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(54) **MAGNETIC ROLL AND METHOD OF PRODUCING SAME**

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(58) **Field of Search** 335/303, 302, 335/306; 355/251.1; 492/18, 22, 25, 47

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(57) **ABSTRACT**

[The magnet roll according to the present invention comprising a cylindrical resin-bonded magnet, a first shaft formed by injection molding integrally with the cylindrical resin-bonded magnet at one end thereof, and a second shaft press-fitted into a bore of the cylindrical resin-bonded magnet at the opposite end thereof.] *A magnetic roll comprises a cylindrical resin-bonded magnet made primarily of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of at least 2×10^4 kg/cm^2, a first shaft formed by injection molding integrally with the cylindrical resin-bonded magnet at one end thereof, and a second shaft made of a rigid conductive material and press-fitted into a bore of the cylindrical resin-bonded magnet at the opposite end thereof. The bore has a splined cross section, the second shaft provided with a base portion having a splined cross section complimentary to that of the bore, and the base portion is inserted into the bore. The ferromagnetic powder is made of at least one selected from the group consisting of barium ferrite, strontium ferrite, a rare earth-cobalt alloy and a rare earth-iron-boron alloy, and the thermoplastic resin is at least one selected from the group consisting of nylon-6, nylon-12 and nylon-66.*

20 Claims, 3 Drawing Sheets

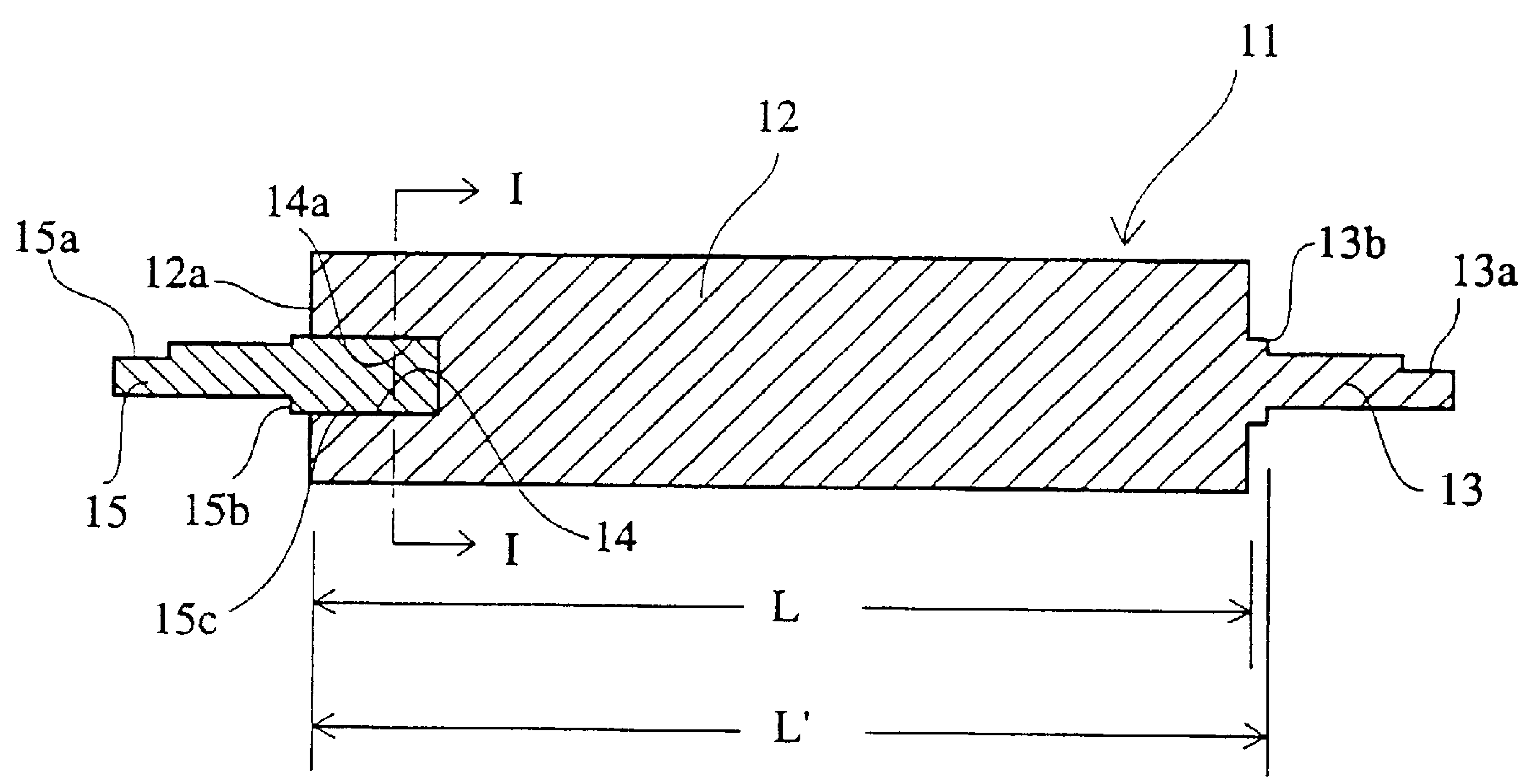


FIG. 1(a)

