



(86) Date de dépôt PCT/PCT Filing Date: 2013/07/26
(87) Date publication PCT/PCT Publication Date: 2014/02/06
(85) Entrée phase nationale/National Entry: 2015/01/19
(86) N° demande PCT/PCT Application No.: EP 2013/065831
(87) N° publication PCT/PCT Publication No.: 2014/019961
(30) Priorité/Priority: 2012/07/30 (DE10 2012 014 958.1)

(51) Cl.Int./Int.Cl. *A44C 21/00* (2006.01)
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(54) Titre : **PIECE DE MONNAIE ET PROCEDE PERMETTANT DE VERIFIER CETTE PIECE DE MONNAIE**
(54) Title: **COIN AND METHOD FOR TESTING THE COIN**

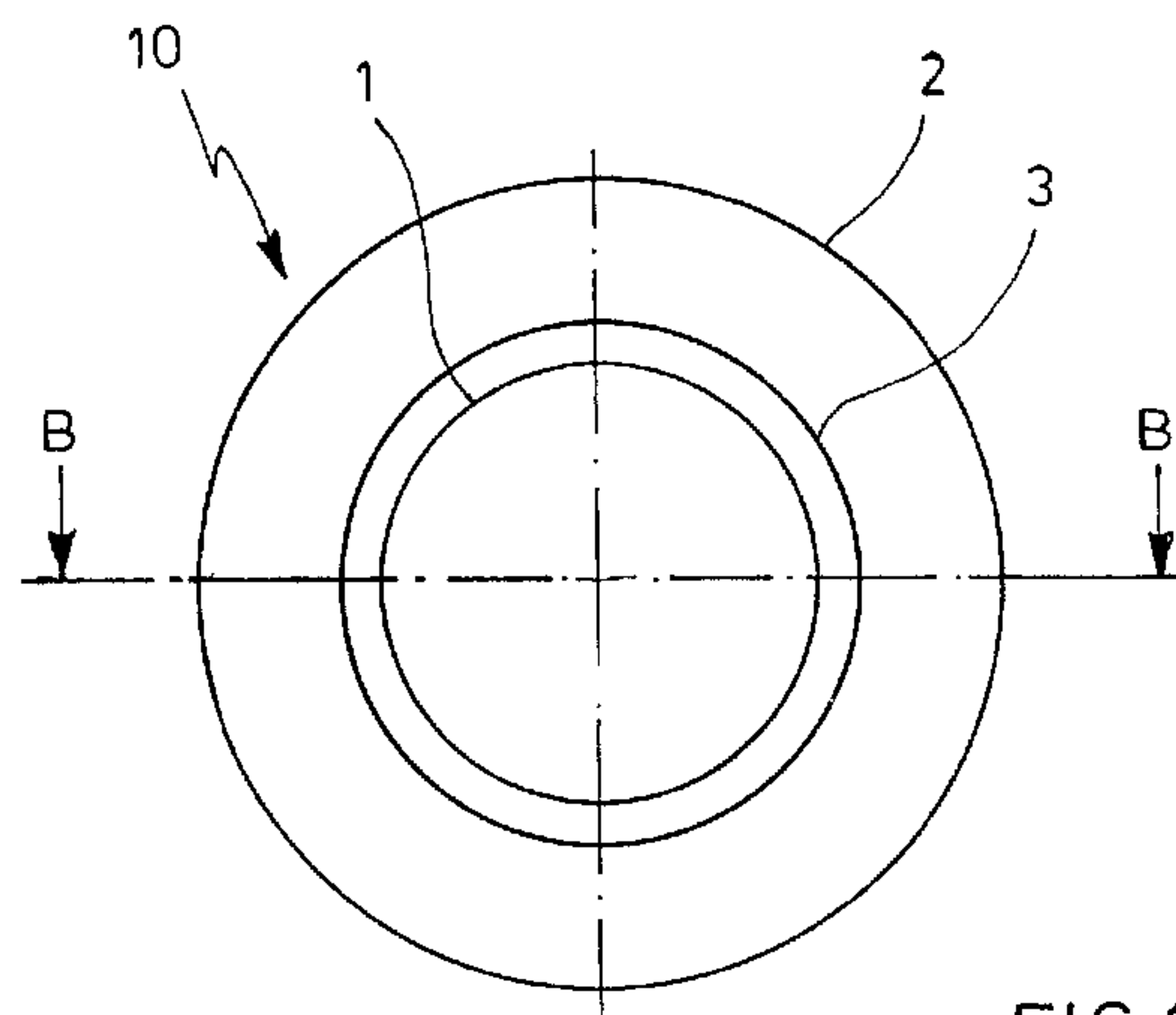


FIG.1A

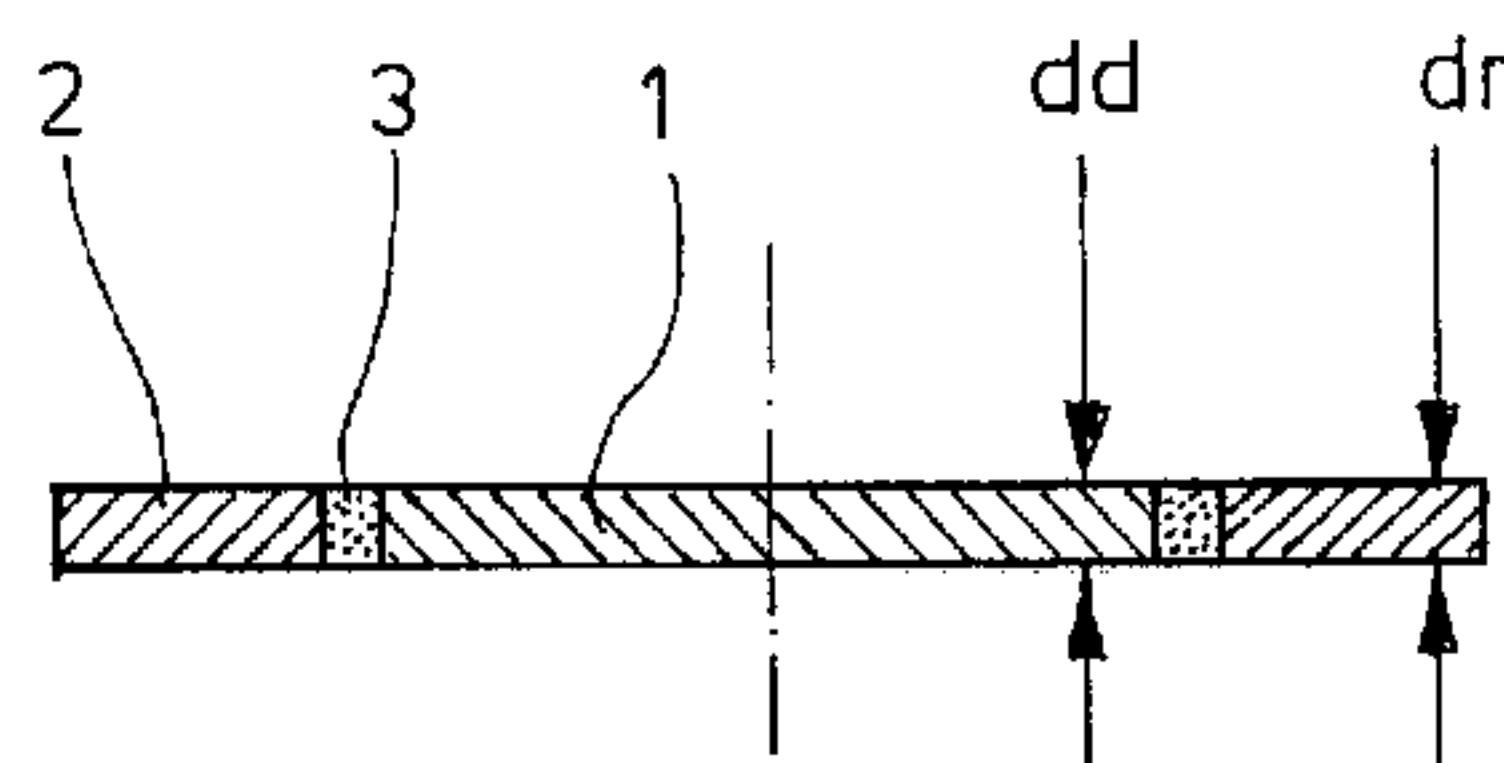


FIG.1B

(57) **Abrégé/Abstract:**

Coin (10) comprising a core (1) of a first metal, an outer ring (2) of a further metal, concentrically surrounding the core, and, between the core and the outer ring, a central ring (3), consisting of an electrically insulating material and solidly bonded to said core and outer ring, characterized in that the central ring is transmissive with respect to electromagnetic waves of a first wavelength range and less transmissive or untransmissive with respect to a second wavelength range.

