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TIMING SCALE OR TIMING DISC

Description

The invention relates to a timing scale or timing disc for the accurate positioning of processing machines, handling tools or other adjusting elements, which consists of a transparent material on which codings for scanning by means of optical sensors are arranged, and also to a process for the manufacture thereof.

As a rule, timing discs are fastened to a rotating spindle by means of a boss. In the transillumination process, a light beam generates impulses as the disc rotates. Under those circumstances, the light source is located parallel to the axis of rotation and transmits a light beam at right angles to the disc.

As a result of the translucent/opaque sequence preset on the coded timing disc, "window" apertures of specific width and length, which are used to generate impulses, are produced on the rotating disc. The light beam emanating from the light source (transmitter) is converted by a receiver (optical sensor) located in the optical axis of the light beam into an impulse, the type of which depends upon the nature of the "window". The electrical impulses serve to set up a control circuit for the measurement of rotational speed, for acceleration and for the more accurate positioning of adjusting quantities such as, for example, a printing head, the arm of a robot or the carriage of a tool. For linear systems, use is made of timing scales or rules which are disposed at right angles to a light source and produce an impulse when a light beam impinges upon an optical sensor arranged behind the timing scale. This system is used, for example, in machine tools for controlling the feed movement.

Timing discs or timing scales are usually manufactured from glass, metal or plastics material. In the manufacture of mass-produced products, plastics and metal discs have gained general acceptance. They are manufactured from transparent films, for example in the case of angle-transmitters or encoder units, e.g. for inkjet printers.

For this purpose, an industrial film is exposed with codings, either by means of masks or by means of photo-plotters, and then developed. The result is a transparent film in which the codings are black and non-reflective. The individual discs or scales are then cut out from the film material.

One disadvantage in the known arrangement of timing discs and optical sensors is caused by the fact that the transmitter and receiver are fitted on opposite sides, in each case, referred to the timing disc or timing scale arrangement. This gives rise to a high outlay on construction and also brings about, under certain circumstances, an increased susceptibility to faults as a result of mechanical stresses, such as oscillatory loading for example, or because of contaminants that may be deposited on both sides of the disc.

The object of the present invention is to avoid the disadvantages described and indicate a novel arrangement or novel construction of timing scales or timing discs, which permits a simpler and, if necessary, less susceptible method of constructing photo-sensory control circuits.

This object is achieved, according to the invention, through the features indicated in the main claim. It has proved possible, by coating the reverse side of timing discs and timing scales with reflective material, to arrange the transmitter and receiver next to each other on one side. It is expedient if transmitter and receiver - that is to say light source and optical sensor - are combined to form one chip and thus closely connected, as an assembly, to the timing scale or timing disc. As a result of this, the distances become smaller, the oscillatory loading becomes lower and the danger of contamination by dust is virtually eliminated.

In order to be able to move the timing disc or timing scale at a higher frequency, it is necessary for errors in the reflection of the light beam to be avoided and for energy losses to be kept as low as possible. This is also important for miniaturization of the timing disc or timing scale. By skilful arrangement on only one side of the carrier material, it is possible to reduce dispersion and diffraction of the light beam and to avoid neutrality phenomena. These measures improve the resolution ratio considerably, compared with arrangement of the coding and of the reflective coating one each side of the timing disc or timing scale. Furthermore, ageing of the film material otherwise used can be prevented by the use of any desired carrier materials.

The invention will be explained in greater detail below with the aid of an exemplified embodiment.

Figure 1 shows a timing disc according to the invention with a transmitter/receiver structural unit, in cross-section and in plan view, and

Figure 2 shows a timing disc similar to that in Figure 1 but of conventional design.

In Figure 1a, the timing disc is designated by 1. It has a diameter (optical diameter) D and rotates about an axis of rotation 2. Slots 3 having a slot length l and a slot width b are arranged on its outer periphery.

The timing disc 1 consists of a carrier material 20, which may be transparent or opaque. A reflex coating 8, a photo-sensitive coating 21 or an antistatic gelatine coating 22 may be applied to this carrier. For the purpose of covering the reflex coating 8, it is expedient to apply a protective coating 23 to the outer side of the timing disc 1.

It has hitherto been customary to apply an adhesive material 24 between a carrier material and the photo-sensitive coatings 21 or gelatine coating 22. According to more recent developments, however, it is also possible to apply the said coatings together with the carrier coating even during the production of the latter, so that adhesive coatings are not needed.

At the outer edge of the timing disc 1 there are located, in each case, a transmitter 4 and a receiver 5 which are arranged on a common structural unit 6. The transmitter and receiver are connected via the lines 7 to a control circuit (not illustrated).

As can be seen from Figure 1b, the carrier material 20 of the timing disc 1 is preferably provided, on the front, with a reflective coating 8. The photo-sensitive coating 21, by means of which the codings are produced, is in that case located on the reflective coating 8. Thus it is only at the "transmission gaps" in the photo-sensitive coating, that is to say between the slots in the mask in the optical axis Z, that the light beams emitted from the transmitter 4 are reflected and registered by the receiver 51 which delivers an impulse via the lines 7 to the control circuit.

If the carrier material 20 is of transparent construction, a light-sensitive coating, which is provided with codings for producing windows for optical sensors, may be located between the carrier material 20 of the timing disc 1 and the reflective coating 8. For this purpose the light-sensitive coating 9, as shown in Figure 1d, may be exposed by means of masks or photo-plotters and developed.

In order to achieve a high degree of accuracy of the timing disc according to the invention, it is necessary for the bore to be arranged exactly in the centre of the disc. This is accomplished by so-called "interception stamping", wherein the central point of the timing disc is detected optically and the bore and the outer contour are stamped out at the same time. In order to avoid the smallest differences in signal, it is necessary for imbalance of the timing disc or timing scale to be avoided. This is accomplished by fine adjustment during processing, the said operation preferably being carried out on one side of the carrier material 1. This saves carrying out two adjusting operations and processing errors are avoided as a result.

In principle, the light-sensitive coating may, as shown in Figure 1e, also be arranged on the other side, which faces towards the sensor 6, of the transparent material 1. In that event, however, diffraction phenomena can occur when the light beam emitted by the transmitter 6 passes through the mask. It is therefore advantageous if the distance between the coatings traversed by the light beam after reflection is minimized. This is the case in the alternative first mentioned (Figure 1c).

In a similar manner to Figure 1, Figure 2 illustrates a timing disc 10 with a rotational axis 2, which likewise has an optical diameter D, a slot length l and a slot width b. Since, however, there is no reflective coating here, the transmitter and receiver 4, 5, or rather 14, 15, are arranged one each side of the timing disc 10.