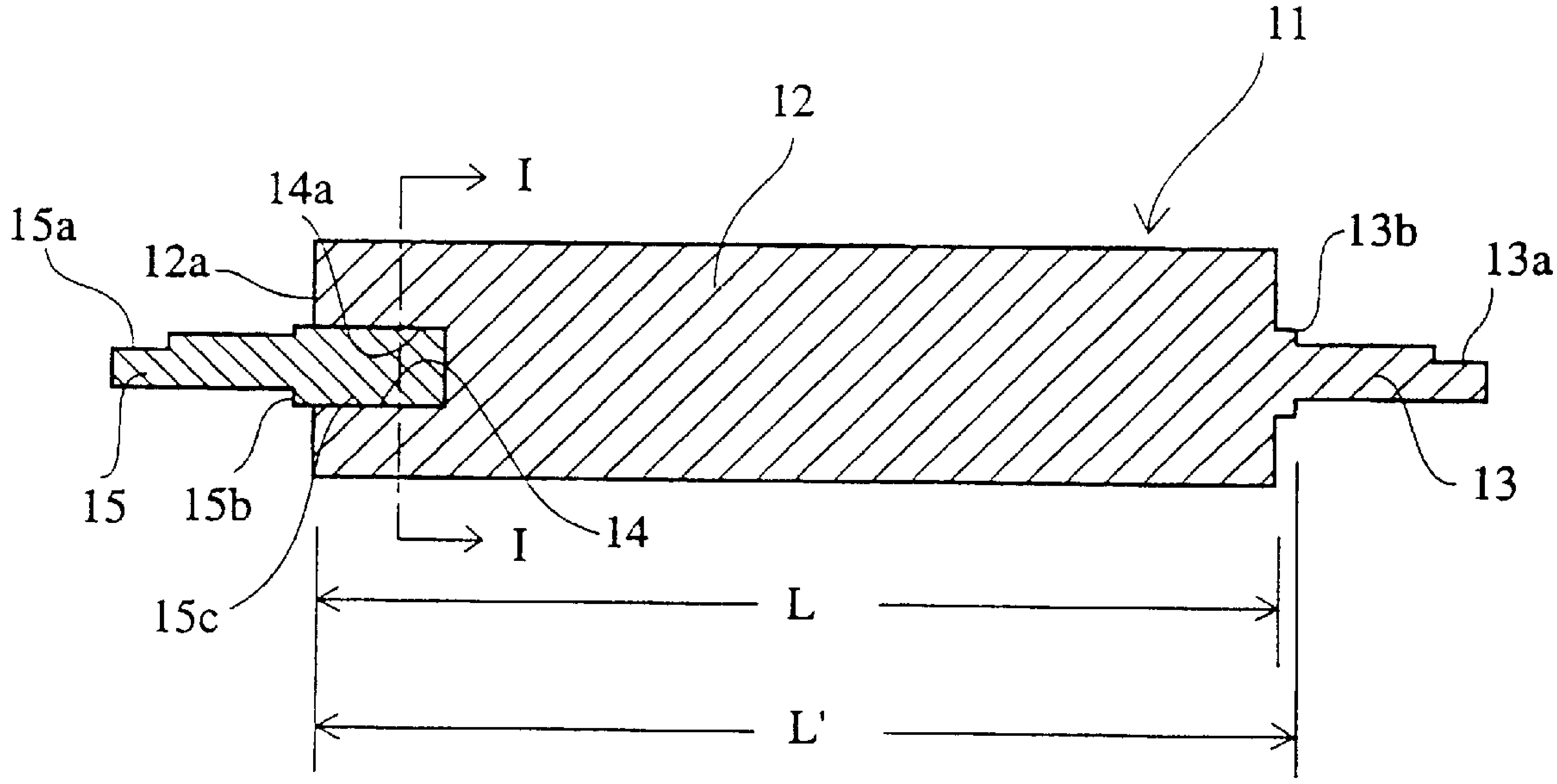


FIG. 1(b)

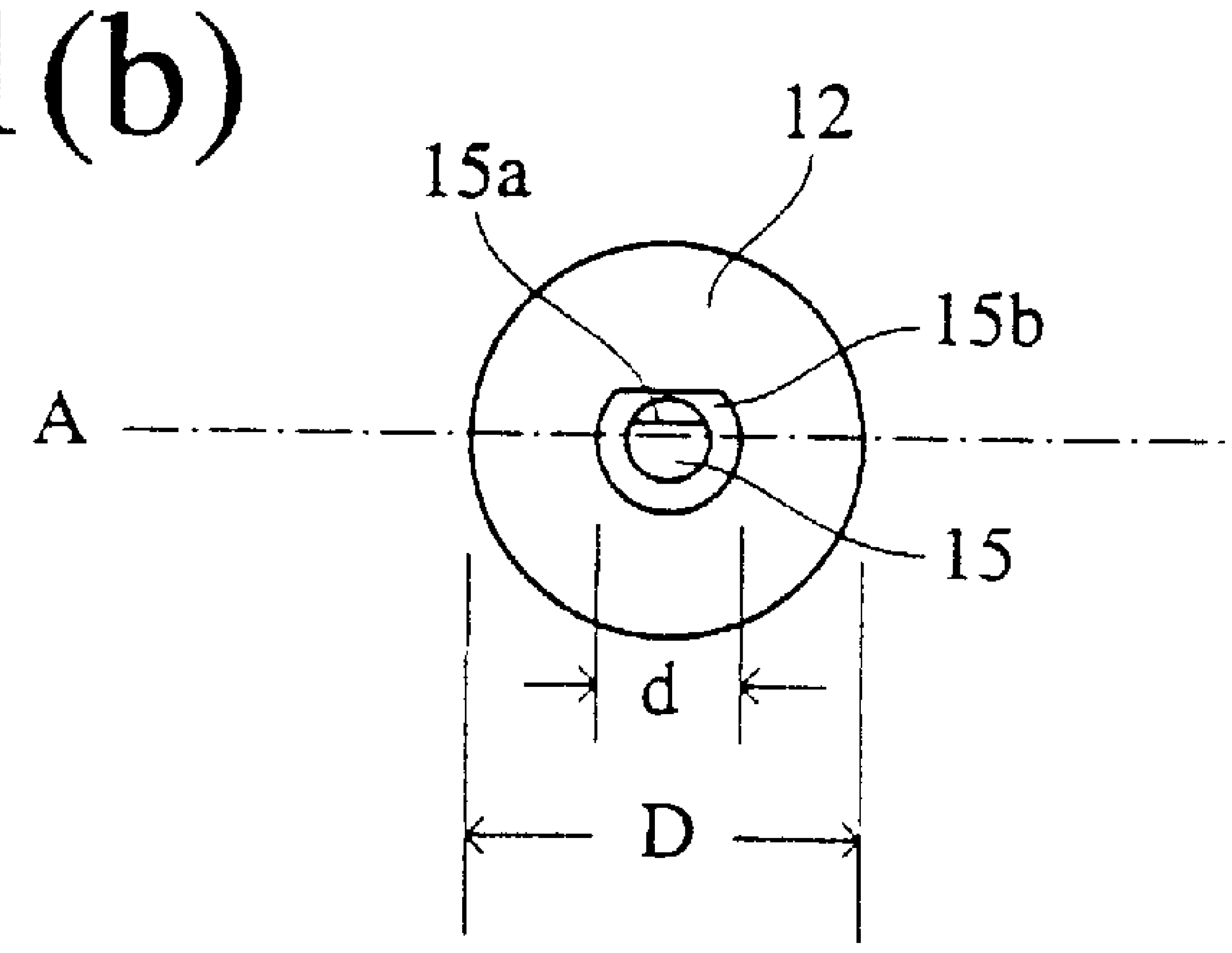


FIG. 1(c)

