



AU9481641

(12) PATENT ABRIDGMENT (11) Document No. AU-B-81641/94
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 678078

- (54) Title
MULTIDIGIT COUNTING WHEEL MECHANISM FOR A VOLUME-MEASURING INSTRUMENT
- International Patent Classification(s)
(51)⁶ **G06M 001/27 G01D 005/24 G01D 005/34 G01F 015/06**
G01R 011/16 G06M 001/272
- (21) Application No. : **81641/94** (22) Application Date : **21.12.94**
- (30) Priority Data
- (31) Number (32) Date (33) Country
3854/93 23.12.93 CH SWITZERLAND
- (43) Publication Date : **29.06.95**
- (44) Publication Date of Accepted Application : **15.05.97**
- (71) Applicant(s)
GWF GAS-UND WASSERMESSEFABRIK AG
- (72) Inventor(s)
ROLAND METTLER; DIETER VISCHER
- (74) Attorney or Agent
WATERMARK PATENT & TRADEMARK ATTORNEYS , Locked Bag 5, HAWTHORN VIC 3122
- (56) Prior Art Documents
US 4031386
GB 2130828
EP 119545
- (57) Claim

1. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:

a plurality of rotatable counting wheels mounted on an axle and provided with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

five contactless sensors, for each of said plurality of counting wheels to be read, said sensors mounted upon an arc in a plane perpendicular to said counting wheel axle, said arc being centred upon said counting wheel axle; and

a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

5. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:

a plurality of rotatable counting wheels mounted on an axle and provided with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

five contactless sensors, for each of said plurality of counting wheels to be read, each of said sensors comprising a source output for transmitting optical energy and a receiver input for receiving optical energy, wherein said source output and said receiver input are positioned on opposing sides of said counting wheel; and

a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

14. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:

a plurality of rotatable counting wheels mounted on an axle and provided with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

five contactless sensors, for each of said plurality of counting wheels to be read, wherein said sensors are radially positioned equidistant from said counting wheel axle, each said sensor comprising a transducer electrically coupled to an exterior surface of said counting wheel; and

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a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on said exterior surface of on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

Multidigit counting wheel mechanism for a volume-measuring instrument

Description:

Volume-measuring instruments for gas and water as well as also electricity meters for the measurement of the energy that has flown through are known, in which the measured volume or energy are transmitted to a mechanical counting wheel mechanism with a step-down ratio adapted to the measuring instrument. The counting wheel mechanism in that case shows the quantity that has flown through since the last zero setting or since putting it into operation. To ascertain the consumption during a certain period, the state of the counting wheel mechanism is read off at the beginning and end of this period. A preferred construction for the counting wheel mechanism consists of an axle, on which the counting wheels are mounted to be rotatable and on the circumference of which the numerals 0 to 9 are applied, as well as of a second axle with "carry" pinions rotatable thereon in such a manner that the lower digit counting wheel in the last tenth of a revolution each time by way of the associated "carry" pinion switches the next higher digit wheel further by one tenth of a revolution. A counting wheel mechanism for a measuring instrument for water is found for example in the DE 2 244 404 A1. According to the construction of the measuring instrument, it is important for the achievement of a large measuring range with a good measuring accuracy to keep the torque required for the drive of the counting wheel mechanism as small as possible.

A solution for the electronic read-out of a counting mechanism, in which the continuous rotational movement of the counting wheels is translated into a snap movement, is known from the US 3 732 404. In that case, it is to be made certain that the spring or the like used for the snap movement receives sufficient energy in order to rotate the entire wheel counting mechanism forward by one step, for example from 19,999 to 20,000. A solution, which permits the electronic read-out for a counting mechanism of the needle type with the use of mechanical contacts without snap movement, is known from the EP 202 722 B1. It is common to all above solutions that an increase in the torque required for the drive of the counting wheel mechanism is connected with them.

The present invention is based on the object to electronically read out digitally the state of indication of a counting wheel mechanism in a measuring instrument with the simplest possible means at any desired instant without the torque required for the drive of the counting wheel mechanism being substantially changed by the means necessary for this purpose.