It will be realized that the optical path in the Z-axis shown in Figure 2a is longer than in the illustration shown in Figure 1b. Furthermore, the increased number of lines and components should be noted. The amount of space required for the timing disc according to the prior art illustrated in Figure 2 is therefore greater, compared with the timing disc according to the invention.

For the purpose of manufacturing the timing disc according to the invention, an industrial film is exposed with codings, either by means of masks or by means of photo-plotters, and developed. The exposed and developed standard film is transparent and the codings are black and non-reflective.

In order to achieve a reflection on the reverse side of the timing disc, the exposed and developed film has a metallic coating vapour-deposited onto one side of it by the high-vacuum process. The film may also be provided with a reflective coating and a photo-sensitive coating during manufacture, resulting in a further improvement in the accuracy of the image-formation. Furthermore, other thin coating processes may also be used for applying metallically highly reflective coatings (with a degree of reflection greater than 90%), such as the sputtering technique, for example. Experiments have shown that, with a light source that emits light waves with a wave length of about 700 nanometers, the following metal coatings may be used: copper, aluminium, chromium and silver.

Other metallic coatings are possible, depending upon the range of wave lengths of the light source and taking into account optimum adhesion to the particular film material used.

Furthermore, the metallic coating may also be provided, in a process which is otherwise the same, with an additional coating providing protection against mechanical damage. After the coating operation, the film is divided off so that the desired timing discs and timing scales can be cut out from the industrial film.

The process according to the invention permits the manufacture of mass-produced products with a high resolution. It also has the advantage of a high degree of process reliability, provided film material with uniform properties is used during manufacture.

The reflective timing scales and timing discs manufactured as mass-produced products will mainly be used in inkjet printers, the quantities involved being several million a year.

Accurate positioning of the printing head over the photosensor system integrated in a control circuit is especially necessary in colour printing. A simple and low-cost method of construction is possible with the aid of the sensors arranged, in accordance with the invention, on one side of the timing disc or timing scale.

Various designs of timing discs have been explained above, in which the codings have been predominantly represented as slots. In principle, however, other geometrical shapes are also possible and, in particular, single and multiple channels for discs and also for scales are technically feasible. In this connection, attention is drawn to Figures 3 and 4, which show examples of a multi-channel arrangement.

Thus, Figure 3 illustrates a three-channel design with the codings in three rotationally symmetrical rings 11, 12, 13 on a timing disc 1.

Figure 4 shows a similar design for a timing scale 16, in which the coding is located in a number of sections, one behind the other. Here it is possible to apply a uniform graduation 17, or even a logarithmic graduation (not illustrated), to the light-sensitive coating 18. Fastening apertures 20 can be seen at the end of the timing scale 16.

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CLAIMS

1. Timing scale or timing disc for the accurate positioning, and/or detection of the position, of processing machines, handling tools or other movable components, which consists of a carrier material on which codings for scanning by means of optical sensors are arranged, characterized in that the carrier material (1) itself reflects or is provided with a reflective coating (8).

2. Timing scale or timing disc according to claim 1, characterized in that the material (1) consists of a film, either transparent or opaque, a light-sensitive coating (9) and a reflective coating (8) being applied to the said film.

3. Timing scale or timing disc according to one of the preceding claims, characterized in that the light-sensitive coating (9) is provided, by means of masks or photo-plotters, with codings for producing windows for optical sensors.

4. Timing scale or timing disc according to one of the preceding claims, characterized in that the reflective coating (8) consists of a metal coating.

5 Timing scale or timing disc according to one of the preceding claims, characterized in that the metal coating is applied by the thin coating process.

6. Timing scale or timing disc according to one of the preceding claims, characterized in that the metal coating consists of copper, aluminium, chromium or silver.

7. Timing scale or timing disc according to one of the preceding claims, characterized in that a further coating providing protection against mechanical damage is applied to the metal coating.

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8. Process for the manufacture of a timing scale or timing disc according to one of the preceding claims, characterized in that the transparent material, consisting of a film with a photo-sensitive coating (8), is exposed with codings by means of masks or photo-plotters and then developed, a metallic coating operation is carried out on the photosensitive coating (9), and the timing discs and timing scales are divided off from the exposed and coated film material.

9. Process according to the preceding claim, characterized in that the exposed and developed film is provided with a reflective coating by the thin coating process.

10. Process according to one of the preceding claims, characterized in that the reflective coating consists of a metal which has good adhesion to the film material.

11. Process according to one of the preceding claims, characterized in that the metallic coating is vapour-deposited onto one side of the film material by the high-vacuum process.

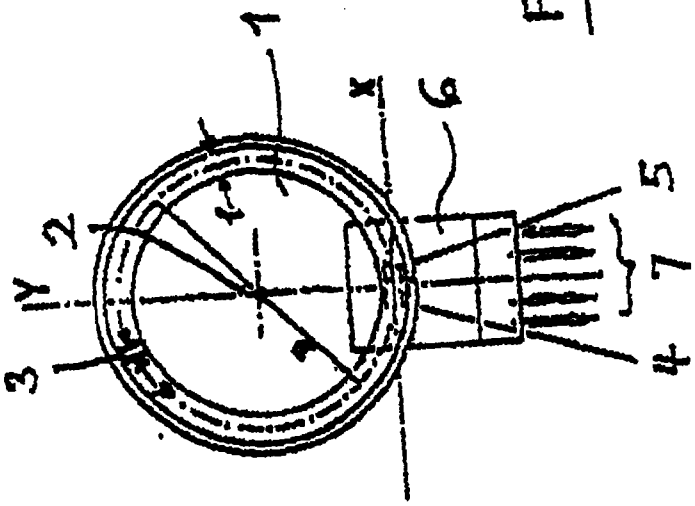
12. Process according to one of the preceding claims, characterized in that the metallic coating is applied by the thin coating process.