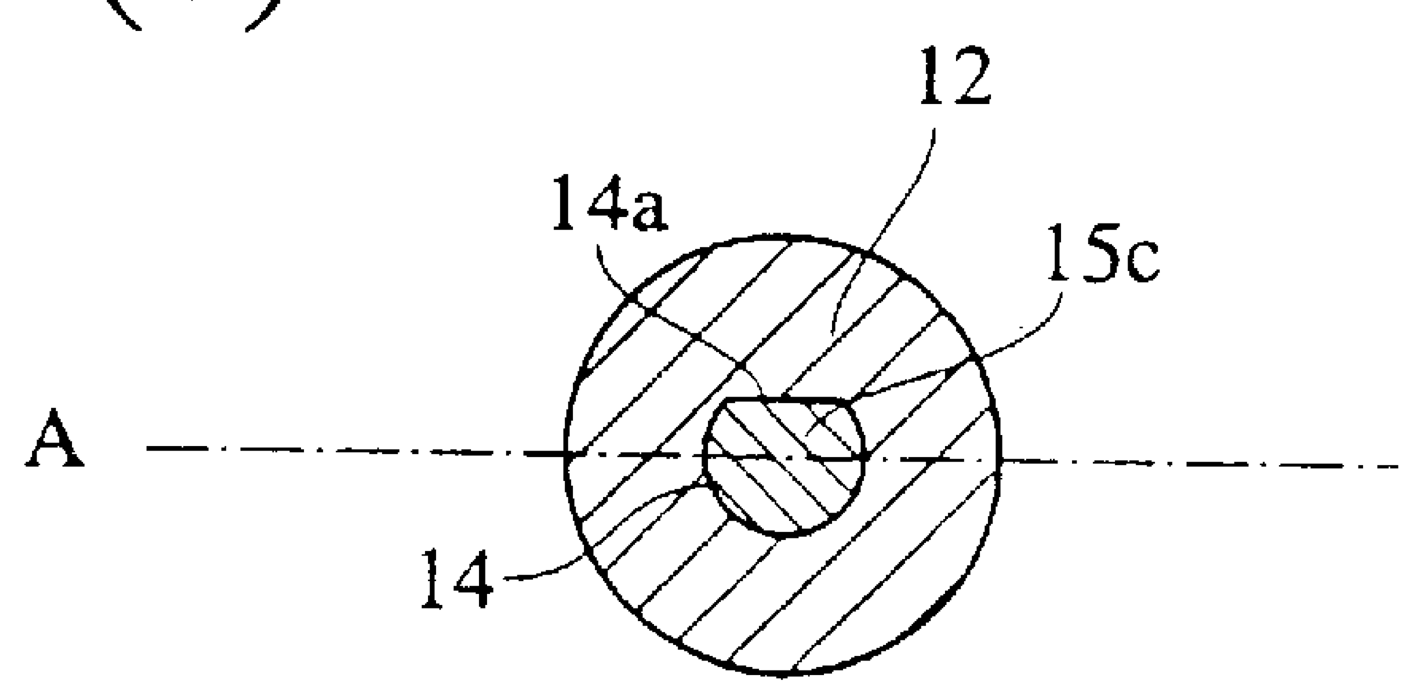


FIG. 2

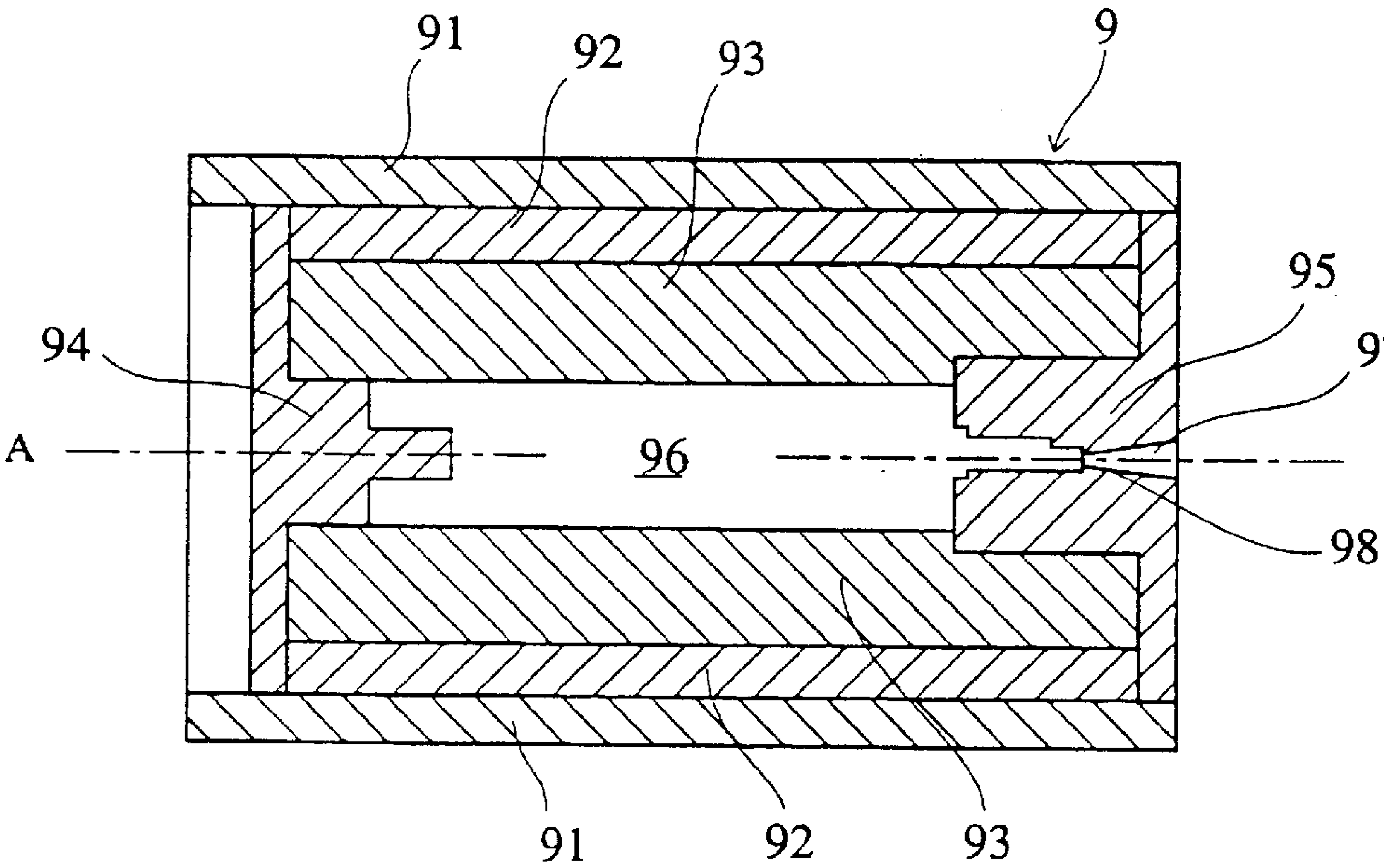