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges

Eigentum

Internationales Büro

(43) Internationales

Veröffentlichungsdatum

6. Februar 2014 (06.02.2014)



(10) Internationale Veröffentlichungsnummer

WO 2014/019961 A1

(51) Internationale Patentklassifikation:
A44C 21/00 (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2013/065831

(22) Internationales Anmeldedatum:
26. Juli 2013 (26.07.2013)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2012 014 958.1 30. Juli 2012 (30.07.2012) DE

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[Fortsetzung auf der nächsten Seite]

(54) Title: COIN AND METHOD FOR TESTING THE COIN

(54) Bezeichnung : MÜNZE UND VERFAHREN ZUM PRÜFEN DER MÜNZE

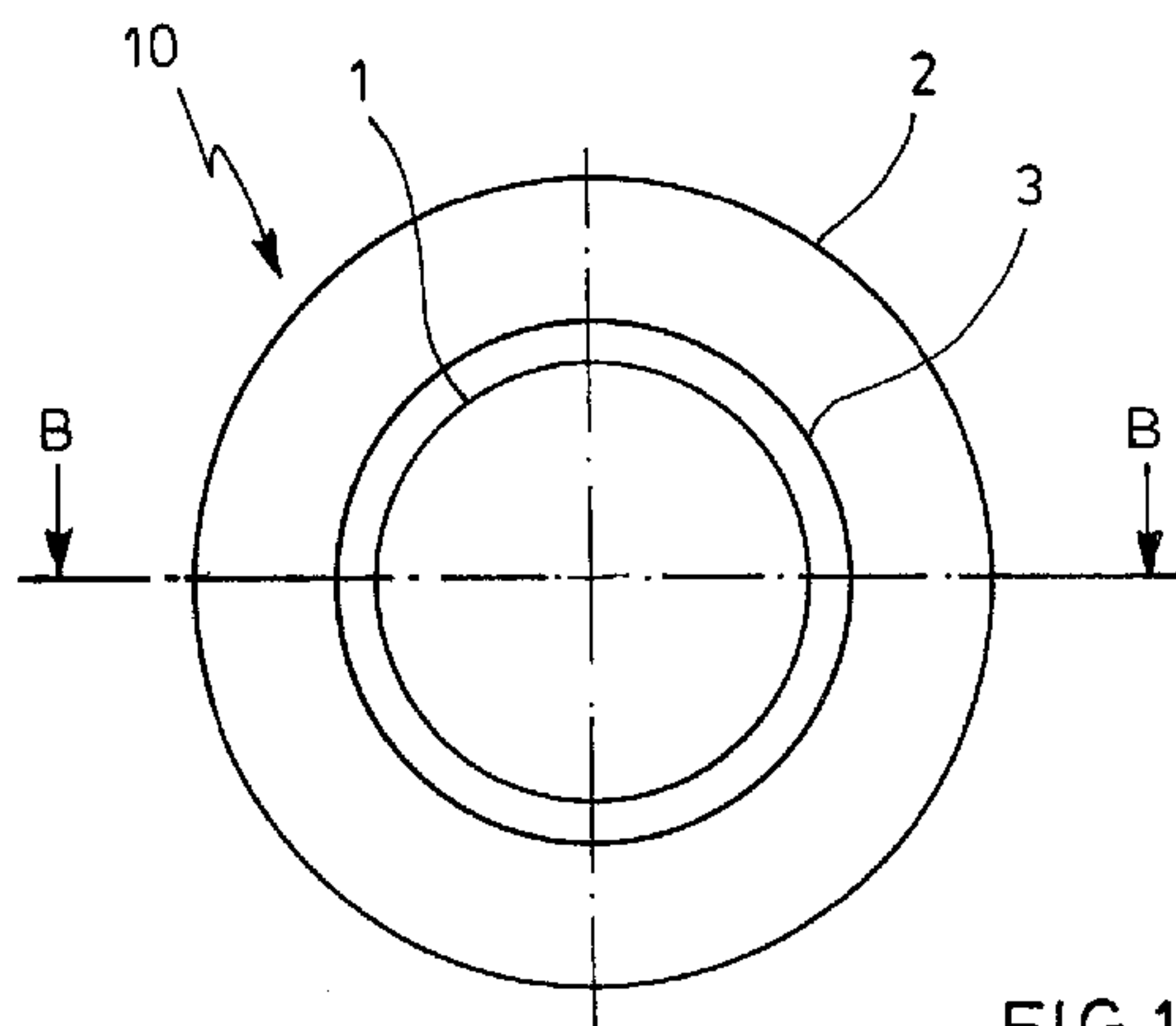


FIG.1A

(57) **Abstract:** Coin (10) comprising a core (1) of a first metal, an outer ring (2) of a further metal, concentrically surrounding the core, and, between the core and the outer ring, a central ring (3), consisting of an electrically insulating material and solidly bonded to said core and outer ring, characterized in that the central ring is transmissive with respect to electromagnetic waves of a first wavelength range and less transmissive or untransmissive with respect to a second wavelength range.

(57) **Zusammenfassung:** Münze (10) mit einem Kern (1) aus einem ersten Metall, einem den Kern konzentrisch umgebenden Außenring (2) aus einem weiteren Metall und einem zwischen Kern und Außenring fest mit diesen verbundenen, aus einem elektrisch isolierendem Material bestehenden mittleren Ring (3), dadurch gekennzeichnet, dass der mittlere Ring für elektromagnetische Wellen eines ersten Wellenlängenbereichs durchlässig und für einen zweiten Wellenlängenbereich weniger durchlässig oder undurchlässig ist.

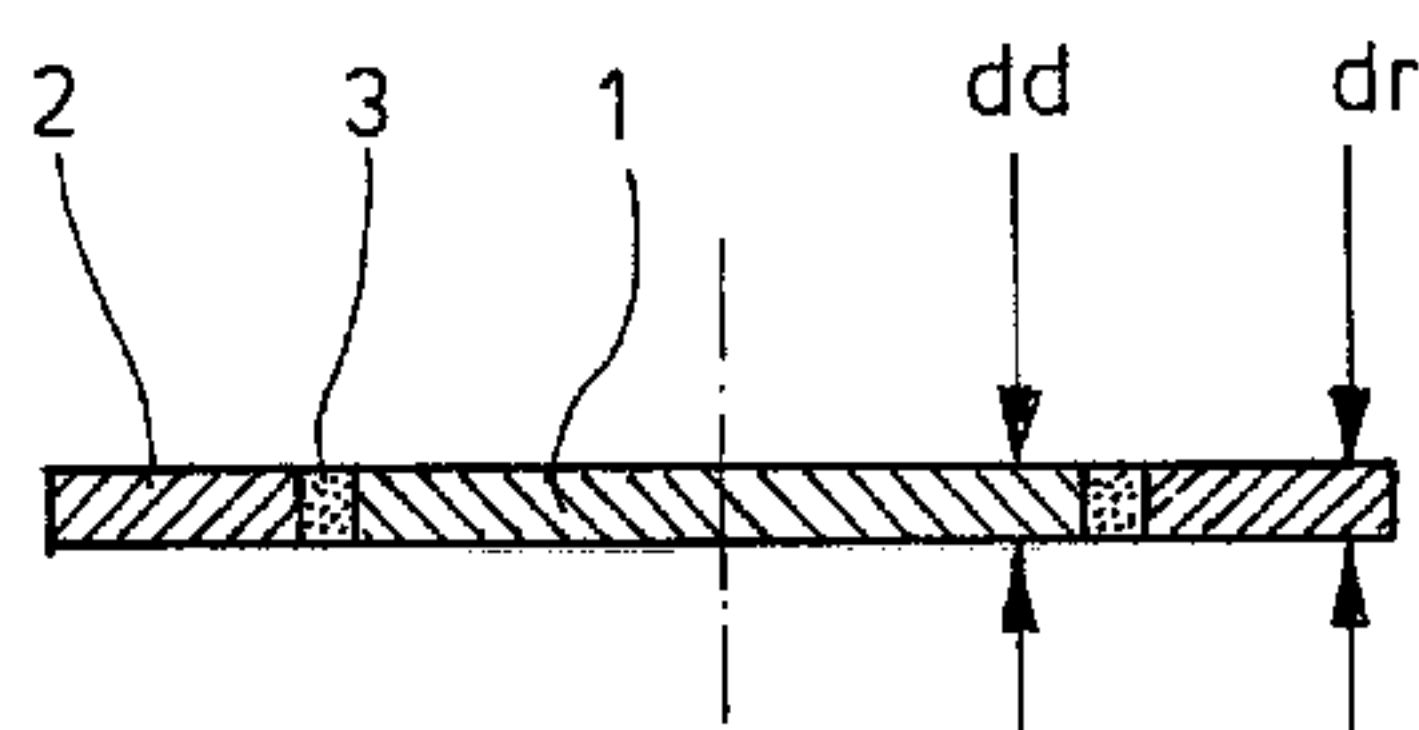


FIG.1B

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LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG). **Veröffentlicht:** — *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

Coin and method for testing the coin

The invention relates to a coin according to Claim 1 and a method for testing the coin according to Claim 11.

For many years, so-called bicolour coins have been in use around the world, said bicolour coins consisting of an inner core and an outer ring surrounding the core. The core and outer ring are produced from different metal materials. It is also disclosed in DE 10 2010 013 148 to add to the coin an additional material component in the form of a central ring. The central ring which is produced, for example, from a polymer or a composite material is connected in an electrically insulating and fixed manner to the outer ring and core.

The testing of bimetal coins takes place primarily by electromagnetic measuring methods. It has been shown that due to corrosion, for example, the transition resistance between the core and the outer ring leads to errors in the measurement results. The effect of these errors is all the greater, the higher the differences in potential of the metals or alloys used.

It is further disclosed in the cited document that the central ring is intended to consist of a transparent, semi-transparent, opalescent material and/or a material producing a colour effect. The width of the central ring is preferably provided to be between 0.5 mm and 3 mm.

In addition to improving the ability to test said coins by electromagnetic means, an improved capacity for differentiation relative to other conventional coins is also achieved. The user may identify, for example, a transparent central ring simply by observation.

It is the object of the invention to provide a coin which may be easily detected by means of optical arrangements. The object of the invention is also based on providing a method by which the coins comprising a central ring may be detected in a simple and effective manner.

This object is achieved by the features of Claims 1 and 11.

