core and flanges on respective ends of the roller core, and in which a diameter of the roller core is partially changed. Moreover a problem lies in that zirconia stabilized by use of yttria is likely to collect static charge electrically. The continuous photo film might be fogged and have a lowered quality.

SUMMARY OF THE INVENTION

In view of the foregoing problems, an object of the present invention is to provide a conveying roller for photosensitive material, which has high resistance to abrasion and can be produced easily, and a method of producing the same.

In order to achieve the above and other objects and advantages of this invention, a conveying roller conveys photosensitive material, the photosensitive material including a support of resin film having a back surface, and a photosensitive layer of photographic emulsion disposed on a surface of the support opposite to the back surface. The conveying roller includes a roller body of metal. A hardness reinforcer layer is formed on a surface of the roller body by thermal spraying and from ceramic or cermet, for avoiding being scratched or ground by the back surface.

Moreover, the hardness reinforcer layer has a surface of which at least one portion is polished and smoothed, and the at least one portion contacts the photosensitive material.

The photosensitive material further includes a magnetic recording layer, formed on the back surface of the support, and including magnetic material and polishing agent.

In another preferred embodiment, the conveying roller includes a roller body of metal. A diamond-like carbon coating is formed on a surface of the roller body by ion plating method, for avoiding being scratched or ground by the back surface.

Furthermore, the roller body has a surface of which at least one portion is polished and smoothed, and the at least one portion contacts the photosensitive material via the diamond-like carbon coating.

Consequently in the present invention, the conveying roller for photosensitive material can have high resistance to abrasion and can be produced easily.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent from the following detailed description when read in connection with the accompanying drawings, in which:

Fig. 1 is an explanatory view illustrating a photo film manufacturing apparatus;

Fig. 1A is an explanatory view in cross section, illustrating a layered structure of photo film;

Fig. 2 is an elevation illustrating a conveying roller with the continuous photo film;

Fig. 3 is a perspective illustrating the conveying roller and the continuous photo film; and

Fig. 4 is a cross section illustrating the conveying roller and the continuous photo film.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

In Fig. 1, a photo film manufacturing apparatus 10 is illustrated. The photo film manufacturing apparatus 10 produces photo film to be used in a photo film cassette. The photo film manufacturing apparatus 10 is constituted by a photo film supplier unit 12, a perforator unit 13, a side printer unit 14 and a cutter unit 15. Continuous photo film 11 is basically constituted by a support 11a and a photosensitive layer 11b. See Fig. 1A. The support 11a consists of a film of resin. The photosensitive layer 11b consists of a coating of photographic emulsion applied to one face of the support 11a. The continuous photo film 11 has a predetermined width by which raw material with a considerable width has been slitted. The continuous photo film 11 is wound about a reel 16 with the photosensitive layer 11b positioned inside, and placed in the photo film supplier unit 12. At first the continuous photo film 11 is conveyed to the perforator unit 13, in which a train of perforations are formed in the continuous photo film 11 along one edge of the continuous photo film 11. Then the continuous photo film 11 is conveyed to the side printer unit 14. The side printer unit 14 is constituted by a printer head 17 including for example a plurality of small light-emitting diodes (LED). While the continuous photo film 11 is moved past the front of the printer head 17, the printer head 17 photographically records information to edges of the continuous photo film 11, the information including a manufacturer's name, the number of available frames, a photo film type, the number of the photographic emulsion, and the like. Then the continuous photo film 11 is conveyed to the cutter unit 15, in which a cutter 18 cuts the continuous photo film 11 by a unit length into a photo filmstrip 19 with regular shapes of a leader and a trailer. Then the photo filmstrip 19 is transferred to a station for assembling parts of a photo film cassette, and is wound into a shell of the cassette.