According to the present invention, the indicated state of a mechanical counting wheel mechanism is read out electronically by means of suitable, fixedly arranged contactless sensors without restrictive conditions, such as for example a snap rotation, having to be fulfilled in respect of the rotational movement of the counting wheel mechanism. In order reliably to read out the indication of a non-snap counting wheel mechanism in all settings and subject to consideration of the mechanically necessary play of the wheel drive by static sensors, it is required that the sensors assume at least 22 different signal states for each revolution of the wheel. Thereby, it is possible to measure the angle of rotation of each counting wheel with an uncertainty of less than 18° and to ascertain the relative setting of two adjacent wheels with an uncertainty of less than 36° and thus reliably to ascertain the state of indication of the counting wheel mechanism. In a preferred solution, the sensors assume 30 different signal states for each revolution, symmetrically distributed at an angle of rotation of the counting wheel of 12° for each signal state. In this solution, a mechanical play from counting wheel to counting wheel of up to almost 12° is permissible independently of the number of the counting wheels to be read out.

A requirement, which is generally known from applications for the detection of a mechanical position with several sensors, on the signal state is that only one signal changes each time from state to state in the manner of a Gray code.

Several examples of embodiment of the invention are illustrated in the drawing and more closely explained in the following description. A first example of embodiment is shown in Figure 1a which is partly a section according line 1a - 1a in Figure 1b, and in Figure 1b which is a cross-section according line 1b - 1b in Figure 1a. Figure 2a shows a second example of embodiment and Figure 2b shows a third one. Figure 3 shows all possible codes for the third example of embodiment. A fourth example of embodiment is shown in elevation in Figure 4a and in cross-section in Figure 4b. Figure 5a shows a fifth example of embodiment and a sixth example of embodiment is shown in partial elevation in Figure 5b and in cross-section in Figure 5c.

The first example of embodiment operates with one-way light barriers which display optical sensors. Several counting wheels 12, which stand in connection one mechanically with the other by way of "carry" pinions 14, are arranged on a counting wheel axle 15. The "carry" pinions 14 sit on a "carry" pinion axle 16. The counting wheels 12 are visually readable in conventional manner through a not illustrated opening. For electronic read-out, five light sources 10 at one side and five sensors or light receivers 11 at the other side are arranged laterally of the counting wheels 12 each time at a different radial spacing. A suitable multitrack binary code 13 (see Figure 1b), which consists of translucent and opaque segments (see Figure 1a), is disposed at each counting wheel 12. Because of the inevitably small spacing of the individual code tracks, this solution makes high demands on the accuracy of the sensors and the code on the counting wheels.

According to the second example of embodiment, five sensors 20 are likewise used for each counting wheel 12, which as in the first example of embodiment are parts of one-way light barriers. The sensors 20 are applied on a sensor print 22 all at equal radial spacing on a circular arc about the counting wheel axle 15 and in one radial plane. For a rational assembly, it is advantageous to mount all five sensors 20 as closely one beside the other as possible in one half of the periphery of the counting wheels 12. This is given in an arrangement of angles of 36° each time between the five sensors 20 (Figure 2a).

For as reliable as possible a construction of the encoder, it is advantageous in the 30 used signal states not to consider the states "1 1 1 1 1" (all sensors on) and "0 0 0 0 0" (all sensors off) so that a global test of the sensor function is possible. For this purpose, the five sensors 20 are to be arranged uniformly distributed at angles of 72° over the entire circumference (Figure 2b). Other possible constructions have the sensors 20 arranged at angles of 72° , 36° , 36° , 72° or 36° , 72° , 36° , 108° .