The coin according to Claim 1 is characterized in that the central ring is transparent to electromagnetic waves of a first wavelength range and/or is less transparent or not transparent to a second wavelength range.

If such a coin passes through a light barrier, for example, when the central ring is made of transparent material, the number of light barrier signals or even the number of light barrier interruptions may be counted. At the same time, the individual times when the light beam is interrupted or, respectively, the light beam passes through may be recorded in the form of changes to the signal or, respectively, durations of the signal. From the resulting signal sequence, the presence of the transparent or translucent ring may be detected and from the detected times, the individual widths of the outer ring, of the translucent central ring and the metal core may be determined.

According to an embodiment of the invention, the material of the central ring is translucent to the visible wavelength range. According to a further embodiment of the invention, the material of the central ring is translucent to the invisible wavelength range. According to a further embodiment of the invention, the material of the central ring is translucent to the visible and invisible wavelength ranges and not transparent to a wavelength range or to specific wavelength ranges of visible or invisible light, in particular the infrared range. The last embodiment of the invention is particularly preferred. This is due to the fact that in coin test devices, presence detection light barriers normally operate using infrared light. If the central ring consists of a material which is translucent but which is not transparent to infrared light, then the sensor arrangement, which is sensitive both to infrared light and to visible light, reacts differently if a coin moves through the optical arrangement and light is passed through the sensor arrangement without an obstruction or with an obstruction. On the other hand, it is also within the scope of the invention to provide that the material for the central ring is not transparent to a visible wavelength range, for example to the red range.

According to a further embodiment of the invention, the material of the central ring is translucent to the visible wavelength range and not transparent to at least one specific wave range of visible light. A further embodiment of the invention provides that the material of the central ring is translucent to the invisible wave range and transparent to at least one specific wave range of visible light.

All disclosed possibilities for the transparency or, respectively, non-transparency of electromagnetic waves in the visible or, respectively, the invisible range, permit simple methods for discriminating coins which are provided with a central ring made of

an electrically insulating material which is transparent to at least one limited spectral range of the light.

According to a further embodiment of the invention, the central ring has a different reflection factor from the core or the outer ring. The reflective nature of the coin surfaces may also be detected by means of an optical arrangement if it is different from that of the outer ring or, respectively, the core. Thus, for example the central ring may be more reflective than the core or the outer ring. It goes without saying, moreover, that additional optically detectable properties of the central ring may be detected by means of a suitable optical arrangement, for example colour pigments, UV stabilizers, fluorescent or holographic particles, etc.

The method for testing a coin comprising a central ring made of electrically insulating material is based on an optical arrangement through which the coins move and at the same time produce a signal which is evaluated in an evaluation device for producing a genuine coin signal or counterfeit coin signal. According to the invention, light is passed through the coins from at least one optical transmitter and an optical arrangement receives the light reflected by the central ring and/or the light passing therethrough, and an evaluation device produces a signal when the coins are moved through the sensor arrangement. If the material of the central ring is transparent, for example, light in the visible wavelength range is passed through the central ring and is able to strike the sensor arrangement and produce a corresponding signal there. If the central ring is transparent to light in the invisible wave range and the sensor arrangement is sensitive to this light, a signal may also be produced if invisible light of the light source or the optical sensor passes through the material of the central ring and strikes the sensor arrangement. Thus, for example, a light barrier located transversely to the direction of travel of the coin may be provided and the evaluation device counts the number of changes to the signal when the coin passes through the light barrier, wherein at the same time the individual times when the light beam is interrupted or, respectively, the light beam passes through are recorded via the duration of the signal.

According to an embodiment of the invention, the evaluation device analyses the signal of the sensor arrangement and produces a genuine coin signal if the spectrum of the received light corresponds to the material of the central ring of a genuine coin. If, for example, white light is produced by the optical sensor, by means of a spectral analysis it

may be established by the sensor arrangement whether the spectrum of the light passed therethrough corresponds to that which is generally produced by the material of the central ring of a genuine coin. It is possible to determine from the analysis whether the light of the optical transmitter has an invisible component or not, in order to test for example whether the material of the central ring is not transparent to invisible light.

If electromagnetic waves or, respectively, light are discussed above and below, this is broadly understood as light in the visible and invisible spectrum, provided it is able to be processed by conventional elements and devices available at the time without safety precautions.

According to an embodiment of the invention, the sensor arrangement is sensitive to at least one defined wave range. According to a further embodiment of the invention, the sensor arrangement is sensitive to a wavelength range of visible light. Alternatively, the sensor arrangement may be sensitive to a wavelength range of invisible light. According to a further embodiment of the invention, the sensor arrangement is sensitive to a wavelength range of visible light and a wave range of invisible light.

It is also possible, instead of assuming the selective sensitivity of the sensor arrangement itself, to arrange one or more filters upstream thereof which allow through or, respectively, block specific wavelength ranges of the light of the optical transmitter.

The sensor arrangement contains at least one sensor element, for example in the form of a phototransistor. According to an embodiment of the invention, two or more sensors may also be provided. Instead of providing sensors with a narrow field of view, according to an embodiment of the invention it is conceivable to use a surface sensor or line sensor. To this end, for example on one side of the coin channel a light source is used which transmits light of the transparent and blocked wavelength range, for example white light. On the opposing side a light sensitive surface sensor or line sensor is located. Said sensor is preferably as least as wide as the width of the central ring of the coin. Generally, this ring width is 1.0 mm to 1.5 mm. The light-sensitive sensor arrangement is designed so that it detects the two wavelength ranges, namely that of the transparent light and also that of the blocked wavelength range or, respectively visible and invisible light. In the resting state, the sensor arrangement detects both wavelength ranges as no object is located between the transmitter and receiver. However, if the coin rolls with the central ring past the sensor arrangement, initially all wavelengths are blocked by the

metal outer ring. If the specific material of the central ring passes the sensor arrangement, only the blocked wavelength range is absorbed, for example the infrared range and not the other wavelengths. This is therefore a feature which is able to be evaluated and which serves for testing or, respectively, discriminating the coins. In the disclosed process, if the core now moves past the sensor arrangement, once again all wavelengths are blocked. Subsequently at a second location, the central ring passes the sensor arrangement and finally the second side of the metal outer ring.

By means of the disclosed light-sensitive sensor arrangement, the entire irradiated surface may be determined in terms of size as well as the width of the individual components of the outer ring and core.

According to an embodiment of the invention, the mechanical dimensions of the coins are determined by means of the signals of the sensor arrangement, in particular the width of the outer ring, the width of the central ring, the diameter of the core and the diameter of the coin.

The simplest optical arrangement for testing the three-part coins may consist of a single light path. According to an embodiment of the invention, it is preferred to move the coins through two optical paths which in each case have an optical transmitter and an optical sensor, wherein for example one path operates at wavelengths of the visible spectral range and the other path operates at wavelengths of the invisible spectral range. In a light source which transmits both light in the visible range and in the invisible range, for example both optical sensors are activated when they receive the light. If the central ring is made of a material which is not transparent to invisible light, only one sensor of the two optical paths receives light when the central ring is moved through the two optical paths.

Alternatively, it may also be provided to make the sensor arrangement simultaneously sensitive to wavelengths in the visible and invisible range and to activate the optical sensor in sequence in order to produce firstly light in the visible range and secondly light in the invisible range. To this end, according to an embodiment of the invention two optical transmitters may be used. Finally, it is also conceivable to operate the optical sensor temporarily in sequence to have different sensitivities, i.e. for defined wavelength ranges.

The invention is to be described in more detail hereinafter with reference to the drawings.

- Fig. 1A shows a plan view of a coin made of three materials.
- Fig. 1B shows a section through the view according to Fig. 1A along the line B-B.
- Fig. 2 shows schematically a coin according to Figures 1A and 1B when passing through two light barriers L1 and L2.
- Fig. 3 shows the response of the light barriers to different materials of the central ring of the coins.
- Fig. 4 shows a similar arrangement to Fig. 2 with two light barriers on top of one another.
- Fig. 5 shows in section an optical arrangement for carrying out the method according to the invention.
- Fig. 6 shows a similar arrangement to Fig. 2 with a line detector or surface detector for the optical arrangement.
- Fig. 7 shows in section the optical arrangement according to Fig. 6 for carrying out the method according to the invention.

Shown in Figs. 1A and 1B is a coin consisting of three parts, namely having a core 1 made of a first metal material, an outer ring 2 made of a second metal material and a central ring 3 made of an electrically insulating material, for example a polymer. Moreover, the material of the central ring 3 may be translucent or, respectively, transparent. The thickness of the core 1 is indicated as d_d and the thickness of the outer ring 2 is indicated as d_r .

Shown in Fig. 2 is a coin running track 20 along which the coin 10 rolls. Two light barriers L1 and L2 are arranged in the spacing a, said light barriers being at a height h above the coin running track 20. The light barriers consist, for example, of at least one optical transmitter and an optical receiver or sensor on different sides of the path of the coin 10. The light barrier L1 operates with light in the visible wavelength range and the light barrier 2 operates in the infrared wavelength range. When the coin 10 passes the light barriers L1 and L2, time recordings are made when the light barriers are interrupted. The interruption takes place for the first time when the edge of the coin 10 passes into the light barrier L1 and represents the time t0 in Fig. 3a. At this time, both (transparent and non-transparent) wavelength ranges are blocked. However, if the edge of the transition from the metal outer ring to the central ring passes the light barrier L1, the transparent wave range is detected by the optical sensor of the light barrier L1 which is represented by the time t1. At the transition from the central ring to the metal core, both wavelength ranges are blocked once again. This occurs at the time t2. When the second half of the coin 10 passes, the times t3, t4 and t5 are similarly determined. The individual ring widths or, respectively, the core diameter and the entire coin diameter may be detected from the determined time periods t0 to t1, t1 to t2, t2 to t3, t3 to t4 and t4 to t5. Such detections are known per se, as disclosed in DE 27 24 868, EP 0 839 364 and EP 0 694 888. The determined individual ring widths may be used as security features.