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Fig. 1

Fig 1a



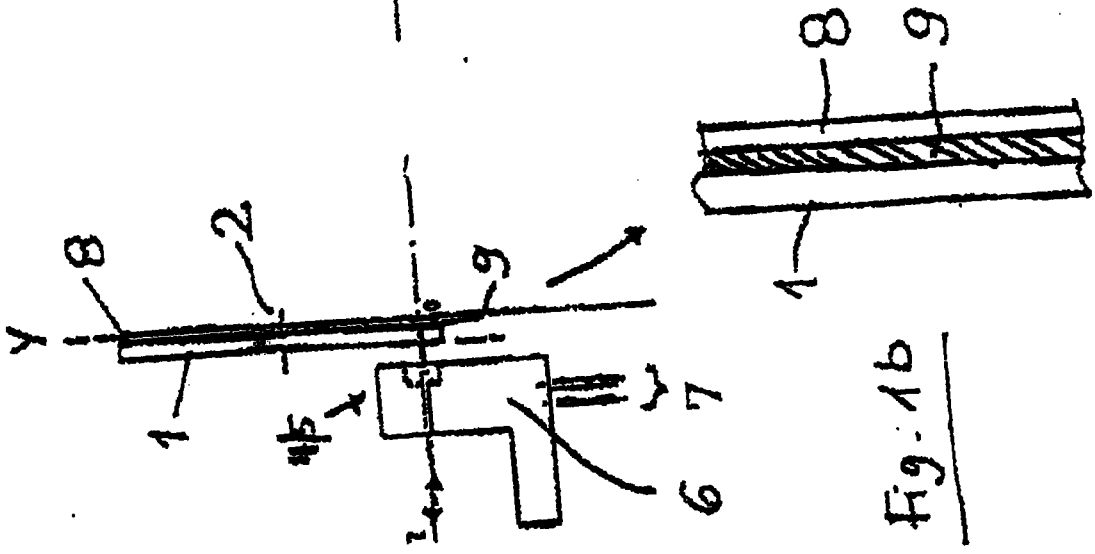


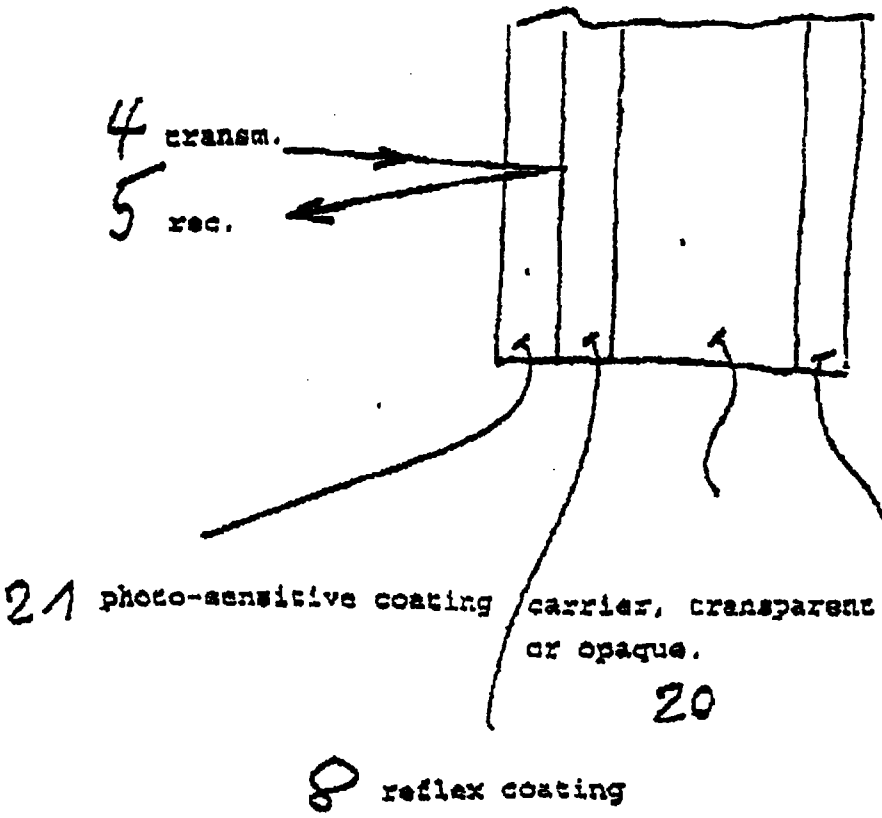
Fig. 1b

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Fig 1c

3) timing disc } reflective
timing scale }

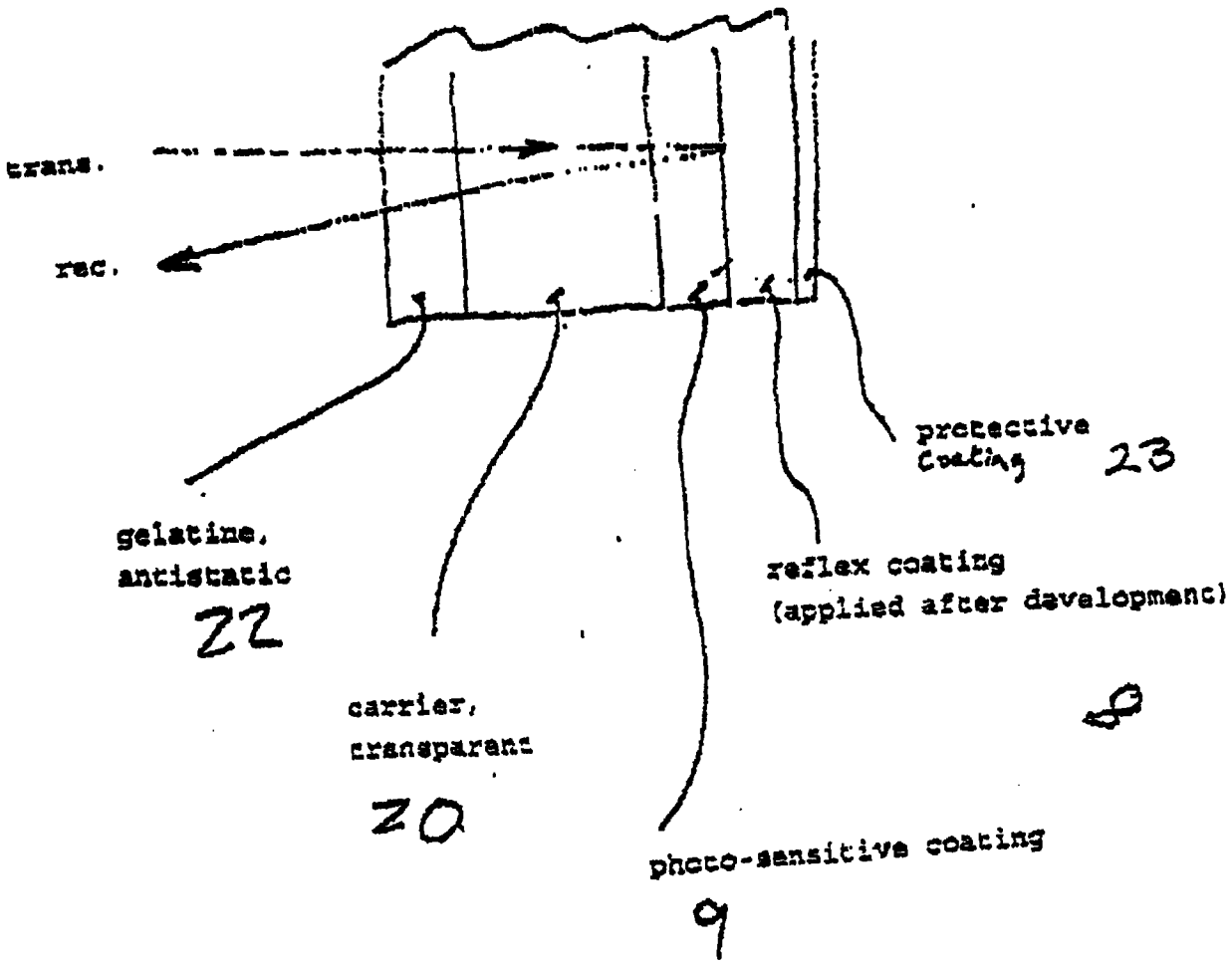