The possible codes 21 on the counting wheels 12 are illustrated in the Figures 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 3i and 3k. They consist of three segments of a first kind 31 and of three segments of a second kind 32. The six dividing lines between the segments 31 and 32 of the code 21 are arranged on the counting wheels 12 at the following angles:

Variant a: 18° , 78° , 174° , 198° , 258° , 354°
Variant b: 18° , 42° , 78° , 126° , 246° , 354°
Variant c: 18° , 42° , 78° , 198° , 318° , 354°
Variant d: 18° , 54° , 174° , 258° , 294° , 354°
Variant e: 18° , 42° , 150° , 198° , 246° , 354°
Variant f: 18° , 54° , 102° , 150° , 258° , 354°
Variant g: 18° , 54° , 114° , 150° , 246° , 354°
Variant h: 18° , 54° , 150° , 186° , 246° , 354°
Variant i: 30° , 78° , 114° , 162° , 270° , 354°
Variant k: 30° , 78° , 126° , 162° , 258° , 354°

The variants b to k are usable only for sensors 30 distributed in radial symmetry, which means a distribution at equal angles between the sensors (see Figure 2b). The codes 21 can also be rotated or reflected. In Figure 3b, the five sensors 30 are also shown by way of example. In the case of one-way light barriers, the segments of the first kind are formed by holes and the segments of the second kind consist of webs. The use of reflective light barriers would also be possible, for which the segments of the first kind would then have to be distinguished clearly in their reflective properties from those of the second kind.

A structuring of optical sensors, which is advantageous for the production of greater piece numbers, consists of photo-electric elements 40 and 41 arranged parallelly to the axle 15 of the counting wheels 12 on a print 39. The elements 41 act as light sources, the light of which is steered by mould-pressed optical conductors 42 to the code-carrying part of the counting wheel 12 (Figure 4). The elements 40 are optical sensors, for example photo-resistors. The arrows on the optical conductors each time indicate the beam direction of the light.

Another sensor variant of favourable costs according to a fifth example of embodiment is equipped with capacitive sensors 50 (Figure 5a). An electrically conductive inner ring 51 with terminal 52 is mounted parallelly to the counting wheel 12 and close to its axis. The sensors, which are stationary relative to the counting wheels 12, consist of five narrow sensor platelets 53, which are arranged at equal angular spacings, with electrical terminals 54. The inner ring 51 and the sensor platelets

53 are arranged in a radial plane, preferably on an insulating plate and at a small radial spacing from the counting wheel 12. The counting wheel 12 carries a code disc 55 with three conducting segments 56 and three non-conducting segments 57. To ascertain the setting of a counting wheel, the capacitance between the inner ring 51 and the individual sensor platelet 53 is measured at the terminals 52 and 54.

The Figures 5b and 5c likewise in a sixth example of embodiment show a capacitive variant with sensor 60 in radial arrangement. The capacitances are measured each time between a metallic inner cylinder 61 and five narrow sensor platelets 63 spaced radially therefrom. The counting wheel 12 displays a code cylinder 65 with metallic and non-metallic segments (66, 67) in alternation laterally in an annular groove 64. In this case, the code cylinder 65 does not lie between sensor platelets 63 and inner ring or cylinder 61, but closely enough to the sensor platelets 63 for the measured capacitance being influenced sufficiently.

Instead of the capacitive sensors, appropriately constructed inductive sensors can be used equally well.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:
a plurality of rotatable counting wheels mounted on an axle and provided with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

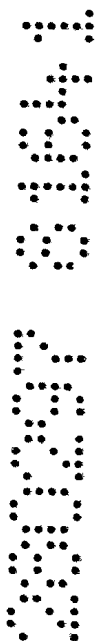
five contactless sensors, for each of said plurality of counting wheels to be read, said sensors mounted upon an arc in a plane perpendicular to said counting wheel axle, said arc being centred upon said counting wheel axle; and

a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

2. The multidigit counting wheel mechanism of claim 1, said plurality of codes comprising a binary code, said binary code being defined by a predetermined arrangement of said three segments of said first kind and said three segments of said second kind.

3. The multidigit counting wheel mechanism of claim 1, wherein the plurality of codes consist of unequal length segments arranged on a circular arc.

4. The multidigit counting wheel mechanism of claim 2, wherein the plurality of codes consist of unequal length segments arranged on a circular arc.



5. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:

a plurality of rotatable counting wheels mounted on an axle and provided with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

five contactless sensors, for each of said plurality of counting wheels to be read, each of said sensors comprising a source output for transmitting optical energy and a receiver input for receiving optical energy, wherein said source output and said receiver input are positioned on opposing sides of said counting wheel; and

a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

6. The multidigit counting wheel mechanism of claim 5, wherein said sensors are arranged such that each of said five source outputs are linearly disposed along a radius of said counting wheel and that each of said five receiver inputs are linearly disposed opposite said source outputs and on an opposite side of said counting wheel.

7. The multidigit counting wheel mechanism of claim 5, each of said source outputs are radially arranged in a circular arc at equal radial spacing from said counting wheel axle on a first side of said counting wheel and each of said receiver inputs are radially arranged to correspond with each of said source outputs on a second side of said counting wheel.

8. The multidigit counting wheel mechanism of claim 5, each of said sensors further comprising a light source and a light receiver, wherein for each sensor, said light source is coupled to said source output and said light receiver is coupled to said receiver input.

9. The multidigit counting wheel mechanism of claim 8, wherein each of said light sources and each of said light receivers are disposed in a single plane parallel to said axle of said plurality of counting wheel.

10. The multidigit counting wheel mechanism of claim 9, wherein said source outputs are radially mounted in a plane parallel to said counting wheel on a first side of said counting wheel and said receiver inputs are radially mounted in a plane parallel to said counting wheel, opposite corresponding source outputs, and on a second side of said counting wheel.

11. The multidigit counting wheel mechanism of claim 10, said source outputs being coupled to said light source through a first optical fiber and said receiver inputs being coupled to said light receiver through a second optical fiber.

12. The multidigit counting wheel mechanism of claim 5, said receiver input comprising a photodetector, and said sensor output and said receiver input form a one-way light barrier.

13. The multidigit counting wheel mechanism of claim 5, said plurality of codes comprising a binary code, said binary code being defined by a predetermined arrangement of said three segments of said first kind and said three segments of said second kind.

14. A multidigit counting wheel mechanism for a volume-measuring instrument including gas, water and electric meters, the mechanism comprising:
a plurality of rotatable counting wheels mounted on an axle and provided

with multiple peripheral digits;

a plurality of rotatable shift pinions operatively connected with pairs of said counting wheels;

wherein in each of two adjacent counting wheels, the adjacent higher digit counting wheel is turned further through one tenth of a revolution, via an associated shift pinion, by the adjacent lower digit counting wheel in the last tenth of the revolution of the latter;

five contactless sensors, for each of said plurality of counting wheels to be read, wherein said sensors are radially positioned equidistant from said counting wheel axle, each said sensor comprising a transducer electrically coupled to an exterior surface of said counting wheel; and

a plurality of codes, each code consisting of three segments of a first kind and of three segments of a second kind, any one of said plurality of codes mounted on said exterior surface of on any one of the plurality of counting wheels in a manner that said five sensors can generate thirty different signal states during one complete revolution of a counting wheel.

15. The multidigit counting wheel mechanism of claim 14, said plurality of codes comprising a binary code, said binary code being defined by a predetermined arrangement of said three segments of said first kind and said three segments of said second kind.

16. The multidigit counting wheel mechanism of claim 14, said sensors further being coplanarly arranged parallel to said counting wheel and comprising capacitive sensors.

17. The multidigit counting wheel mechanism of claim 14, said exterior surface comprising two concentric ring members, said sensors further comprising a hollow circular member extending to position that said hollow circular member coaxially between said two concentric ring members.

18. The multidigit counting wheel mechanism of claim 17, said sensors comprising capacitive sensors with metallic and non-metallic surfaces positioned on an outer face of said hollow circular member and said plurality of

codes comprising metallic and non-metallic surfaces positioned on an inner face of an outer ring of said two concentric ring members.

19. The multidigit counting wheel mechanism of claim 18, said mechanism further comprising a metallic surface positioned on an inner face of said hollow circular member and a metallic surface positioned on an outer face of an inner ring of said two concentric ring member.