The light barrier L2 is positioned at the same distance from the track 20 as the light barrier L1 and the spacing L1 to L2 is known. From these preset measurements the mechanical spacings of the coins may be calculated. The light barrier L2 is designed for a specific wavelength range, for example infrared light. For this specific wavelength range, no changes to the signal are currently identified at t11 and t12, t13 and t14, but only at t15 if the entire coin 10 has passed the light barrier L2, as the material of the central ring does not allow the infrared light to pass. This is revealed from the graph of Fig. 3a at the bottom. Fig. 3b shows the process when a coin with a material of the central ring which is transparent to infrared light is tested. It may be seen that the same signal sequences are then produced for the light barriers L1 and L2. Thus, this is an effective discrimination feature for identifying coins which are provided with a counterfeit material for the central ring.

Fig. 3c shows the signal sequence for the two light barriers L1 and L2 both for a conventional bicolour coin and for coins provided with a central ring, where the material for the central ring is not transparent to both visible light and invisible light.

As a whole, the following security features are able to be identified:

Material of the central ring which is transparent to visible light

Material where infrared light is blocked

Widths of the outer ring to the left and right

Width of the material of the central ring to the left and right

Core diameter

In Fig. 4 four light barriers respectively consisting of one optical transmitter and one optical receiver which are identified by 11 or, respectively, 11' and 12 or, respectively, 12' are arranged one above the other at a distance h or, respectively, h' from the coin running track 20 and at a distance a from one another. If a standard coin of smaller diameter moves through the light barriers 11 and 12, a signal sequence $t1$ and $t2$ is produced. For a coin of larger diameter, similar signal sequences are also produced by the light paths 11' and 12'. However, if the light barriers are located level with a central ring according to Fig. 1A or 1B, similar signal sequences for 11 and 12 and 11' and 12' may be produced once again, as have been described in connection with Fig. 3.

In Fig. 5 a principal plate 30 and a pivoting plate 32 are shown, wherein said pivoting plate forms the coin running track 20. An LED 34 is incorporated in the plate 32, said LED passing light through a coin 10 when it moves along the running track 20 past the LED. A phototransistor 36 is arranged in the principal plate, said phototransistor cooperating with an optical element 38 which produces the effect of a lens and with a portion 40 having a small diameter protrudes into a recess 42 of the principal plate 30, and which receives the light produced by the LED provided it is either not blocked by the coin 10 or is allowed through by a region of the coin 10 as is the case in connection with the above-described figures.

Instead of a receiver at one point for the light of the LED 34, a line sensor or surface sensor may also be provided in a vertical and or horizontal arrangement as is shown in 44 or, respectively, 46 in Fig. 6. In Fig. 7, the line sensor 46 is shown in a

horizontal arrangement through which light is passed by the LED 34 over the entire width in order to receive light from the LED 34 which is either not blocked by the coin or, respectively, is allowed to pass through thereby.

Claims:

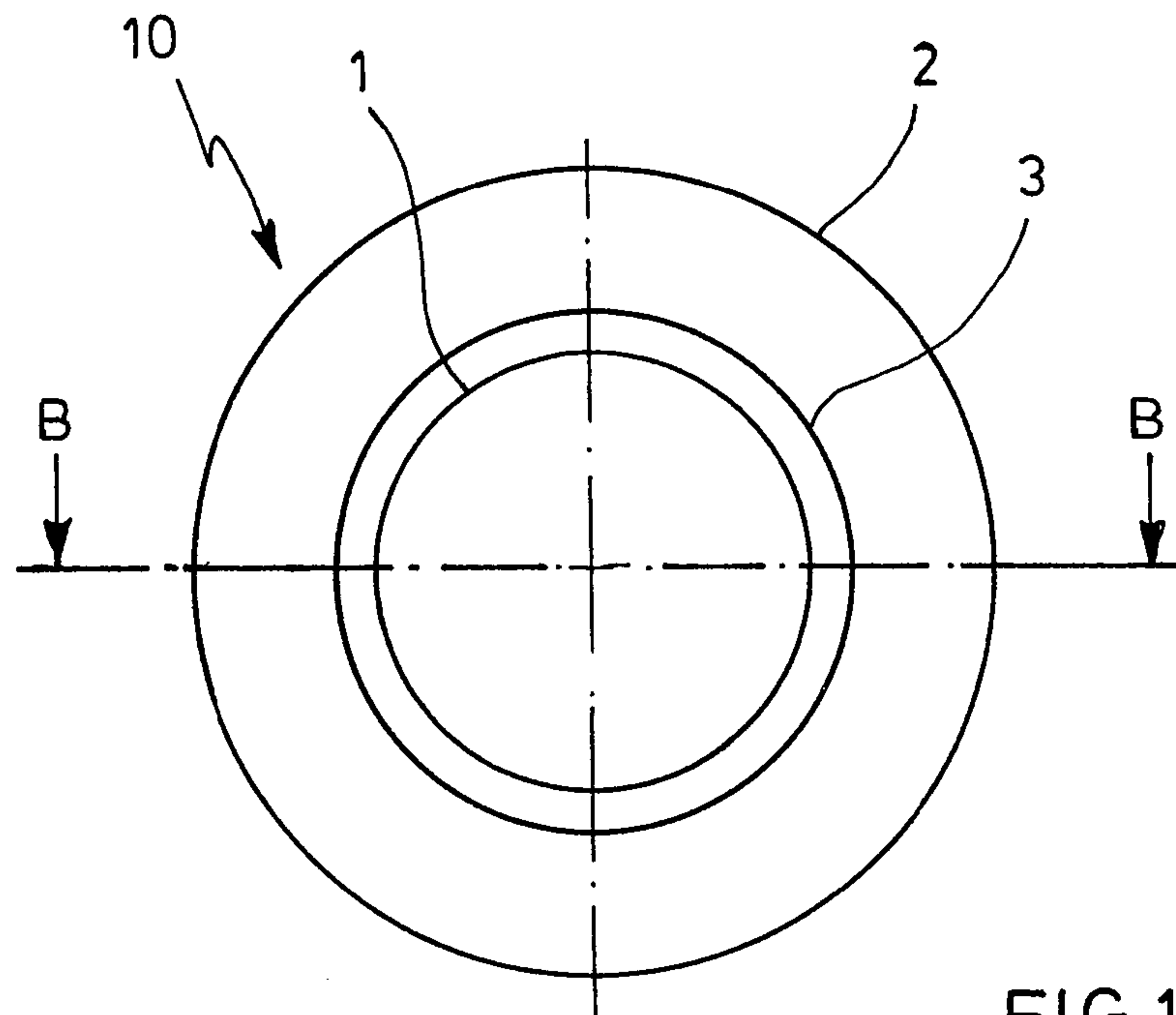
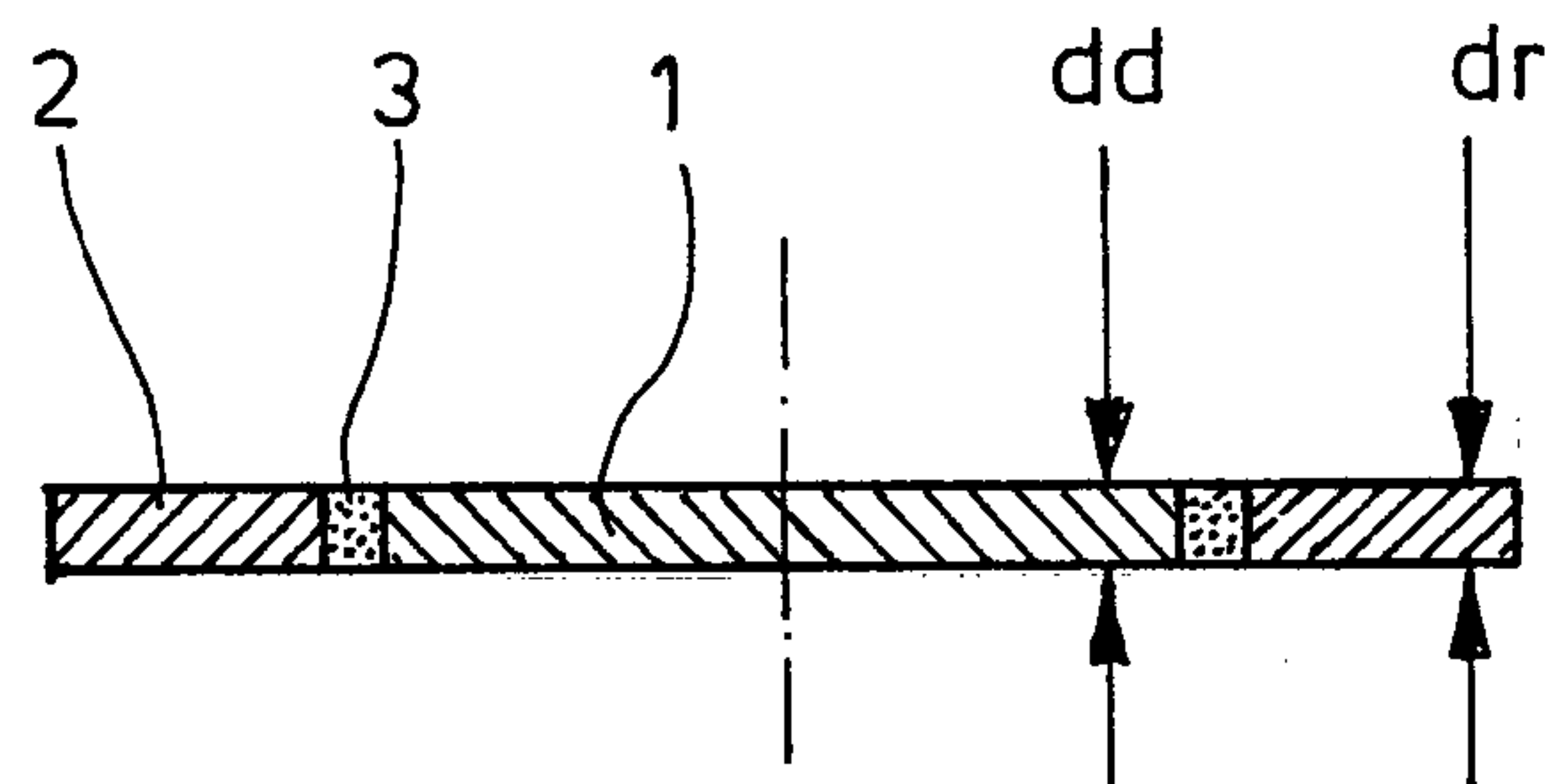
1. A coin comprising a core made of a first metal, an outer ring surrounding the core concentrically and made of a further metal, and a central ring between the core and outer ring fixedly connected thereto, consisting of an electrically insulating material, characterised in that the central ring is transparent to electromagnetic waves of a first wavelength range and is less transparent or not transparent to a second wavelength range.
2. The coin according to Claim 1, characterised in that the material of the central ring is translucent to the visible or invisible wavelength ranges.
3. The coin according to Claim 1, characterised in that the material for the central ring is translucent to the visible and invisible wavelength ranges.
4. The coin according to Claim 1, characterised in that the material for the central ring is translucent to the visible wavelength range and not transparent to at least one specific wavelength range of invisible light, in particular the infrared range.
5. The coin according to Claim 1, characterised in that the material for the central ring is translucent to the invisible wavelength range and not transparent to at least one specific wavelength range of visible light.
6. The coin according to Claim 1, characterised in that the material of the central ring is translucent to the visible wavelength range and not transparent to the at least one specific wavelength range of visible light.
7. The coin according to Claim 1, characterised in that the material of the central ring is translucent to the invisible wavelength range and transparent to at least one specific wavelength range of visible light.