FIG. 3

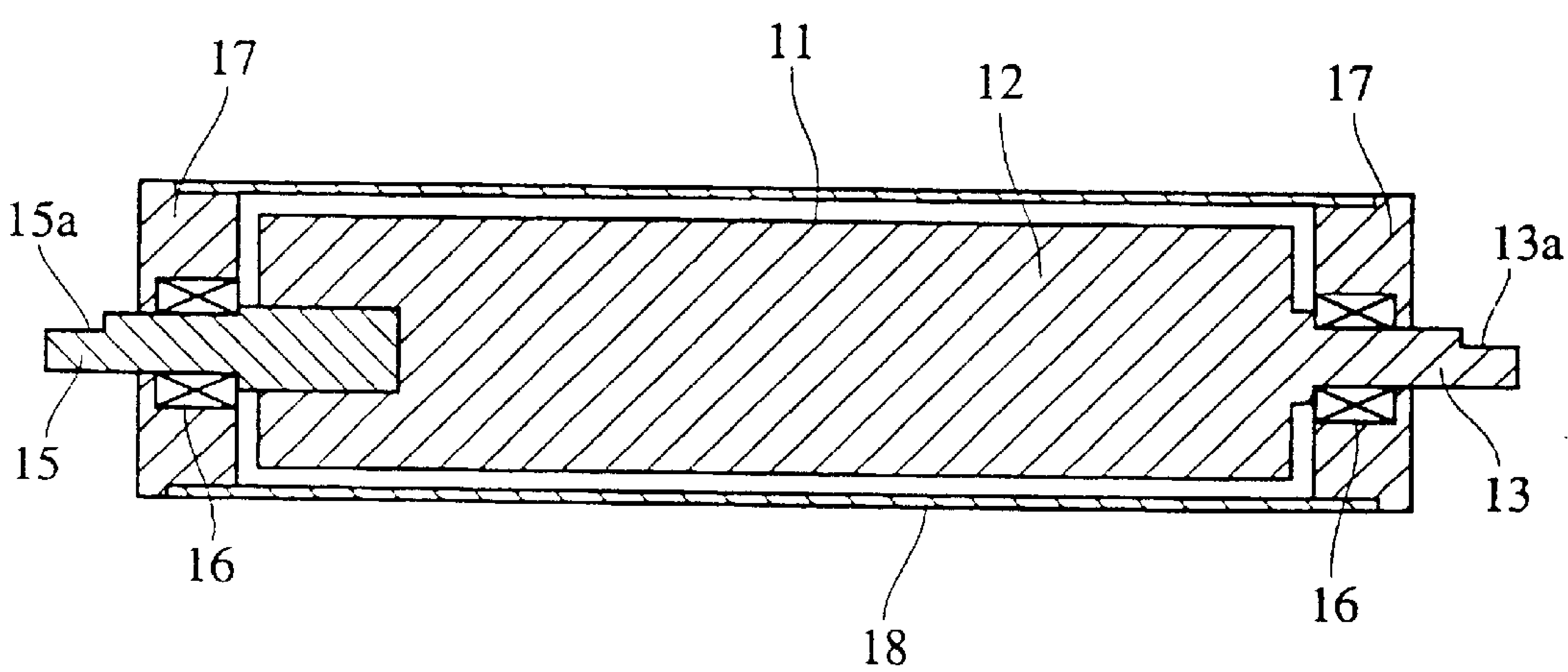
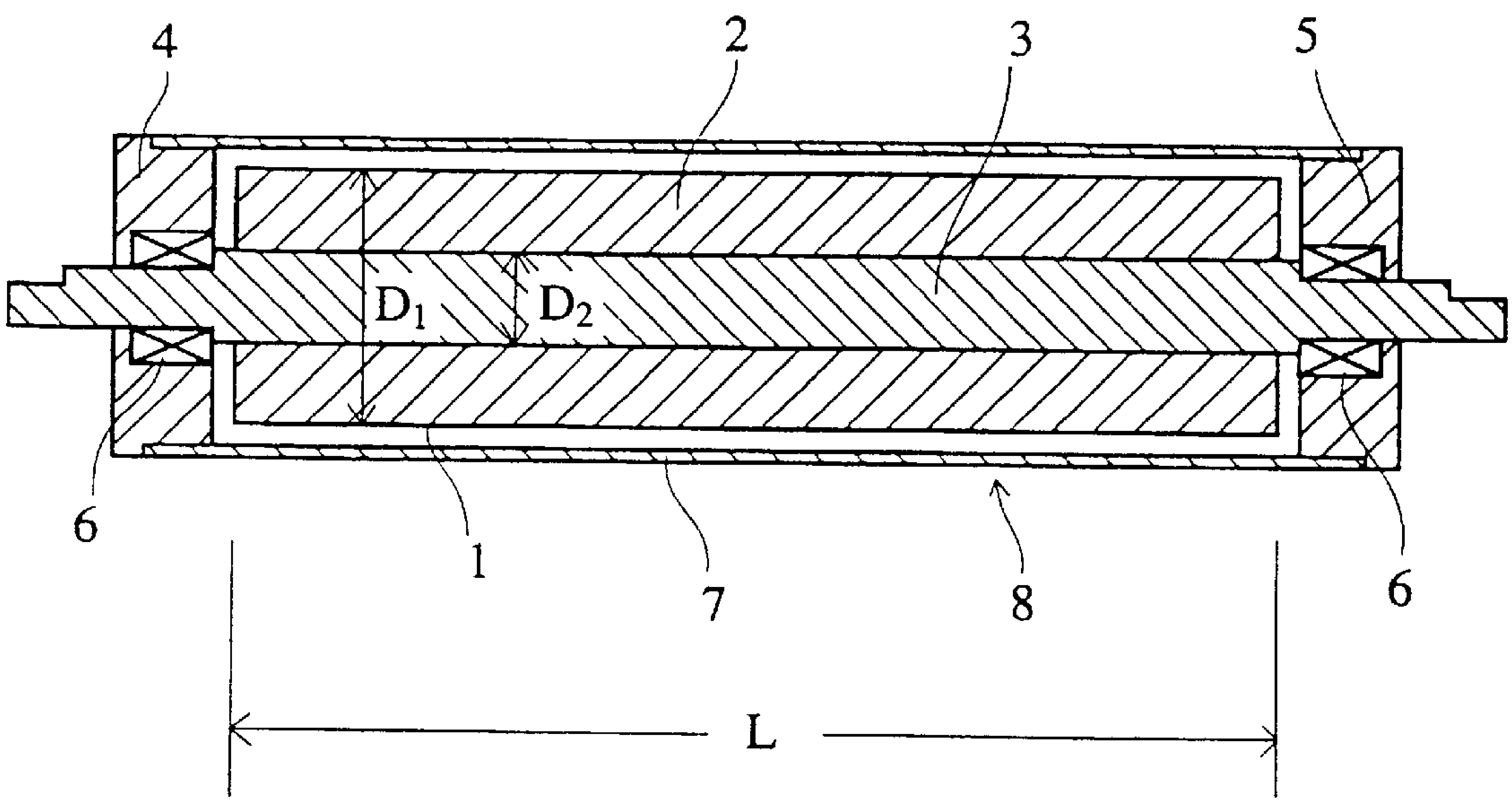