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Fig 1d

1) timing disc } reflective
timing scale }

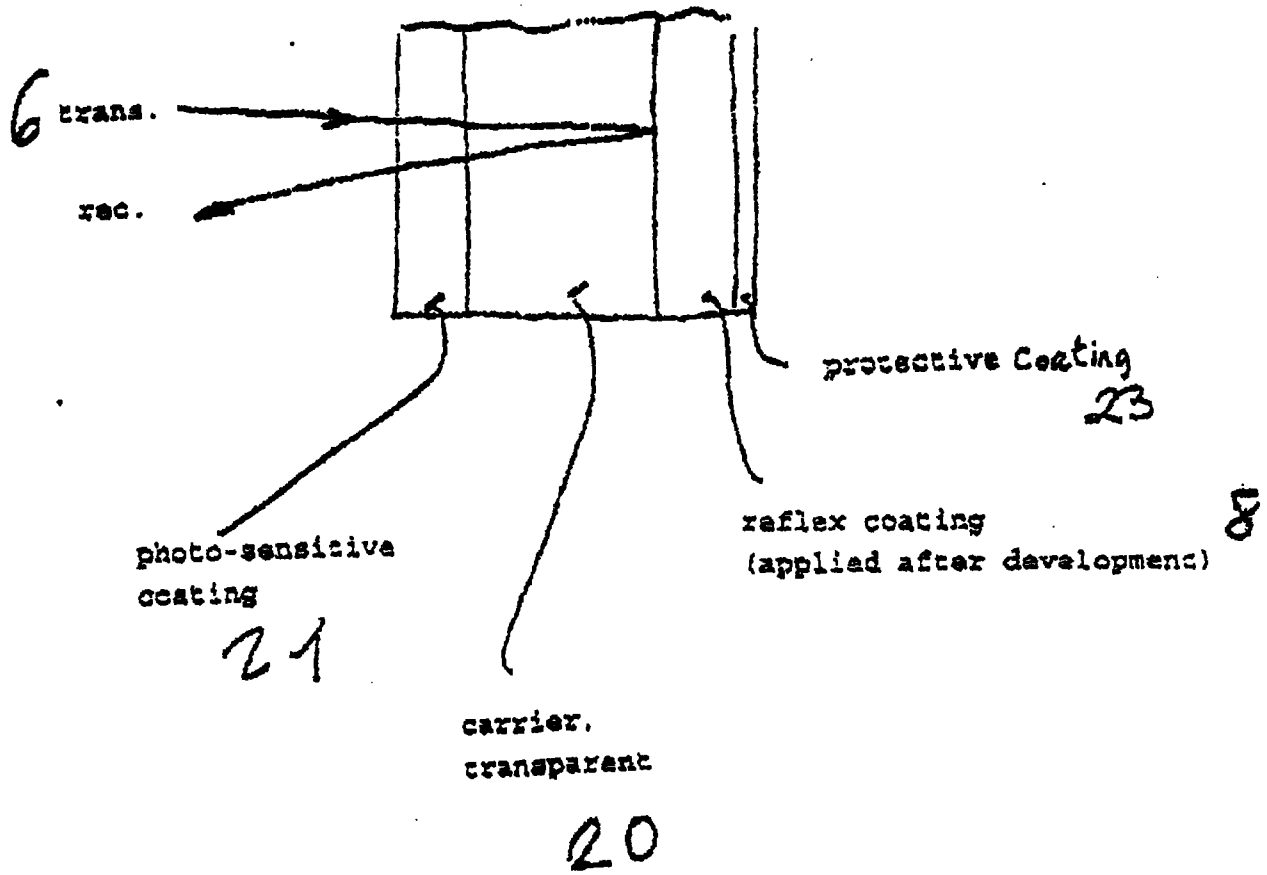


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fig 1e

2) timing disc } reflective
timing scale }



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Fig.2

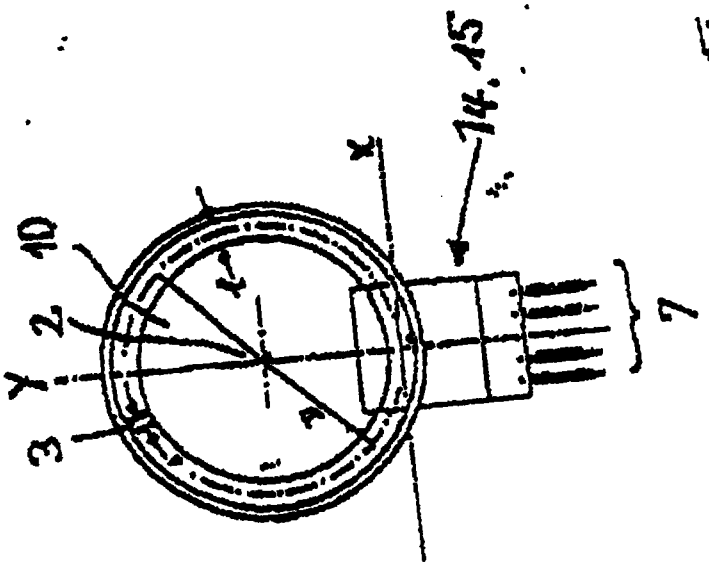


Fig. 2b