8. The coin according to Claim 1, characterised in that the central ring has a different reflection factor from the core or the outer ring.
9. The coin according to Claim 7, characterised in that the central ring is more reflective than the core or the outer ring.
10. The coin according to one of Claims 1 to 8, characterised in that the ring consists of a polymer.
11. The coin according to one of Claims 1 to 8, characterised in that the central ring consists of a composite material.
12. A method for testing coins which have a core made of a first metal, an outer ring made of a second metal and a ring made of electrically insulating material arranged between the core and outer ring, in which method the coins are moved through an optical arrangement and signals are evaluated in the optical arrangement by an evaluation device for producing a genuine coin signal or counterfeit coin signal, characterised in that light is passed through the coins by at least one optical sensor and an optical sensor arrangement receives the light reflected by the central ring or passing therethrough and the evaluation device produces a signal when the coin moves past the sensor arrangement.
13. The method according to Claim 11, characterised in that the evaluation device analyses the signal of the sensor arrangement and produces a genuine coin signal if the spectrum of the received light corresponds to the material of the central ring of a genuine coin.
14. The method according to Claim 11 or 12, characterised in that the sensor arrangement is sensitive to at least one defined wavelength range.
15. The method according to Claim 13, characterised in that the sensor arrangement is sensitive to a wavelength range of visible light.

16. The method according to Claim 13, characterised in that the sensor arrangement is sensitive to a wavelength range of invisible light.
17. The method according to Claim 13, characterised in that the sensor arrangement is sensitive to a wavelength range of visible light and a wavelength range of invisible light.
18. The method according to Claim 16, characterised in that two sensors are provided.
19. The method according to one of Claims 11 to 17, characterised in that the light is produced by an LED.
20. The method according to one of Claims 11 to 18, characterised in that a phototransistor is used as a sensor.
21. The method according to one of Claims 11 to 18, characterised in that the sensor arrangement uses a surface sensor or line sensor.
22. The method according to one of Claims 11 to 20, characterised in that the mechanical dimensions of the coin are determined by means of the signals of the sensor arrangement, in particular the width of the outer ring, the width of the central ring, the diameter of the core and the diameter of the coin.
23. The method according to one of Claims 11 to 21, characterised in that the coins pass through two optical paths which in each case have an optical transmitter and an optical sensor, wherein one path operates at wavelengths in the visible spectral range and the other path operates at wavelengths in the invisible spectral range.
24. The method according to one of Claims 11 to 21, characterised in that the sensor arrangement is sensitive to waves in the visible spectral range and in the invisible

spectral range and the optical transmitter is temporarily activated in sequence and produces firstly light in the visible spectral range and secondly light in the invisible spectral range.