20. The multidigit counting wheel mechanism of claim 18, a gap formed between said capacitive sensors and said plurality of codes being approximately 1 mm.

21. The multidigit counting wheel mechanism of claim 18, said metallic surfaces equidistantly spaced about a periphery of said outer face of said hollow circular member.

22. The multidigit counting wheel mechanism of claim 14, said sensors comprising narrow metallized sensor platelets and said plurality of codes comprising one of a code disc and a code cylinder, said one including metallic segments and the other including noncontinuous non-metallic segments, said one of said code disc and said code cylinder being disposed in the immediate proximity of said sensor platelets, and said capacitance measured between said sensor platelets and an electrically conductive inner ring.

DATED this 15th day of February, 1997.

GWF GAS-UND WASSERMESSERFABRIK AG

WATERMARK PATENT & TRADEMARK ATTORNEYS
LEVEL 4, AMORY GARDENS
2 CAVILL AVENUE
ASHFIELD NSW 2131
AUSTRALIA
LJD:MB:GL DOC10 AU8164194.WPC

A B S T R A C T

Absolute encoder for measuring instrument with mechanical counting wheel mechanism consisting of five sensors (20), which are mounted in one plane perpendicularly to the counting mechanism axle (15), for each counting wheel (12) and a code (21), which produces a digital rotary angle signal with a resolution of 12° , on the counting wheel (12). The counting wheel mechanism can be read off visually in conventional manner and the encoder does not increase the torque required for the drive of the counting mechanism.

(Figure 2b)