FIG. 4 PRIOR ART



MAGNETIC ROLL AND METHOD OF PRODUCING SAME

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

The present invention relates to a magnet roll for use as a delivery means for a magnetic developer in an electrophotographic apparatus, an electrostatic recording apparatus etc., and a method of producing the magnet roll. Particularly, the present invention relates to a magnet roll which does not suffer from breakage or cracking, and a method of producing the magnet roll in which a cylindrical resin-bonded magnet is formed by injection molding integrally with one shaft and the other shaft is press-fitted into a bore of the cylindrical resin-bonded magnet at the opposite end, thereby reducing the number of manufacturing steps and production cost.

In conventional electrophotographic apparatus, electrostatic recording apparatus, etc., a magnet roll used as a developing roll or a cleaning roll generally has a structure as shown in FIG. **4**. The magnet roll **1** comprises a cylindrical permanent magnet **2** such as a resin-bonded magnet provided with a plurality of magnetic poles (not shown) on an outer surface thereof, and a shaft **3** coaxially secured into a central bore extending axially through the cylindrical permanent magnet **2**.

A pair of flanges **4, 5** are rotatably mounted to the opposite ends of the shaft **3** via bearings **6, 6**. A hollow cylindrical sleeve **7** is fixed to the flanges **4, 5** to surround the cylindrical permanent magnet **2**. Incidentally, the flanges **4, 5** and the sleeve **7** are made of a non-magnetic material such as aluminum alloys, stainless steel, etc.

In case the magnet roll **1** is employed in the developer roll **8** as shown in FIG. **4**, the magnet roll **1** and the sleeve **7** rotate relative to each other. For instance, the magnet roll **1** is kept stationary while the sleeve **7** secured to the flanges **4, 5** are allowed to rotate relative to the magnet roll **1**. By this construction, a magnetic developer is attracted onto an outer surface of the rotating sleeve **7** by a magnetic attraction force of the cylindrical permanent magnet **2** and conveyed into a developing region for carrying out the development of an electrostatic latent image on an image-bearing member (not shown) to obtain a developed toner image. Incidentally, the magnetic developer is usually of a one-component type including a magnetic toner, or of a two-component type including a toner and a magnetic carrier.

In the magnet roll **1** described above, the cylindrical permanent magnet **2** is generally made of a sintered magnet such as a ferrite magnet, or a resin-bonded magnet. The resin-bonded magnet is primarily used when the weight reduction of the developer roll **8** is desired. When the cylindrical permanent magnet **2** is made of a resin-bonded magnet, the magnet roll **1** is produced, for instance, by (1) blending a ferromagnetic powder (usually ferrite powder) and a polymer material (usually rubber or plastics) to prepare a mixture, (2) charging the mixture into a cavity of an injection-molding die, in which the shaft **3** as an insert is held in place, to shape a cylindrical resin-bonded magnet **2** fixed to the shaft **3** while applying a magnetic field thereto, (3) cooling and solidifying the cylindrical resin-bonded magnet **2** in the die and then removing an integral body composed of the cylindrical resin-bonded magnet **2** and the shaft **3** from the die, and (4) magnetizing the integral body in the anisotropic direction to form magnetic poles on the cylindrical resin-bonded magnet **2**, thereby obtaining the magnet roll **1**.

A variety of thermoplastic resin materials have been used to form the cylindrical resin-bonded magnet **2** of the magnet roll **1**. However, since the cylindrical resin-bonded magnet **2** is of such an elongated shape that a ratio of a length L to a diameter D_1 is 3 or more, a crystalline resin having a modulus of longitudinal elasticity of 1×10^5 kg/cm^2 or higher should be generally utilized to prevent the deformation of the cylindrical resin-bonded magnet **2** and reduce the molding time.

When the electrostatic latent image is developed, it is necessary to apply a bias voltage to the sleeve **7** of the developer roll **8** to prevent fogging on a recording medium or to achieve a reversal development. For this reason, the shaft **3** is generally made of a metal such as steel, stainless steel, etc. and is connected at one end thereof, for instance at an end adjacent to the flange **4**, to a voltage source so that a necessary bias voltage is applied via the shaft **3** and the bearings **6, 6**, such as sintered bearings, roller bearings, etc. to the sleeve **7**.

However, in the magnet roll having such a structure, it is likely that the cylindrical resin-bonded magnet **2** breaks or cracks in its boundary region with the shaft **3** due to a large difference in coefficient of linear expansion therebetween. For instance, the shaft **3** made of steel has a coefficient of linear expansion of 1.1×10^{-5} cm/cm/° C. and the cylindrical resin-bonded magnet **2** has a coefficient of linear expansion of about 3–4×10^{-5} cm/cm/° C. (refer to Japanese Patent Publication No. 5-37331). When heated during the injection-molded process and thereafter cooled, the integral body is caused to shrink in the axial direction. In this case, a shrinkage of the cylindrical resin-bonded magnet **2** is larger than that of the shaft **3** so that breakage or cracking is likely to take place in a boundary region between the cylindrical resin-bonded magnet **2** and the shaft **3**. Particularly, when the size of the magnet roll **1** is reduced, the thickness of the cylindrical resin-bonded magnet **2** must be reduced correspondingly, for instance, to such an extent that a ratio of an inner diameter D_2 to an outer diameter D_1 is 0.4 or more. As a result, the tendency of breakage or cracking is further accelerated.