25. The method according to Claim 23, characterised in that two optical sensors of different sensitivities are used.

FIG. 1AFIG. 1B

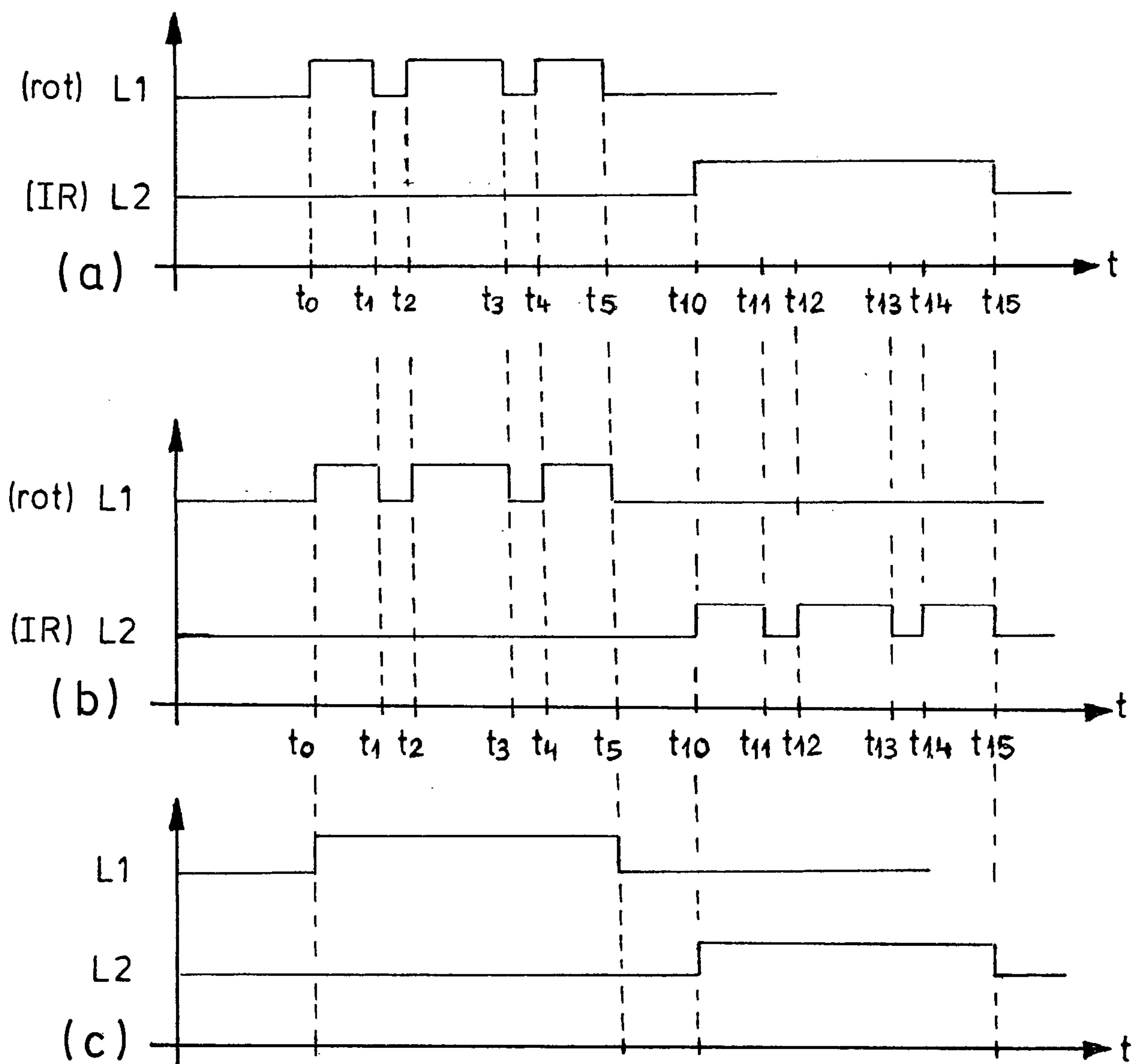
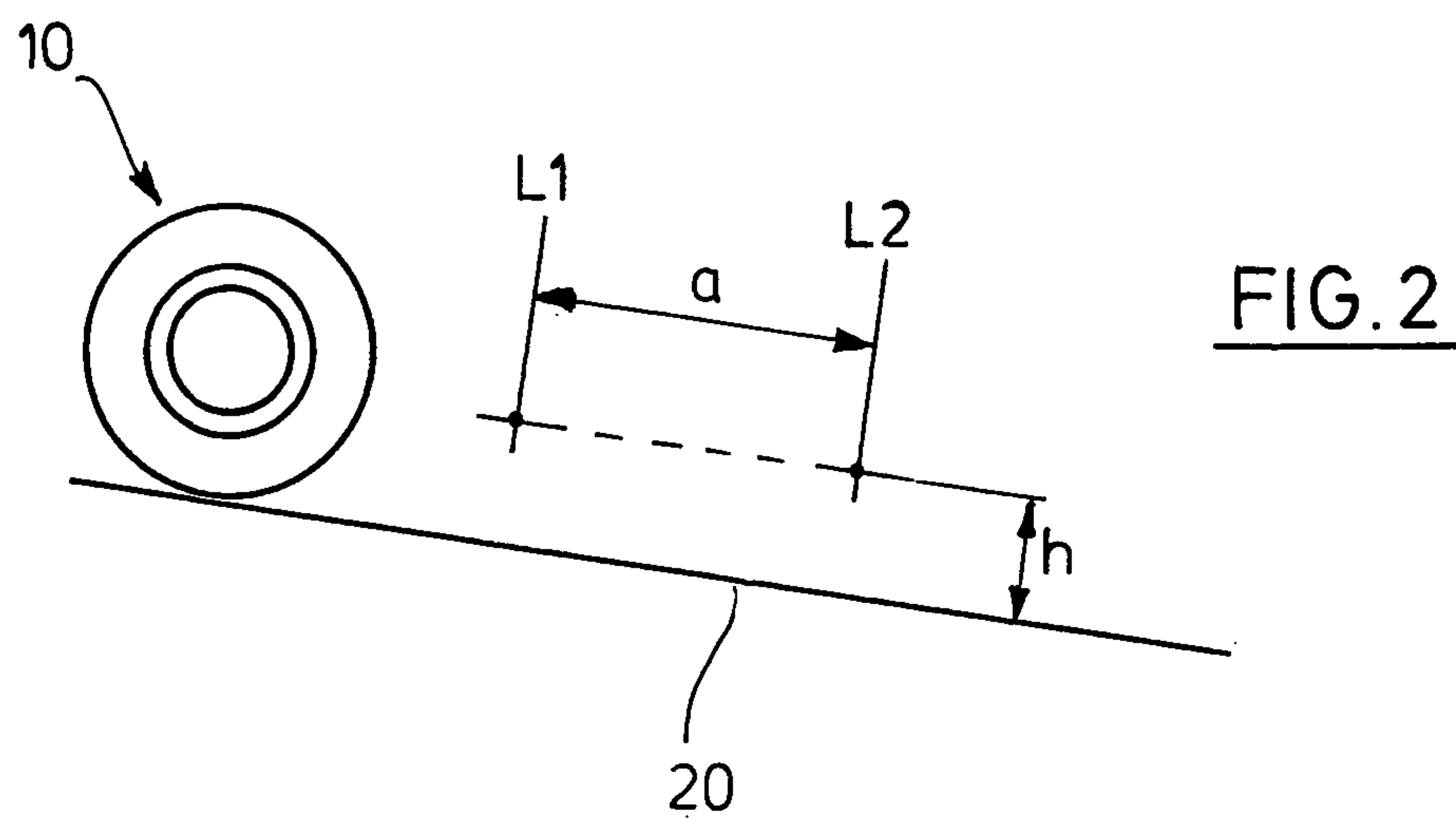