A plurality of conveying rollers 30 are disposed in

the photo film manufacturing apparatus 10 for conveying the continuous photo film 11. In Figs. 2 and 3, each of the conveying rollers 30 includes a roller core 33 and flanges 34a and 34b disposed on respective ends of the roller core 33. The flanges 34a and 34b contact edges of the continuous photo film 11, and limit a movable range of the continuous photo film 11 in its width direction. Thus the continuous photo film 11 is stably conveyed, and appropriately can have a perforating position and an image recording position in the perforator unit 13 and the side printer unit 14. The roller core 33 has a central portion 33a of a relatively small diameter. Roll portions 33b and 33c have a greater diameter, and support respective edge portions of the continuous photo film 11. An area of the contact between the conveying roller 30 and the continuous photo film 11 is reduced by means of the central portion 33a, so that the possibility of degrading the continuous photo film 11 with scratches is kept the smaller.

In Fig. 1A, the continuous photo film 11 further includes a magnetic recording layer 11c, which is a coating of magnetic material applied to the support 11a on the side opposite to the photosensitive layer 11b, so that the photo filmstrip can operate for storing magnetic information written thereto. There is abrasive material or polishing agent, mixed with the magnetic material, for contacting a magnetic head of an information reader/writer, to remove dust or dirt from the magnetic head.

In Fig. 4, the conveying roller 30 includes a roller body 31 of metal and a hardness reinforcer layer 32 of hard material.

To produce the roller body 31, a rod of stainless steel is prepared, and cut and scraped. To form the hardness reinforcer layer 32, hard material of either ceramics or cermet is deposited to a surface of the roller body 31 by a method of thermal spraying. A region of applying the coating of the hardness reinforcer layer 32 is determined for contact with the continuous photo film 11. Examples of the hard material of the hardness reinforcer layer 32 are aluminum oxide (alumina), titanium oxide (titania), chromium oxide, mixture of aluminum oxide (alumina) and titanium oxide (titania), mixture of chromium oxide and titanium oxide (titania), tungsten carbide, and the like.

Of course the metal material for the roller body 31 is not limited to the stainless steel. The metal for producing the roller body 31 can be selected from such having sufficient hardness for being cut and scraped with a complicated partial shape. In view of ensuring sufficient physical intensity of the roller body 31, soft metal is preferably used.

It is preferred to polish and smooth the surface of the hardness reinforcer layer 32, at least peripheral surfaces of the roll portions 33b and 33c for contact with the continuous photo film 11. A smoothness between the conveying roller 30 and the continuous photo film 11 contacting each other is raised, so that abrasion of the

conveying roller 30 can be avoided the more reliably. It is possible to prevent pressure fogging and scratches which would damage photographing quality of the continuous photo film 11.

Experiments were conducted for the conveying roller by use of various coatings. Samples A-E of the conveying roller were produced, and subjected to a test of resistance to abrasion. For any of Samples A-E, a cylindrical rod of stainless steel was prepared, and had a diameter of 16 mm and a length of 50 mm. The rod was cut and scraped to form the roller body. A coating of hard material of plural kinds was applied to the roller body by the method of plasma thermal spraying. For evaluation of the resistance to abrasion, Samples A-E were experimentally incorporated in the photo film manufacturing apparatus, in which the continuous photo film was conveyed by each of them by a predetermined length. An amount of surface abrasion of Samples A-E was measured. Comparative Example F according to the prior art was also produced, which included a roller body with a coating of a hard chromium plating. Comparative Example F was similarly evaluated.

The hard material used in the hardness reinforcer layer 32 of Samples A-E was as indicated below:

- Sample A: aluminum oxide (alumina);
- Sample B: aluminum oxide (alumina) and titanium oxide (titania);
- Sample C: chromium oxide;
- Sample D: tungsten carbide and cobalt;
- Sample E: tungsten carbide and nichrome.

As a result, the conveying rollers of Samples A-E had only 1/6 as much an abraded amount of the surface as Comparative Example F in contact with the continuous photo film. It was confirmed that the conveying roller of the present invention had higher resistance to abrasion than the prior art, and had six (6) or more times as long a life as the prior art.