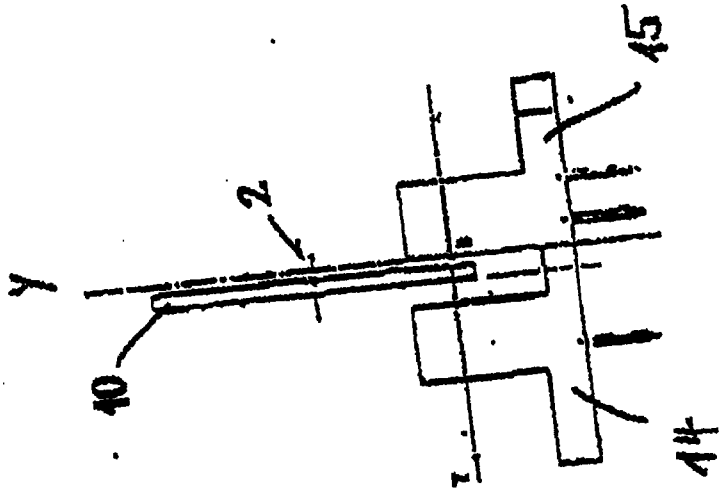


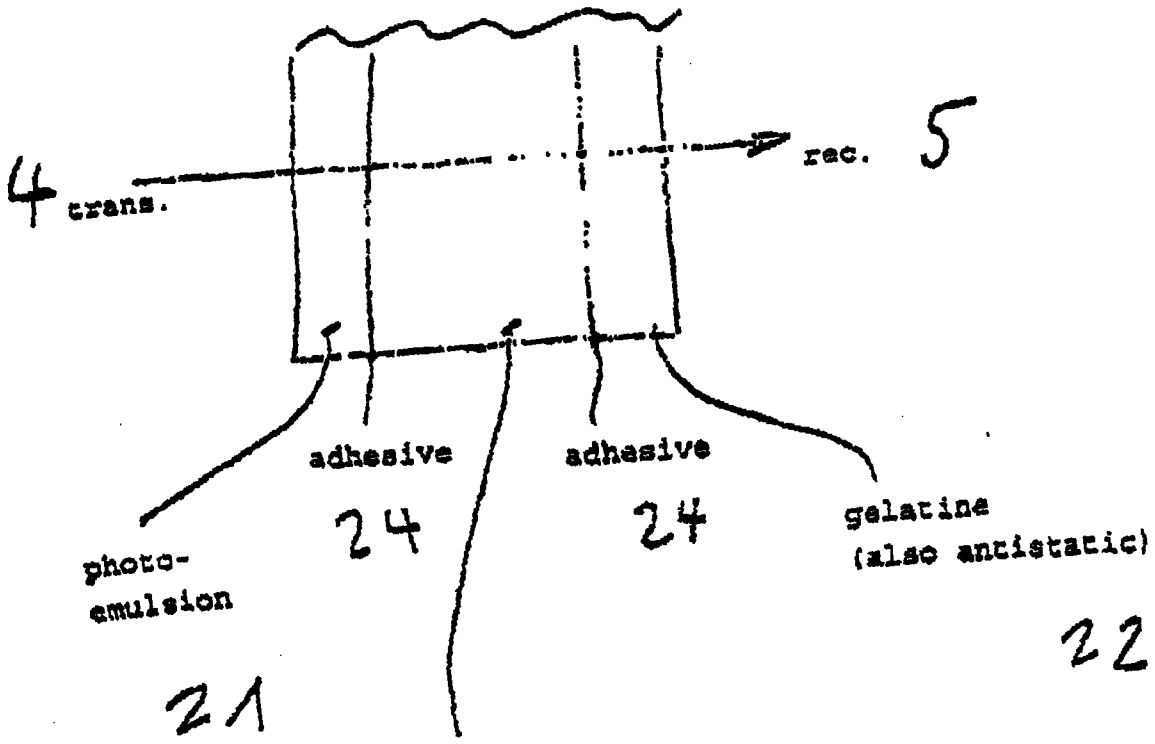
Fig. 2a

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Fig. 2c

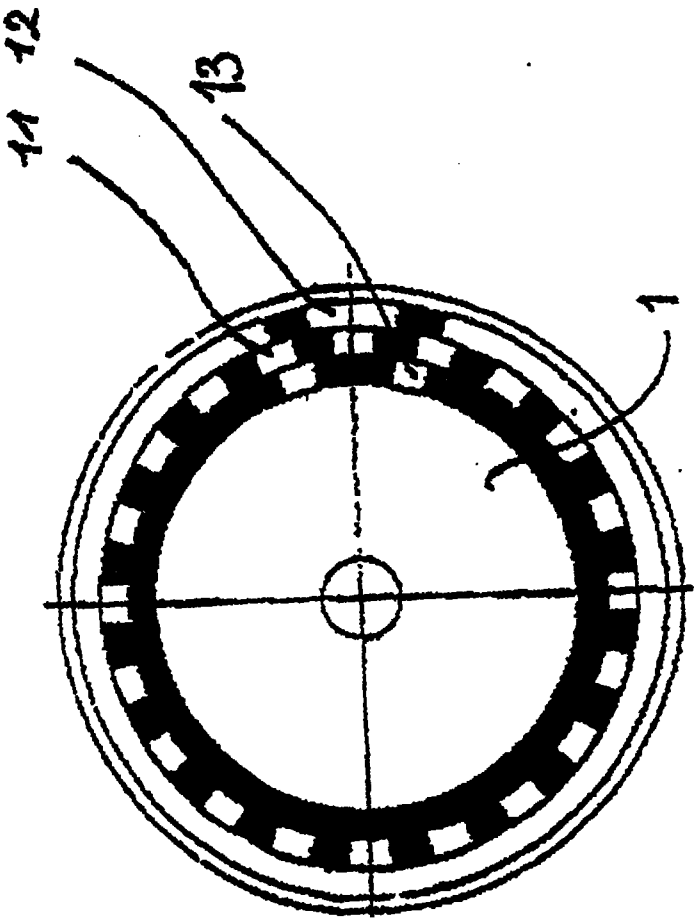
1) timing disc) transparent
timing scale)



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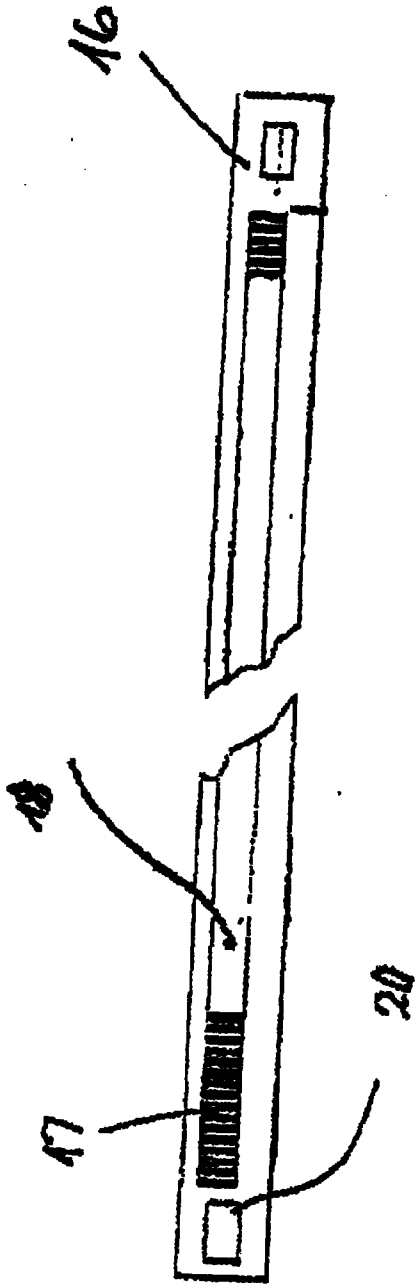
Fig.3