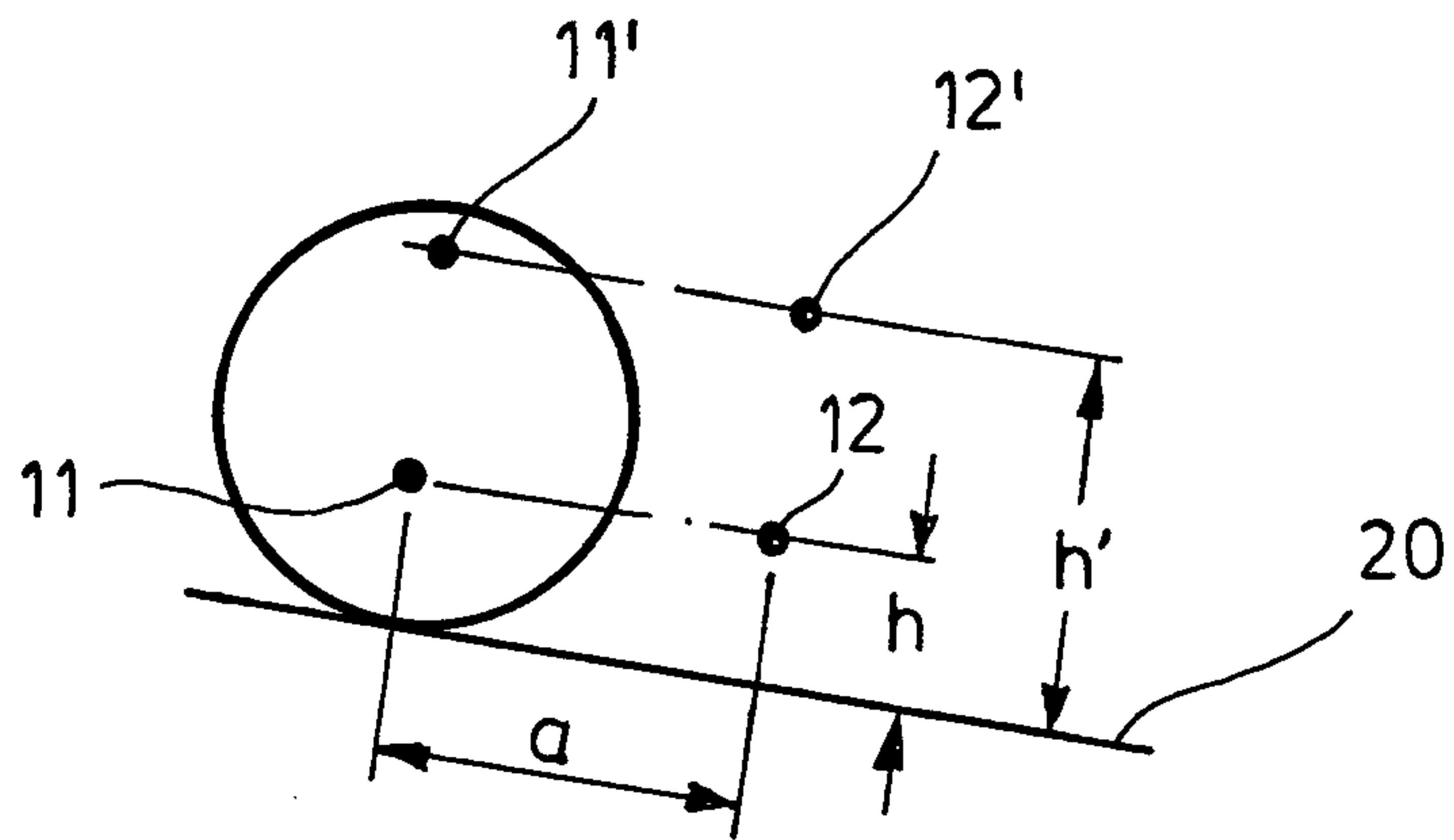
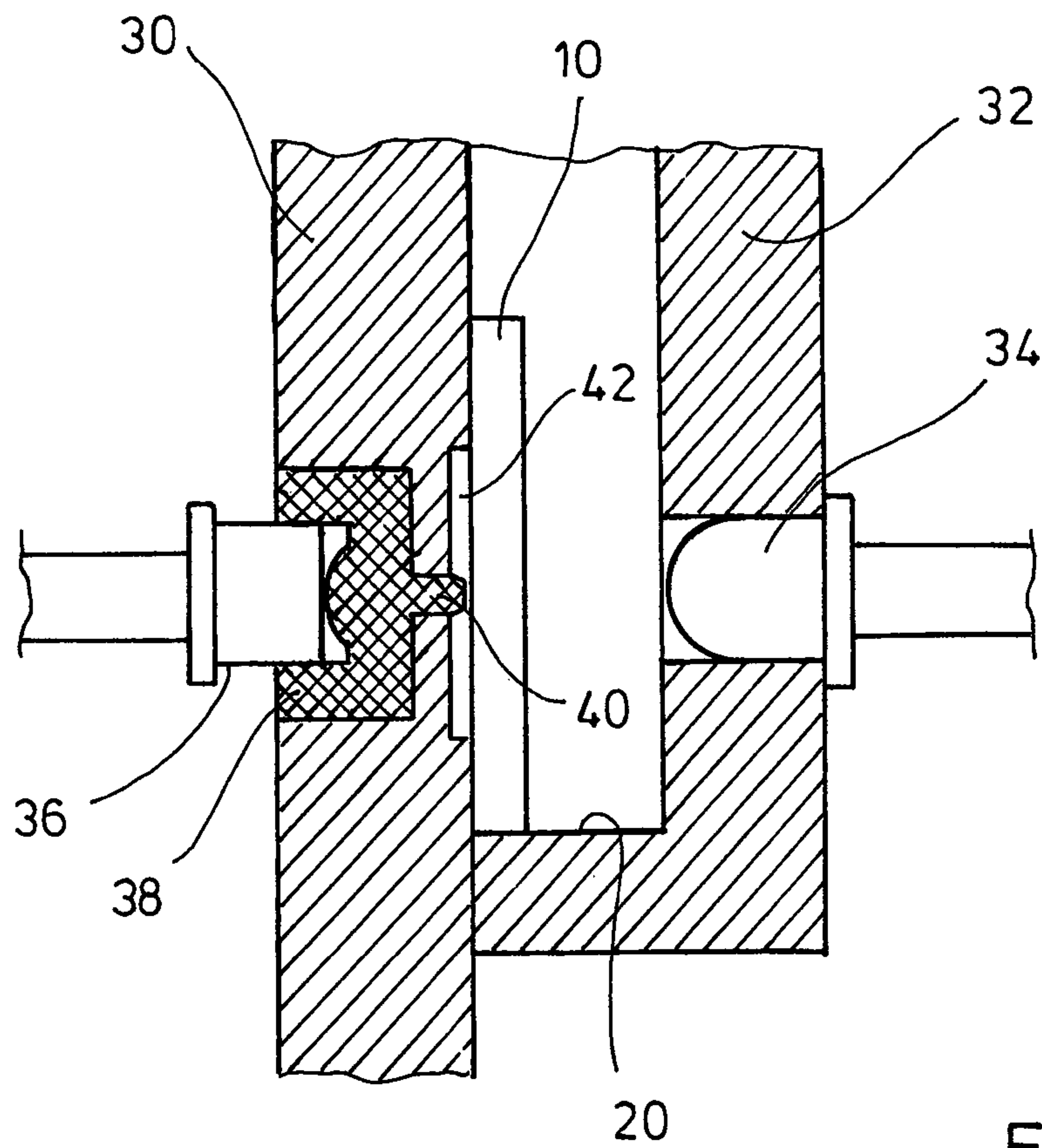
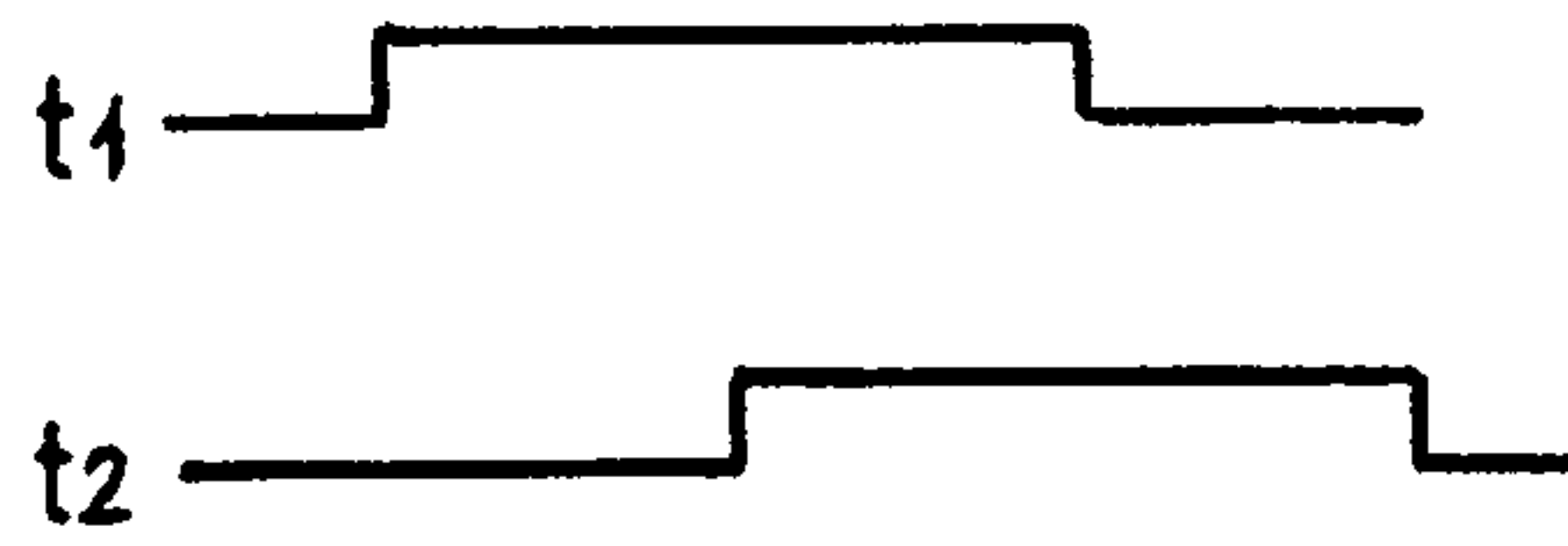
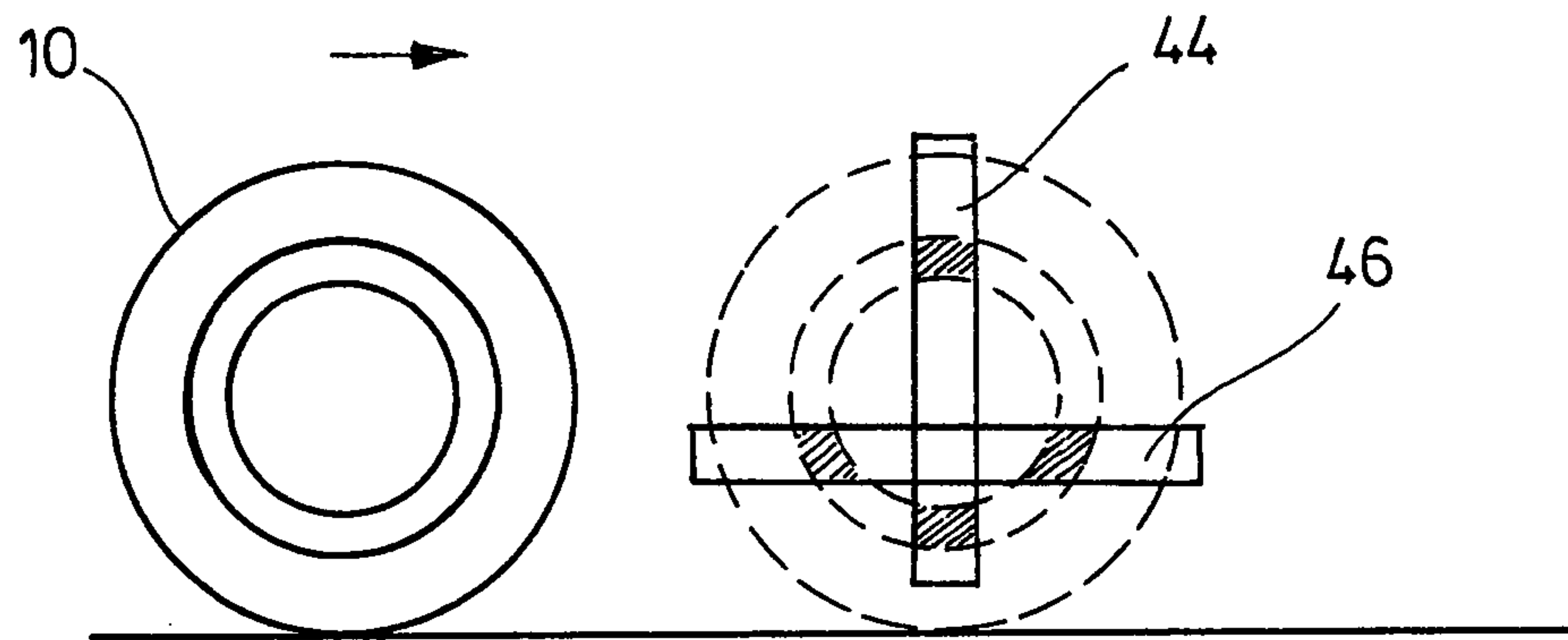
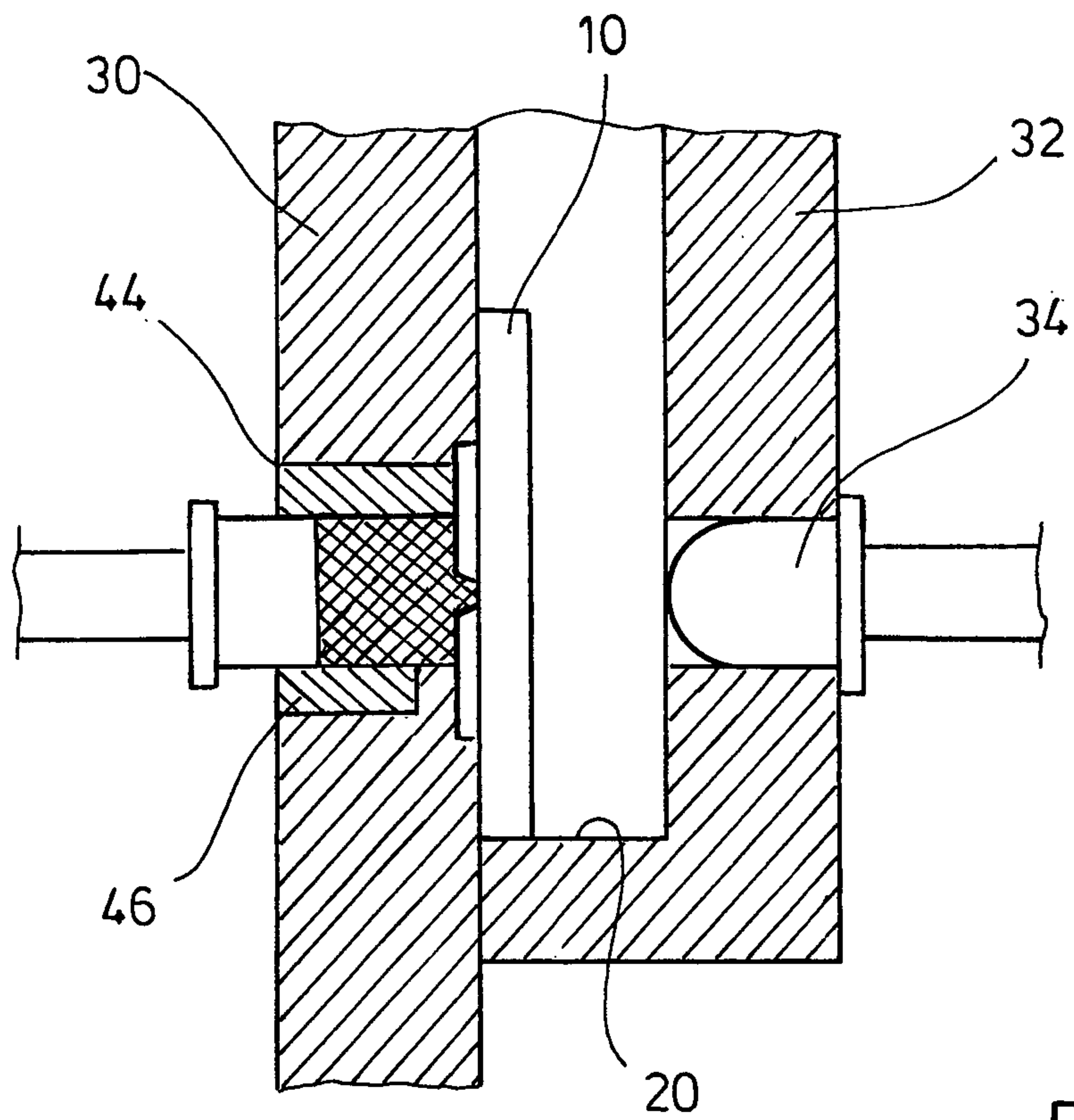