Despite those effects derived from the use of the ceramics, the ceramics characteristically have a comparatively great weight. If the conveying roller with the ceramic coating is used as a free roller not being directly driven by any drive unit, an effect of inertia of rotation is so great as to cause slip of the roller. The ceramic roller has a shortcoming in likeliness in damaging the photosensitive material.

Another preferred embodiment is referred to, in which a diamond-like carbon membrane or coating is used as the hardness reinforcer layer 32 on the roller surface.

To produce the roller body 31, a rod of metal is prepared, and cut and scraped. Material for producing the roller body 31 may be selected from such having sufficient hardness for being cut and scraped with a complicated partial shape. Examples of the metal for the roller body 31 include stainless steel, aluminum, or other soft metal used widely in the techniques of the rollers.

The hardness reinforcer layer 32 of a diamond-like carbon coating is formed by the ion plating method and in the region contacting the continuous photo film 11. The ion plating method is to form a coating by decomposing benzene (C_6H_6) in the plasma by specialized ion source. The ion plating method is characteristically useful for an article of a complicated shape, as it can form a coating in an uniform manner and with high tightness of the coating. The diamond-like carbon coating has very high hardness nearly equal to that of diamond, and has high resistance to heat, high resistance to welding, and high releasability. The diamond-like carbon coating has a very small coefficient of friction, which is 0.1-0.3 time as much as coefficients of friction of steel, super hard alloy, aluminum, glass, and ceramics. The hardness reinforcer layer 32 on the surface of the roller body 31 increases the surface hardness of the conveying roller 30, and thus increases resistance to abrasion.

The hardness reinforcer layer 32 of the diamond-like carbon coating has an amorphous structure and thus has a very smooth surface. It is likely that the diamond-like carbon coating, if a surface of the roller body 31 underlying the diamond-like carbon coating is rough, has surface roughness developed due to the surface roughness of the roller body 31 itself. Accordingly the roller body 31, before forming the diamond-like carbon coating, is polished and smoothed at least in regions of peripheral surfaces of the roll portions 33b and 33c for contact with the continuous photo film 11. The diamond-like carbon coating being subsequently formed by the ion plating method, the conveying roller 30 can have the sufficiently smoothed surface. The smoothness between the conveying roller 30 and the continuous photo film 11 is increased. Abrasion of the conveying roller 30 is reduced the more reliably. It is possible to prevent pressure fogging and scratches which would damage the continuous photo film 11.

In the above embodiment, the conveying roller has the flanges. However a conveying roller of the present invention may lack the flanges, and may have a rod shape.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

Claims

1. A conveying roller for conveying photosensitive material (11), said photosensitive material including a support (11a) of resin film having a back surface, and a photosensitive layer (11b) of photographic emulsion disposed on a surface of said support opposite to said back surface, said conveying roller

comprising:

a roller body (31) of metal; and
a hardness reinforcer layer (32), formed on a
surface of said roller body by thermal spraying
of ceramic or cermet.

2. A conveying roller as defined in claim 1, wherein
said hardness reinforcer layer (32) has a surface of
which at least one portion is polished and
smoothed, and said at least one portion contacts
said photosensitive material (11).

3. A conveying roller as defined in claim 2, wherein
said photosensitive material (11) further including a
magnetic recording layer, formed on said back sur-
face of said support (11a), and including magnetic
material and polishing agent.

4. A conveying roller as defined in claim 3, wherein
said roller body (31) includes:

a roller core;
a pair of flanges, disposed to project from said
roller core in a disk manner, for contacting
respective edges of said photosensitive mate-
rial (11), to regulate said photosensitive mate-
rial therebetween in a width direction thereof;
and
a pair of roll portions, disposed respectively
near to an inner face of said flanges, having a
greater diameter than a diameter of said roller
core, for supporting said photosensitive mate-
rial near to said edges of said photosensitive
material.