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Fig. 4



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ABSTRACT

TIMING SCALE OR TIMING DISC

A timing scale or timing disc for the accurate positioning, and/or detection of the position, of processing machines, handling tools or other movable components, which consists of a carrier material on which codings for scanning by means of optical sensors are arranged, characterized in that the carrier material itself reflects or is provided with a reflective coating.

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ABSTRACT

TIMING SCALE OR TIMING DISC

A timing scale or timing disc for the accurate positioning, and/or detection of the position, of processing machines, handling tools or other movable components, which consists of a carrier material on which codings for scanning by means of optical sensors are arranged, characterized in that the carrier material itself reflects or is provided with a reflective coating.

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11 JAN 1996

(Figure 1)

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24 FEB 1997

TIMING SCALE OR TIMING DISC

Description

The invention relates to a timing scale or timing disc for the accurate positioning of processing machines, handling tools or other adjusting elements, which consists of a transparent material on which codings for scanning by means of optical sensors are arranged, and also to a process for the manufacture thereof.

As a rule, timing discs are fastened to a rotating spindle by means of a boss. In the transillumination process, a light beam generates impulses as the disc rotates. Under those circumstances, the light source is located parallel to the axis of rotation and transmits a light beam at right angles to the disc.

As a result of the translucent/opaque sequence preset on the coded timing disc, "window" apertures of specific width and length, which are used to generate impulses, are produced on the rotating disc. The light beam emanating from the light source (transmitter) is converted by a receiver (optical sensor) located in the optical axis of the light beam into an impulse, the type of which depends upon the nature of the "window". The electrical impulses serve to set up a control circuit for the measurement of rotational speed, for acceleration and for the more accurate positioning of adjusting quantities such as, for example, a printing head, the arm of a robot or the carriage of a tool. For linear systems, use is made of timing scales or rules which are disposed at right angles to a light source and produce an impulse when a light beam impinges upon an optical sensor arranged behind the timing scale. This system is used, for example, in machine tools for controlling the feed movement.

Timing discs or timing scales are usually manufactured from glass, metal or plastics material. In the manufacture of mass-produced products, plastics and metal discs have gained general acceptance. They are manufactured from transparent films, for example in the case of angle-transmitters or encoder units, e.g. for inkjet printers.

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According to GB 2 163 253 A a photoelectric displacement detector measures a distance from a number of repetitions of dark and light portions which are formed by the repetition of overlapping of slits in slit trains formed in a main scale and an index scale when they are moved relative to each other. The photoelectric displacement detector comprises reference marks disposed on the main scale at appropriate spacing, mark-detecting means provided on the index scale, identification marks positioned in the spaces between adjacent reference marks so as to identify the spaces, identification mark reading means and identification mark verification means.

In GB 2 276 238 a sensor for detecting the rotation of a meter wheel, paticularly and eddy wheel in an electric power meter is described. The sensor includes a pair of light sources arranged to focus light on a selected region of the wheel, and a light detector arranged to sense reflections from the wheel caused by the light from the light source.

A similar sensor is disclosed in AT 386 900 B. The meter wheel used in combination with the sensor has a reflecting surface and a non-reflective surface for periodically reflecting the signal of a LED.

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Amended claims

1. Timing scale or timing disc for the accurate positioning, and/or detection of the position of processing machines, handling tools or other movable components, which consists of a carrier material on which codings for scanning by means of optical sensors are arranged, characterized in that
the carrier material (1) consists of a film, either transparent or opaque and a light-sensitve coating (9) which is provided by means of masks or photo-plotters with codings for producing windows for optical sensors
further characterized in that the carrier material (1) is provided with a reflective coating (8) beeing applied to said film.

2. Timing scale or timing disc according to one of the preceding claims, characterized in that the reflective coating (8) consists of a metal coating.

3. Timing scale or timing disc according to one of the preceding claims, characterized in that the metal coating is applied by the thin coating process.

4. Timing scale or timing disc according to one of the preceding claims, characterized in that the metal coating consists of copper, aluminium, chromium or silver.

5. Timing scale or timing disc according to one of the preceding claims, characterized in that a further coating providing protection against mechanical damage is applied to the metal coating.

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Fig. 1

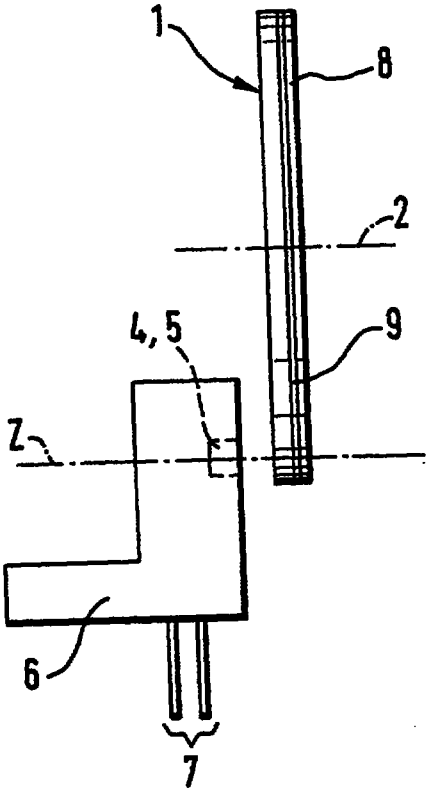
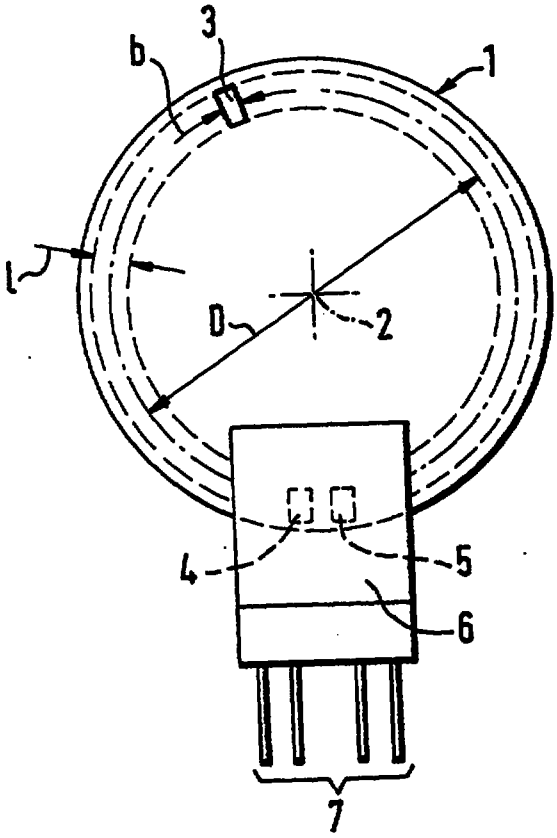