FIG. 3

FIG. 4FIG. 5

FIG. 6FIG. 7

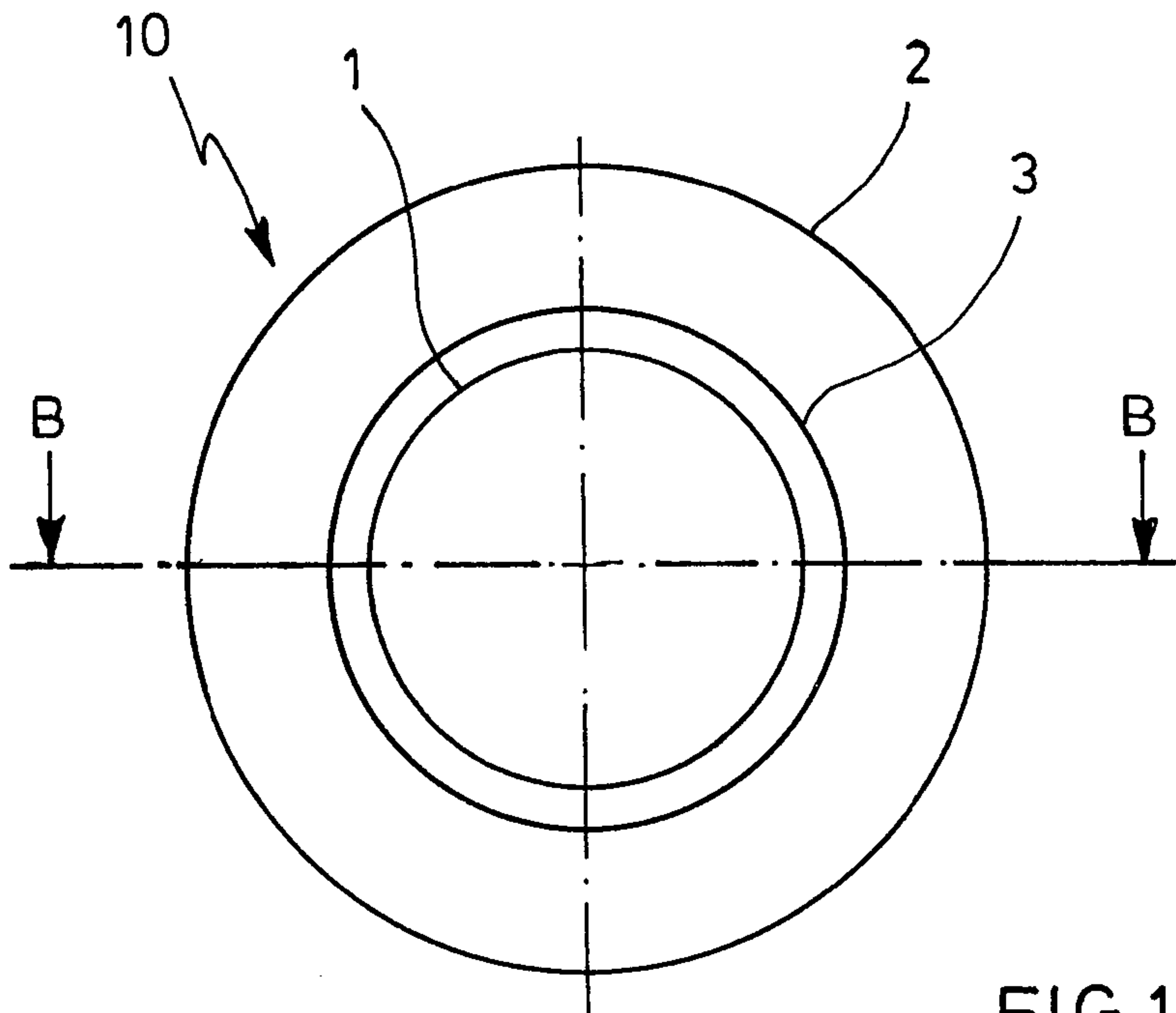


FIG. 1A

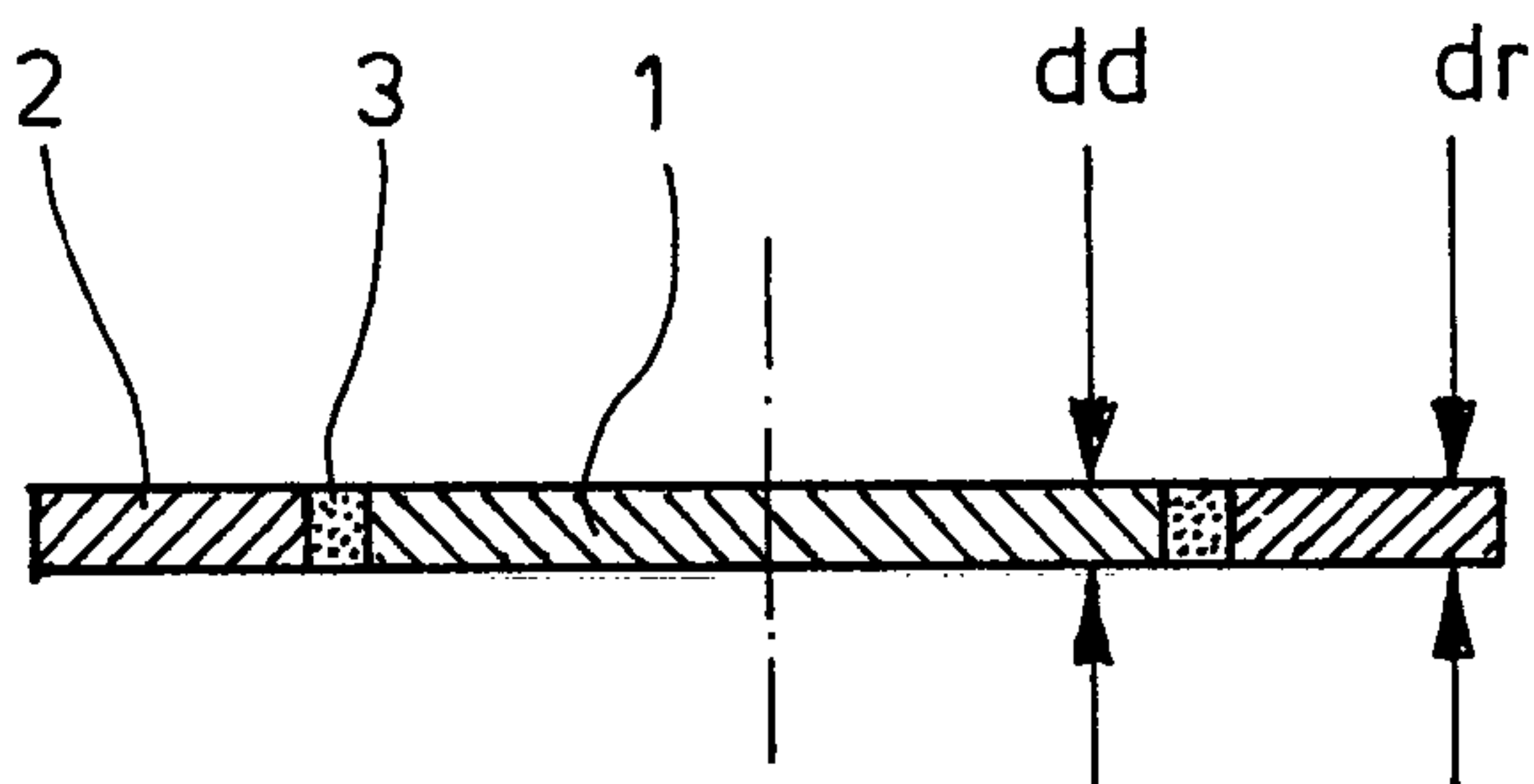


FIG. 1B