5. A conveying roller as defined in claim 4, wherein
said roller body (31) further includes a pair of ring-
shaped grooves each of which is formed between
one of said roll portions and one of said flanges.

6. A conveying roller as defined in claim 5, wherein
said ceramic comprises at least one of aluminum
oxide, titanium oxide, chromium oxide, mixture of
aluminum oxide and titanium oxide, mixture of chro-
mium oxide and titanium oxide, and tungsten car-
bide.

7. A conveying roller as defined in claim 5, wherein
said cermet comprises tungsten carbide with
cobalt, or tungsten carbide with nichrome.

8. A conveying roller as defined in claim 6, wherein
said metal comprises stainless steel.

9. A method of producing a conveying roller for con-
veying photosensitive material (11), said photosen-
sitive material including a support (11a) of resin film

having a back surface, and a photosensitive layer
(11b) of photographic emulsion disposed on a sur-
face of said support opposite to said back surface,
said producing method comprising steps of:

cutting a rod material of metal into a roller body
(31);
and
forming a hardness reinforcer layer (32) of
ceramic or cermet on a surface of said roller
body by thermal spraying.

10. A producing method as defined in claim 9, further
comprising a step of polishing and smoothing at
least one portion of a surface of said hardness rein-
forcer layer (32), said at least one portion contact-
ing said photosensitive material (11).

11. A conveying roller for conveying photosensitive
material (11), said photosensitive material including
a support (11a) of resin film having a back surface,
and a photosensitive layer (11b) of photographic
emulsion disposed on a surface of said support
opposite to said back surface, said conveying roller
comprising:

a roller body (31) of metal; and
a diamond-like carbon coating (32), formed on
a surface of said roller body by ion plating
method.

12. A conveying roller as defined in claim 11, wherein
said roller body (31) has a surface of which at least
one portion is polished and smoothed, and said at
least one portion contacts said photosensitive
material (11) via said diamond-like carbon coating
(32).

13. A conveying roller as defined in claim 12, wherein
said photosensitive material (11) further including a
magnetic recording layer, formed on said back sur-
face of said support (11a), and including magnetic
material and polishing agent.

14. A conveying roller as defined in claim 13, wherein
said roller body (31) includes:

a roller core;
a pair of flanges, disposed to project from said
roller core in a disk manner, for contacting
respective edges of said photosensitive mate-
rial (11), to regulate said photosensitive mate-
rial therebetween in a width direction thereof;
and
a pair of roll portions, disposed respectively
near to an inner face of said flanges, having a
greater diameter than a diameter of said roller
core, for supporting said photosensitive mate-

rial near to said edges of said photosensitive material.

15. A conveying roller as defined in claim 14, wherein said metal comprises stainless steel or aluminum. 5

16. A method of producing a conveying roller for conveying photosensitive material (11), said photosensitive material including a support (11a) of resin film having a back surface, and a photosensitive layer (11b) of photographic emulsion disposed on a surface of said support opposite to said back surface, said producing method comprising steps of: 10

cutting a rod material of metal into a roller body (31); 15
and
forming a diamond-like carbon coating (32) on a surface of said roller body by ion plating method. 20

17. A producing method as defined in claim 16, further comprising a step of, before forming said diamond-like carbon coating (32) on said roller body (31), polishing and smoothing at least one portion of a surface of said roller body, said at least one portion contacting said photosensitive material (11) via said diamond-like carbon coating. 25