Fig. 1a



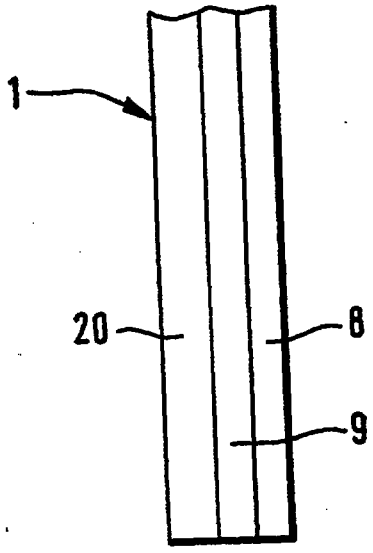


Fig. 1b

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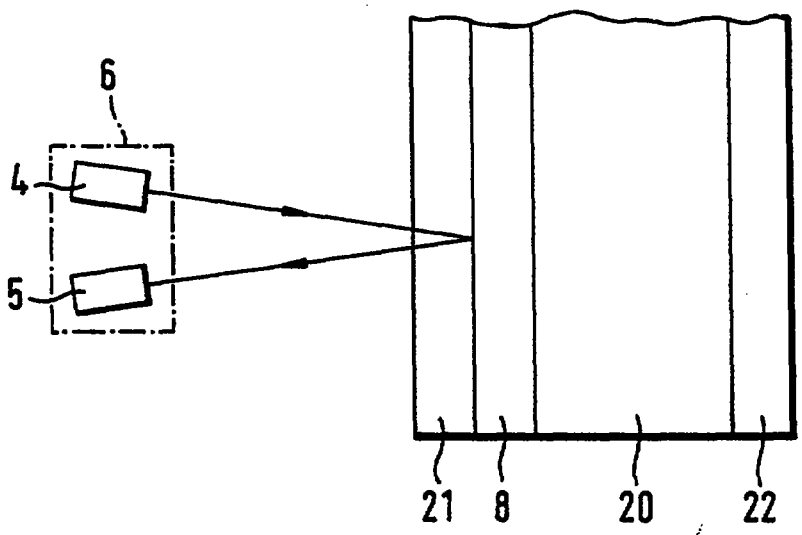