OBJECT AND SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a magnet roll having an enhanced resistance to breakage or cracking with easiness of applying a bias voltage to a sleeve.

Another object of the present invention is to provide a method of producing such a magnet roll.

To achieve the above objects, in the first aspect of the present invention, there is provided a magnet roll comprising a cylindrical resin-bonded magnet made primarily of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of *2×10^4 kg/cm^2 or more, such as* 1×10^5 kg/cm^2 *or more*, a first shaft made of the same material as that of the cylindrical resin-bonded magnet and integrally formed at one end of the cylindrical resin-bonded magnet by injection molding, and a second shaft made of a rigid conductive material and press-fitted into a bore of the cylindrical resin-bonded magnet at the opposite end.

In the second aspect of the present invention, there is provided a method of producing a magnet roll composed of a cylindrical resin-bonded magnet made of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of *2×10^4 kg/cm^2 or more, such as* 1×10^5 kg/cm^2 *or more*, and first and second shafts concentrically projecting from opposite ends of the cylindrical resin-bonded magnet, comprising the steps of (a) mixing the ferromagnetic powder with the thermoplastic resin to prepare a mixture; (b) charging the mixture into an injection-molding die to produce an integrally shaped body of the cylindrical resin-bonded magnet having a first shaft concentrically projecting from one end of the cylindrical resin-bonded magnet and a bore at the other end thereof; (c) removing the integrally shaped body from the injection-molding die; (d) press-fitting a separately prepared second shaft made of a rigid conductive material into the bore of the cylindrical resin-bonded magnet; and (e) placing the cylindrical resin-bonded magnet in a magnetic field to form a plurality of magnetic poles on an outer surface of the cylindrical resin-bonded magnet.

Since the magnet roll according to the present invention has such a structure that the first shaft is integrally formed at one end of the cylindrical resin-bonded magnet by injection molding, while the second shaft is press-fitted into a bore of the cylindrical resin-bonded magnet at the opposite end, the magnet roll does not suffer from breakage or cracking due to difference in coefficient of shrinkage between the cylindrical resin-bonded magnet and the shaft. Further, since the second shaft is made of a rigid conductive material, a bias voltage can be effectively applied to a sleeve via bearings and flanges.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**(a) is a longitudinal cross-sectional view showing a magnet roll according to the present invention;

FIG. **1**(b) is a left side view of the magnet roll shown in FIG. **1**(a);

FIG. **1**(c) is a cross-sectional view taken along the line **1**—**1** of FIG. **1**(a);

FIG. **2** is a sectional view showing an injection-molding die for producing the magnet roll according to the present invention;

FIG. **3** is a longitudinal cross-sectional view showing a developing roll assembly equipped with the magnet roll according to the present invention; and

FIG. **4** is a longitudinal cross-sectional view showing a conventional magnet roll.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described in detail below referring to the attached drawings.

Referring to FIGS. **1**(a) through **1**(c), there is shown a magnet roll **11** according to the present invention. The magnet roll **11** comprises a cylindrical resin-bonded magnet **12**, at one end (a right end in FIG. **1**(a)) of which a first shaft **13** is integrally formed. The cylindrical resin-bonded magnet **12** is provided, at the opposite end thereof (a left end in FIG. **1**(a)), with a bore **14** into which a second shaft **15** separately prepared is pressure-fitted. As best seen from FIG. **1**(c), the bore **14** may have a partially cut-away circular or a crescent cross section (splined cross section). A base portion **15**c of the second shaft **15** which is inserted into the bore **14** also has a partially cut-away circular, or crescent, cross section (splined cross section) which is substantially the same as that of the bore **14**, so that the second shaft **15** is press-fitted into the bore **14**. The splined cross sections of the bore **14** and the base portion **15**c of the second shaft **15** serve to prevent the rotation of the second shaft **15**.

As mentioned above, in the magnet roll according to the present invention, the cylindrical resin-bonded magnet **11** and the first shaft **13** are integrally formed from a composition composed of a ferromagnetic powder and a thermoplastic resin.

Suitable materials of the ferromagnetic powder include barium ferrite, strontium ferrite, rare earth-ferromagnetic materials such as a rare earth-cobalt alloy (R—Co) and a rare earth-iron-boron alloy (R—Fe—B), etc. An average particle size of the ferromagnetic powder is preferably in the range of 0.3–5 μm to obtain high magnetic properties, moldability and productivity.

The ferromagnetic powder may be coated with an organic silicon compound (silane coupling agent), etc., an organic titanate compound (titanium coupling agent), etc. to improve the wettability of the ferromagnetic powder.

To obtain the desired magnetic properties, a proportion of the ferromagnetic powder is 85 weight % or more based on the total amount of the cylindrical resin-bonded magnet **12**. However, when the proportion of the ferromagnetic powder exceeds 91 weight %, the mechanical strength and moldability of the cylindrical resin-bonded magnet **12** become low due to insufficient content of a resin component. Therefore, the proportion of the ferromagnetic powder is preferably in the range of 85–91 weight %.

Suitable materials for the thermoplastic resins may be any known thermoplastic resin such as polyamide, polycarbonate, polyphenylene sulfide, etc. However, since the first shaft **13** is integrally formed with the cylindrical resin-bonded magnet **12**, it is preferable to employ the thermoplastic resins having a high mechanical strength and a high wear resistance. Specific examples of such thermoplastic resin include, for instance, polyamides such as nylon-6, nylon-12, nylon-66, etc.

The molding composition for the cylindrical resin-bonded magnet **12** and the first shaft **13** may further contain a slip agent such as polyethylene wax and calcium stearate, a plasticizer such as phthalates, an anti-oxidizing agent such as aromatic amines, etc. alone or in combination in as small a proportion as 1 weight % or less.

The molding composition composed of the ferromagnetic powder and the thermoplastic resin may be mixed together by a kneader while heating to obtain a mixture (compound) which is used in an injection-molding process.

The second shaft **15** may be separately prepared by a casting method, a machining method, etc. Suitable materials for the second shaft **15** are rigid conductive materials such as metals. Preferably, the second shaft **15** is made of steel, stainless steel, etc. to make it possible to apply a bias voltage to the sleeve **18**.