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FIG. 1

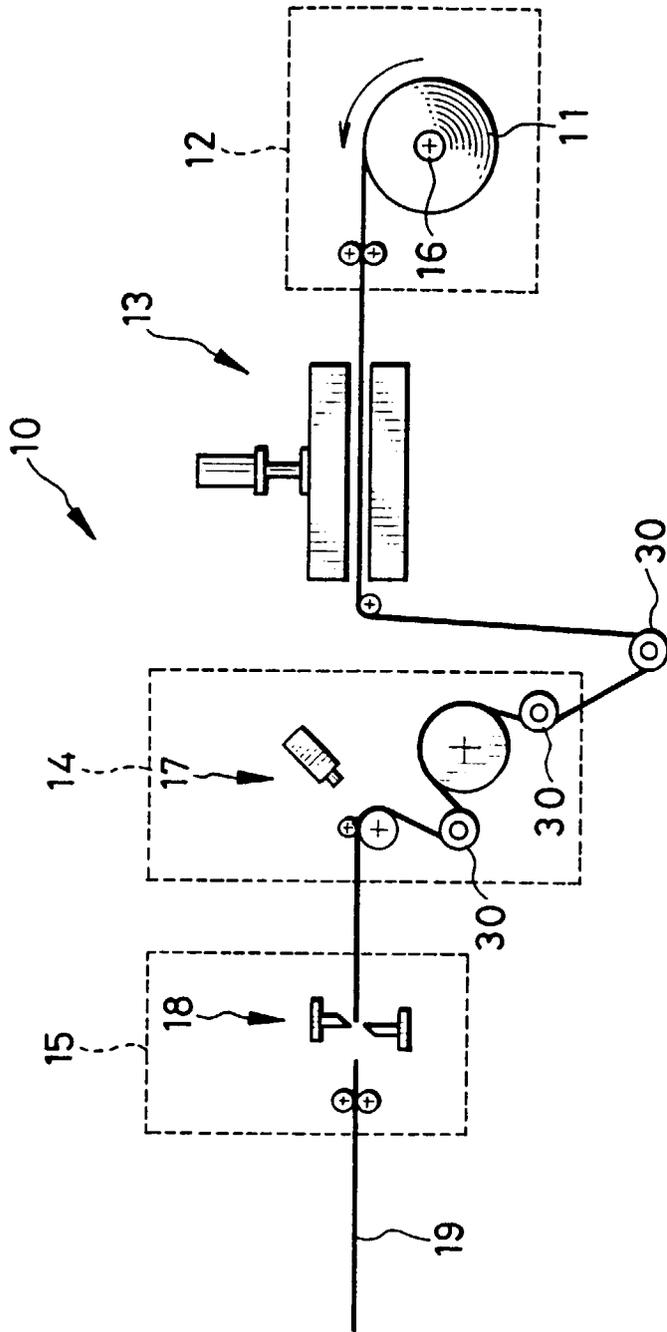


FIG. 1A

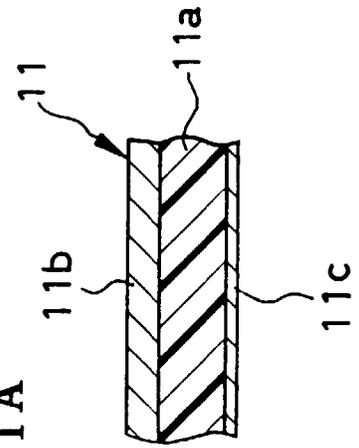


FIG. 2

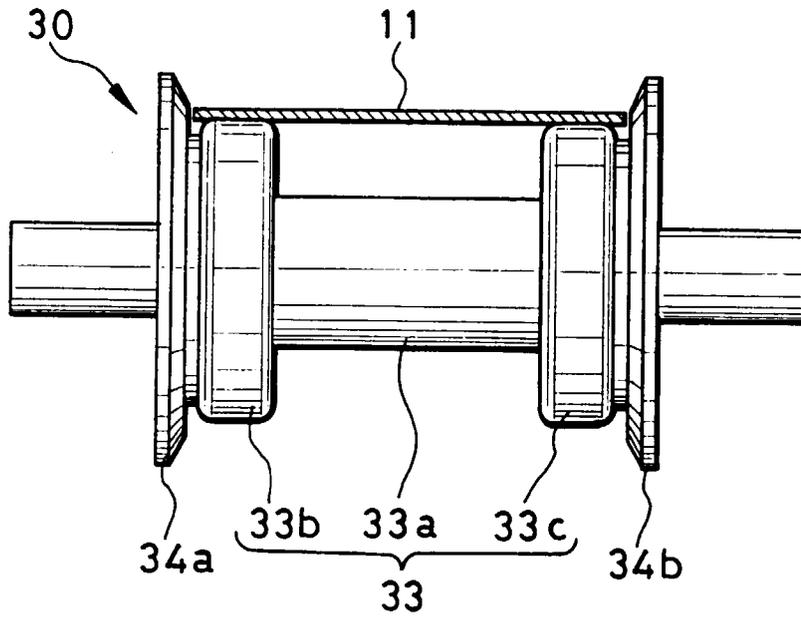


FIG. 3

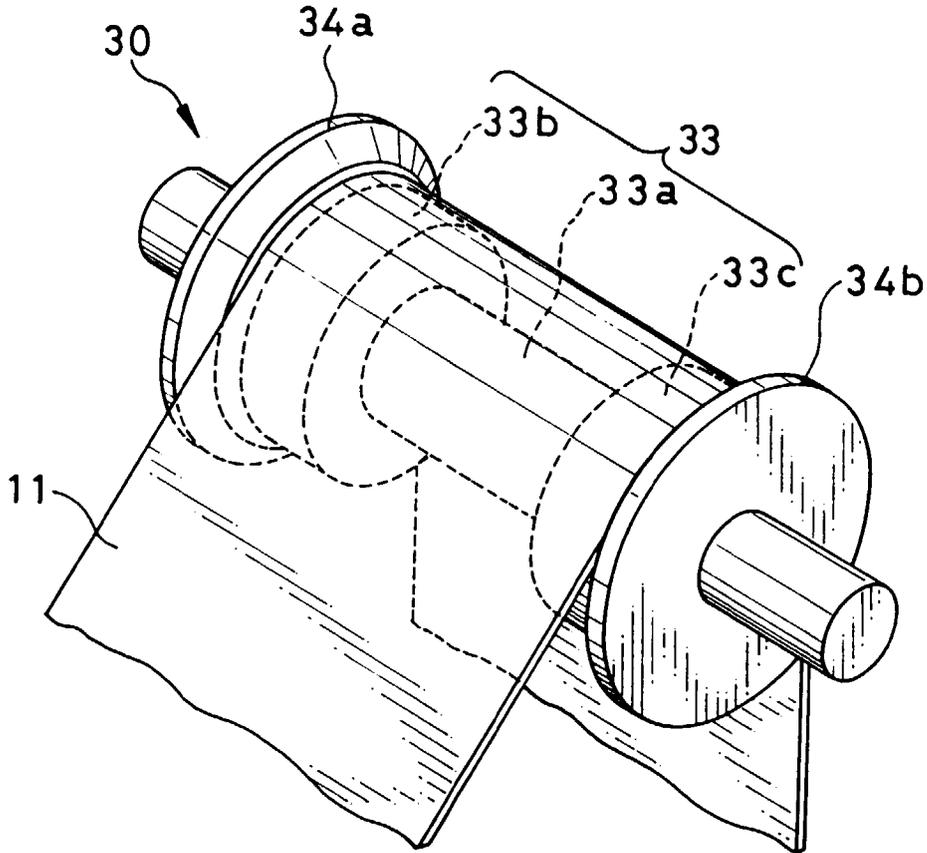
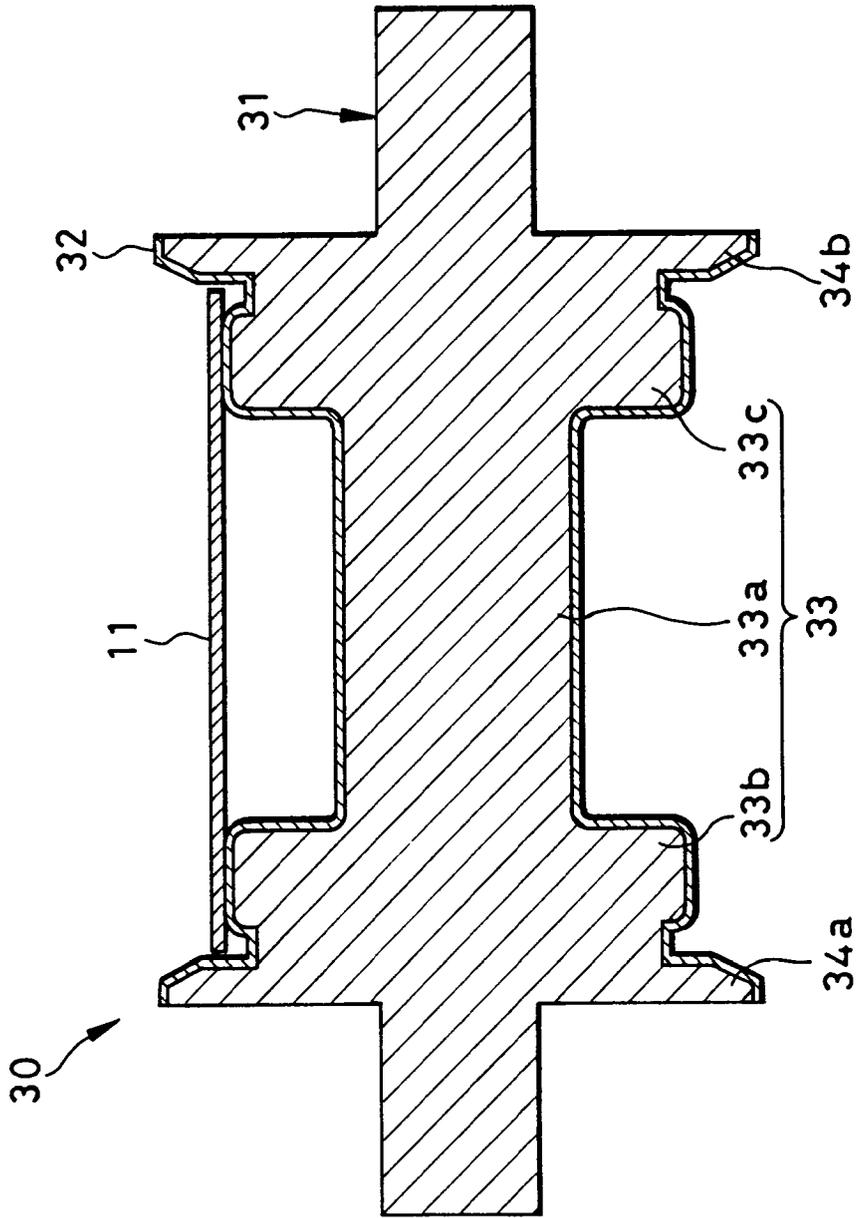


FIG. 4





European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 5216

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	DE 81 02 225 U (BISCHL JOHANN) * the whole document *	1-3,9,10 4-7, 11-17	B65H27/00
Y	--- PATENT ABSTRACTS OF JAPAN vol. 016, no. 471 (M-1318), 30 September 1992 & JP 04 169462 A (IBIDEN CO LTD), 17 June 1992, * abstract *	4-7,14, 15	
A	--- EP 0 401 886 A (STORK SCREENS BV) 12 December 1990 * column 9, line 8 - line 48; figure 13 *	1	
Y	--- EP 0 651 385 A (MATSUSHITA ELECTRIC IND CO LTD) 3 May 1995 * page 2, line 10 - line 47; figure 1A; example 1 *	7	
A	---	1	
Y	---	11-17	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B65H
Place of search	Date of completion of the search	Examiner	
BERLIN	2 June 1998	David, P	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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