Fig. 1c

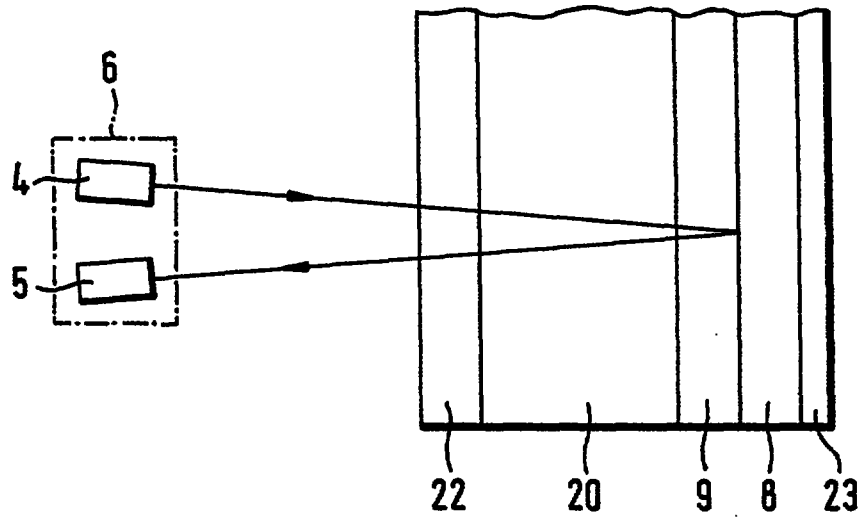


Fig. 1d

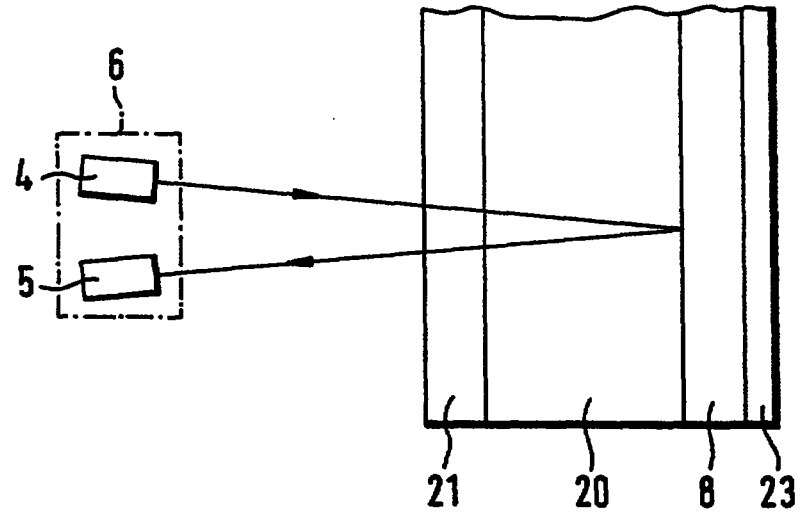


Fig. 1e

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Fig. 2a

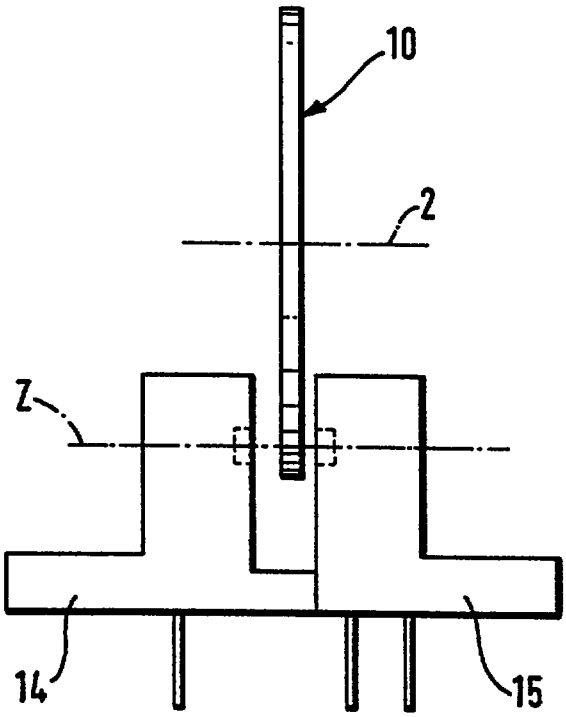


Fig. 2b

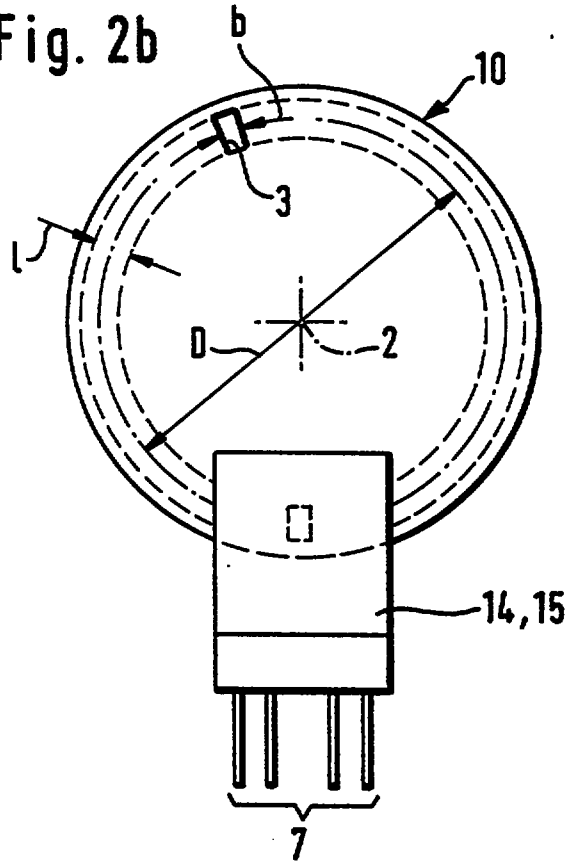
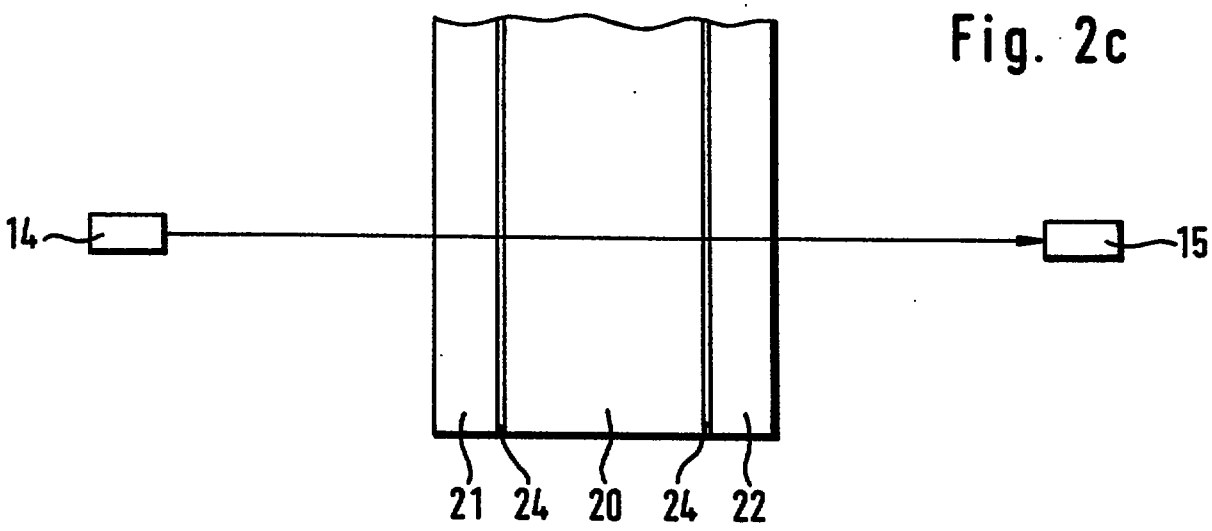


Fig. 2

Fig. 2c



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Fig. 3

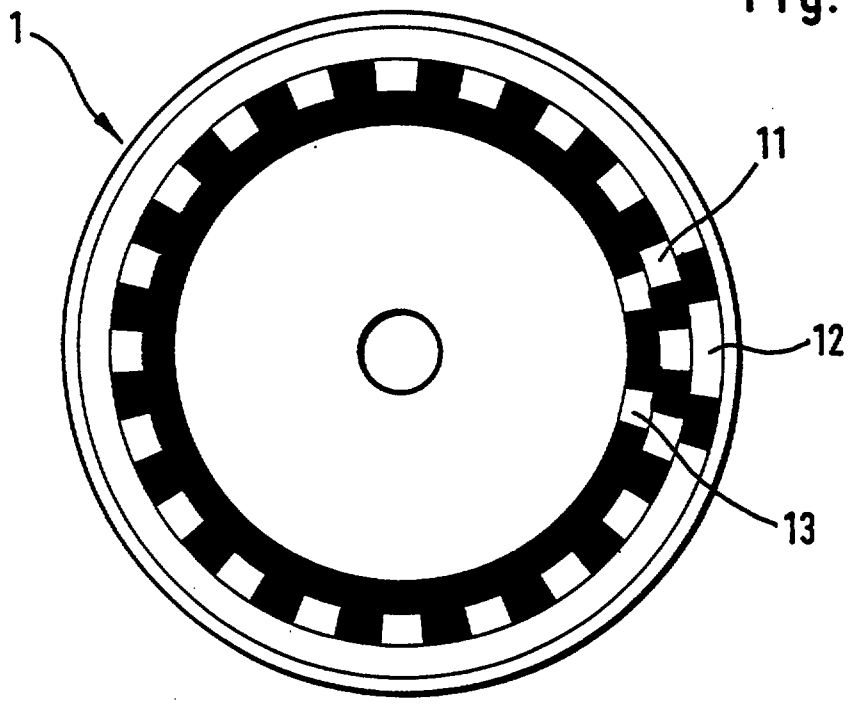


Fig. 4