The magnet roll **11** may be produced by an injection-molding method using a vertical-type split die (for instance, refer to Japanese Patent Publication No. 3-18723). The vertical-type split die may be composed of a movable die segment and a stationary die segment parting from each other at a parting surface in parallel to an axis of the magnet roll to be molded. Preferably, the magnet roll **11** can be produced by using a split die of a type shown in FIG. **2** and having a parting surface extending axially so as to pass through the axis of the magnet roll to be molded, as indicated by a broken line A in FIG. **2**. In a case where such a split die having the axially extending parting surface is employed, the mixture is preferably injected into a die cavity from one end of the die. This ensures a dimensional accuracy of a distance (L') between an end surface of a shoulder portion **13**b of the first shaft **13** and an end surface **12**a of the cylindrical resin-bonded magnet **12** as shown in FIG. **1**(a), because these end surfaces can be produced in the same stationary die segment.

The split die **9** shown in FIG. **2** includes a base **91**, a cylindrical outer shell **92** fitted into the base **91**, a cylindrical inner shell **93** fitted into the outer shell **92** and end plates **94**, **95**. The outer shell **92** may be made of a magnetic material, while the inner shell **93** and end plates **94**, **95** may be made of a non-magnetic material. A die cavity **96** is defined by an inner surface of the inner shell **93** and the end plates **94**, **95**. A magnetic field-generating means (not shown) may be disposed in the inner shell **93** to magnetize the shaped body at the desired intervals during the injection-molding process. Incidentally, the end plate **95** is provided with a runner **97** communicating with a sprue (not shown), and a gate **98**.

After the shaped body is removed from the die **9**, the shaft **15** made of a rigid conductive material such as steel is press-fitted into the bore **14** of the cylindrical resin-bonded magnet **12**. As described hereinbefore, the bore **14** has a partially cut-away circular, or crescent, cross section (splined cross section) so as to provide a flat inner surface **14**a extending in the axial direction, and the shaft **15** is provided with a flat surface mating with the flat surface **14**a of the bore **14**. When the shaft **15** is fitted into the bore **14**, the mating of these flat surfaces serves to ensure the fixing of the shaft **15** to the cylindrical resin-bonded magnet **12**, thereby preventing the rotation of the second shaft **15**.

The magnet roll **11** thus produced is placed in a magnetic field for magnetization. The [opposite shafts **13**, **15**] *shaft 15 is* are further provided with [flat portions **13**a, **15**a] *a flat portion 15a* which [extend] *extends* axially on [outer surfaces] *an outer surface* of the [shafts **13**, **15**, respectively] *shaft 15*. The [flat portions **13**a, **15**a] *flat portion 15a* may be formed by a proper machining method such as a surface grinding method. [However, as] *As* shown in FIG. **2**, the [flat portion **13**a] *shaft 13* is preferably formed by injection molding [to eliminate the subsequent machining process]. The [flat portions **13**a, **15**a function as reference surfaces] *flat portion 15a functions as a reference surface* for positioning the magnet roll **11** in a magnetic field in which the cylindrical resin-bonded magnet **12** is magnetized. The [flat portions **13**a, **15**a ensure] *flat portion 15a ensures* that the magnet roll **11** is held in place in the magnetic field to accurately produce respective magnetic poles at intended positions on the cylindrical resin-bonded magnet **12**. The [flat portions **13**a, **15**a] *flat portion 15a* also [serve as reference surfaces] *serves as a reference surface* for positioning the magnet roll **11** when it is installed in a developing device or a cleaning device of an electrophotographic apparatus.

Shown in FIG. **3** is a magnet roll assembly such as a developing roll unit or a cleaning roll unit, into which the magnet roll **11** produced above is incorporated in the same manner as shown in FIG. **4**. Namely, a pair of flanges **17**, **17** are rotatably mounted via bearings **16**, **16** to the first and second shafts **13**, **15**, respectively of the magnet roll **11**. A hollow cylindrical sleeve **18** is fixed to the flanges **17**, **17** to surround the magnet roll **11**. When mounted to the first and second shafts **13**, **15**, the bearings **16**, **16** are in rotatable contact with the shoulder portions **13**b and **15**b of the first and second shafts **13**, **15**, respectively, thereby attaining a dimensional accuracy of the assembly. Incidentally, the flanges **17**, **17** and the sleeve **18** may be made of a non-magnetic material such as aluminum alloys, stainless steel, etc.

Furthermore, to improve the wear resistance of the shafts **13**, **15**, bush members made of a metal such as stainless steel, etc. may be fitted to journal portions of the shafts **13**, **15** around which the bearings **16**, **16** are disposed.

The present invention will be described in further detail below by way of Example.

EXAMPLE 1

90 parts by weight of ferrite powder ($SrO.6Fe_2O_3$) having an average particle size of 1 μm and 10 parts by weight of nylon-12 having a modulus of longitudinal elasticity of 2×10^4 kg/cm^2 were mixed together by a kneader at 250° C. to prepare a mixture. By using an injection-molding apparatus equipped with the split die **9** shown in FIG. **2**, an injection-molding process was performed in such a manner that the mixture was charged through a gate **98** into a cavity **96** at 270° C. and 960 kg/cm^2.

The resultant shaped body was taken out of the die **9**, and sprues, runners, etc. were removed from the shaped body to obtain a cylindrical resin-bonded magnet **12** having an outer diameter (D) of 14 mm and a length (L) of 224 mm and integrally formed at one end thereof with the first shaft **13** having an outer diameter (d) of 6 mm, as shown in FIGS. **1**(a) and **1**(b). The cylindrical resin-bonded magnet **12** was formed at the other end thereof with a bore **14** having a diameter of 6 mm. The second shaft **15** separately produced from steel was press-fitted into the bore **14** of the cylindrical resin-bonded magnet **12**. The magnet roll **11** thus obtained was placed in a magnetic field to provide eight (8) magnetic poles symmetrically on an outer surface thereof. A magnetic flux density of the magnet roll **11** was 750 G when measured at an outer surface of the sleeve **18** having an outer diameter of 16 mm.

Five hundreds magnet rolls were prepared in the same manner as mentioned above and observed as to whether cracking or breakage took place. As a result, it was observed that the magnet rolls had no cracking and breakage.

Next, the sleeve **18** was mounted to the magnet roll **11** via bearings **16**, **16** and flanges **17**, **17** to form a developing roll unit as shown in FIG. **3**. The developing roll unit was subjected to a continuous rotation test at 120 rpm for 300 hours. After the test, no abnormality was observed, and stable electric conduction was achieved between the shaft **15** and the sleeve **18**.

COMPARATIVE EXAMPLE 1

For comparison, the same procedure as in Example 1 was conducted to produce a conventional magnet roll **8** shown in FIG. **4**. Namely, the shaft **3** having an outer diameter of 6 mm and made of stainless steel (SUS304) was placed in the die of substantially the same type as shown in FIG. **2**. A mixture of ferrite power and nylon-12 prepared in the same manner as in Example 1 was injected into the die to form the cylindrical resin-bonded magnet **2** having an outer diameter of 14 mm and a shaft **3** fixed thereto. Twenty magnet rolls thus produced were subjected to a continuous rotation test and observed with respect to surface conditions. As a result, it was observed that six magnet rolls suffered from cracking.

As described above, since the cylindrical resin-bonded magnet has one shaft integrally formed at one end by injection molding and the other shaft press-fitted into a bore of the cylindrical resin-bonded magnet at the other end in the present invention, the magnet roll having enhanced magnetic properties and improved applicability of a bias voltage to the sleeve can be produced at improved productivity, without suffering from breakage or cracking due to thermal stress, etc.

What is claimed is:

1. A [magnet] *magnetic* roll comprising a cylindrical resin-bonded magnet made primarily of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of [1×10^5 kg/cm^2] *at least* 2×10^4 *kg/cm*^{2}, a first shaft formed by injection molding integrally with said cylindrical resin-bonded magnet at one end thereof, and a second shaft made of a rigid conductive material and press-fitted into a bore of said cylindrical resin-bonded magnet at the opposite end thereof.

2. The [magnet] *magnetic* roll according to claim **1**, wherein said bore has a splined cross section, and said second shaft is provided with a base portion having a splined cross section complimentary to that of said bore, said base portion being inserted into said bore.

3. The [magnet] *magnetic* roll according to claim **1**, wherein said ferromagnetic powder is made of at least one selected from the group consisting of barium ferrite, strontium ferrite, a rare earth-cobalt alloy and a rare earth-iron-boron alloy.

4. The [magnet] *magnetic* roll according to claim **1**, wherein said thermoplastic resin is at least one selected from the group consisting of nylon-6, nylon-12 and nylon-66.

5. The [magnet] *magnetic* roll according to claim **1**, wherein said second shaft is made of steel.

6. A method of producing a [magnet] *magnetic* roll composed of a cylindrical resin-bonded magnet made of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of [1×10^5 kg/cm^2] *at least* 2×10^4 *kg/cm*^{2}, and first and second shafts concentrically projecting from opposite ends of said resin-bonded magnet, comprising the steps of:

(a) mixing said ferromagnetic powder with said thermoplastic resin to prepare a mixture;

(b) charging said mixture into an injection-molding die to produce an integrally shaped body of said cylindrical resin-bonded magnet having a first shaft concentrically projecting from one end thereof and a bore at the other end thereof;

(c) removing said integrally shaped body from said injection-molding die;

(d) press-fitting a separately prepared second shaft made of a rigid conductive material into said bore of said cylindrical resin-bonded magnet; and

(e) placing said cylindrical resin-bonded magnet in a magnetic field to form a plurality of magnetic poles on an outer surface of said cylindrical resin-bonded magnet.

7. The method according to claim **6**, wherein said bore has a splined cross section, and said second shaft is provided with a base portion having a splined cross section complimentary to that of said bore, said base portion being inserted into said bore.

8. The method according to claim **6**, wherein said ferromagnetic powder is made of at least one selected from the group consisting of barium ferrite, strontium ferrite, a rare earth-cobalt alloy and a rare earth-iron-boron alloy.

9. The method according to claim **6**, wherein said thermoplastic resin is at least one selected from the group consisting of nylon-6, nylon-12 and nylon-66.

10. The method according to claim [**1**] *6* wherein said second shaft is made of steel.

11. The magnetic roll according to claim 1, wherein thermoplastic resin more specifically has a modulus of longitudinal elasticity of at least 1×10^5 *kg/cm*^{2}.

12. The method according to claim 6, wherein thermoplastic resin more specifically has a modulus of longitudinal elasticity of at least 1×10^5 *kg/cm*^{2}.

13. The magnetic roll according to claim 1, wherein said thermoplastic resin is a polyamide.

14. The magnetic roll according to claim 13, wherein said polyamide is at least one selected from the group of nylon-6, nylon-12 and nylon-66.

15. The magnetic roll according to claim 1, wherein said thermoplastic resin has a modulus of longitudinal elasticity ranging from 2×10^4 *kg/cm*^{2} *to* 1×10^5 *kg/cm*^{2}.

16. The method according to claim 6, wherein said thermoplastic resin is a polyamide.

17. The method according to claim 16, wherein said polyamide is at least one selected from the group of nylon-6, nylon-12 and nylon-66.

18. The method according to claim 6, wherein said thermoplastic resin has a modulus of longitudinal elasticity ranging from 2×10^4 *kg/cm*^{2} *to* 1×10^5 *kg/cm*^{2}.

19. A magnetic roll comprising a cylindrical resin-bonded magnet made primarily of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of 1×10^5 *kg/cm*^{2} *or higher, a first shaft formed by injection molding integrally with said cylindrical resin-bonded magnet at one end thereof, and a second shaft made of a rigid conductive material and press-fitted into a bore of said cylindrical resin-bonded magnet at the opposite end thereof.*

20. A method of producing a magnet roll composed of a cylindrical resin-bonded magnet made of a ferromagnetic powder and a thermoplastic resin having a modulus of longitudinal elasticity of 1×10^5 *kg/cm*^{2} *or higher, and first and second shafts concentrically projecting from opposite ends of said resin-bonded magnet, comprising the steps of:*

(a) mixing said ferromagnetic powder with said thermoplastic resin to prepare a mixture;

(b) charging said mixture into an injection-molding die to produce an integrally shaped body of said cylindrical resin-bonded magnet having a first shaft concentrically projecting from one end thereof and a bore at the other end thereof;

(c) removing said integrally shaped body from said injection-molding die;

(d) press-fitting a separately prepared second shaft made of a rigid conductive material into said bore of said cylindrical resin-bonded magnet; and

(e) placing said cylindrical resin-bonded magnet in a magnetic field to form a plurality of magnetic poles on an outer surface of said cylindrical resin-bonded magnet.

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