21 12 94 81641

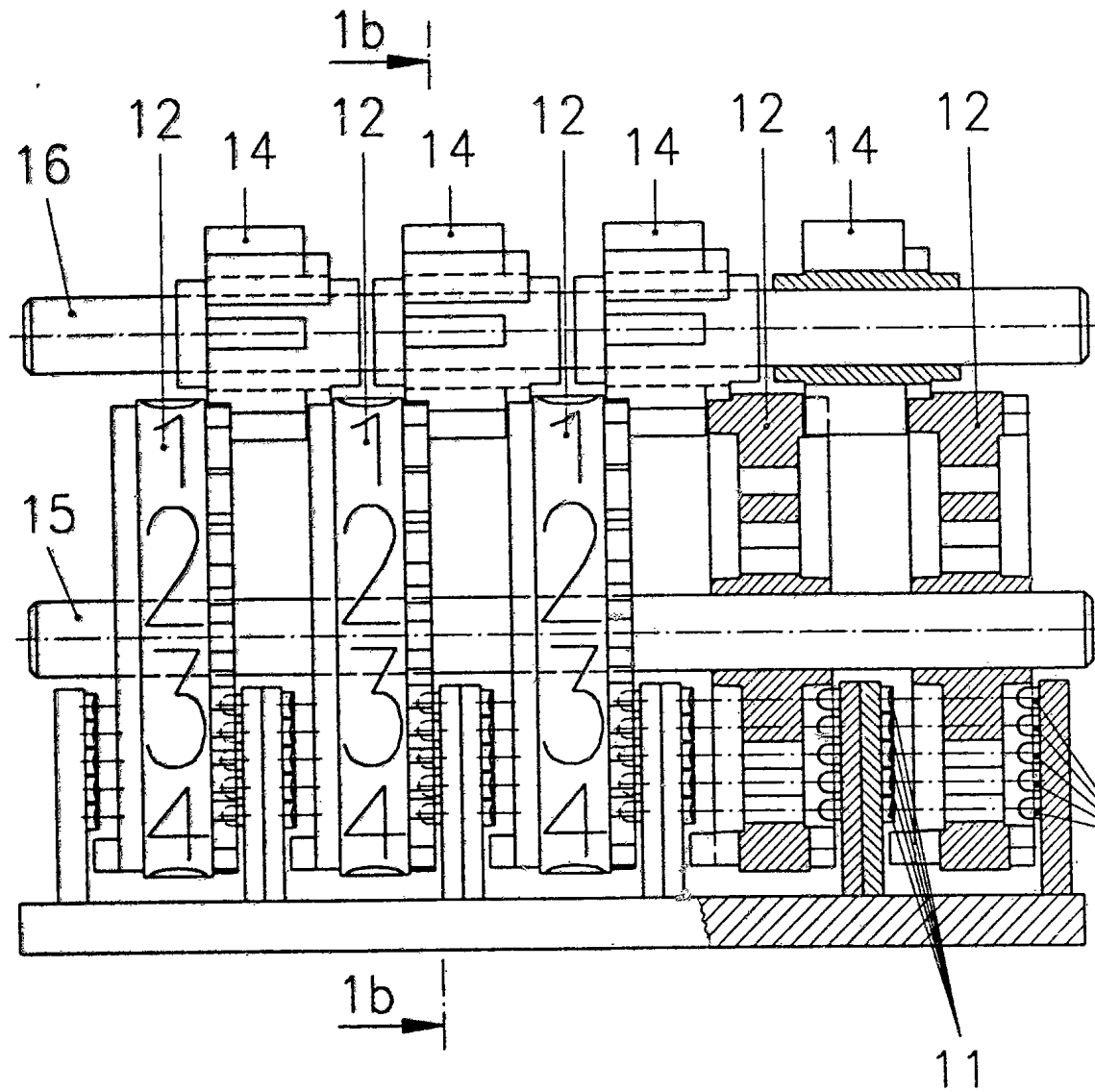


Fig. 1a

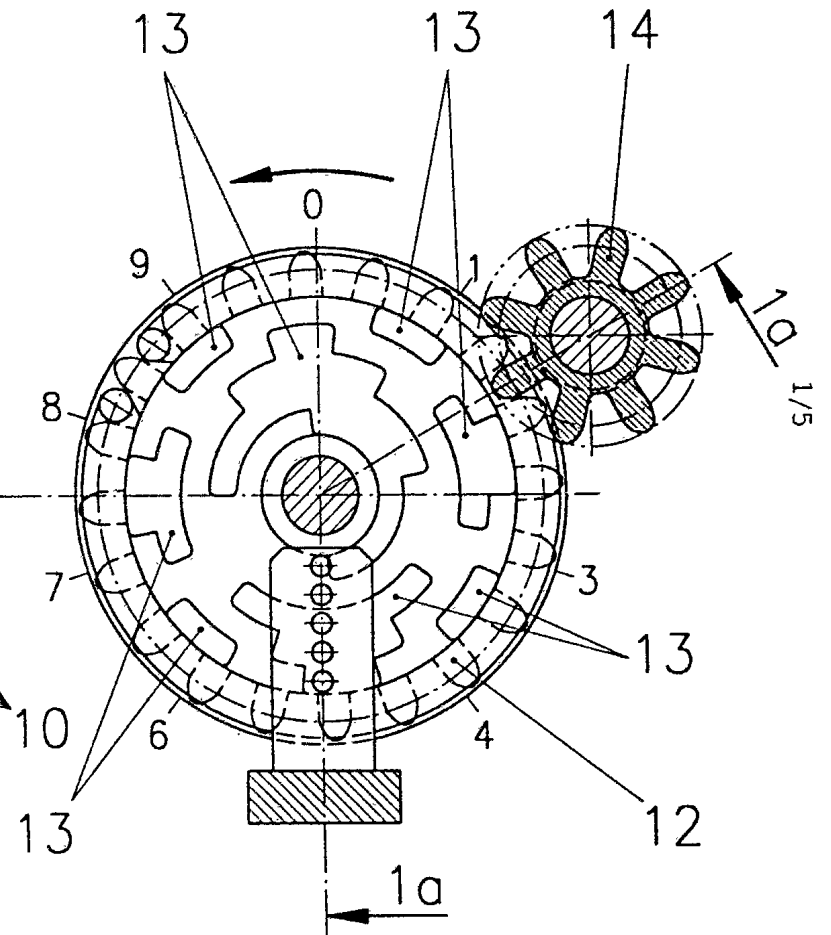


Fig. 1b

21 12 94 81641

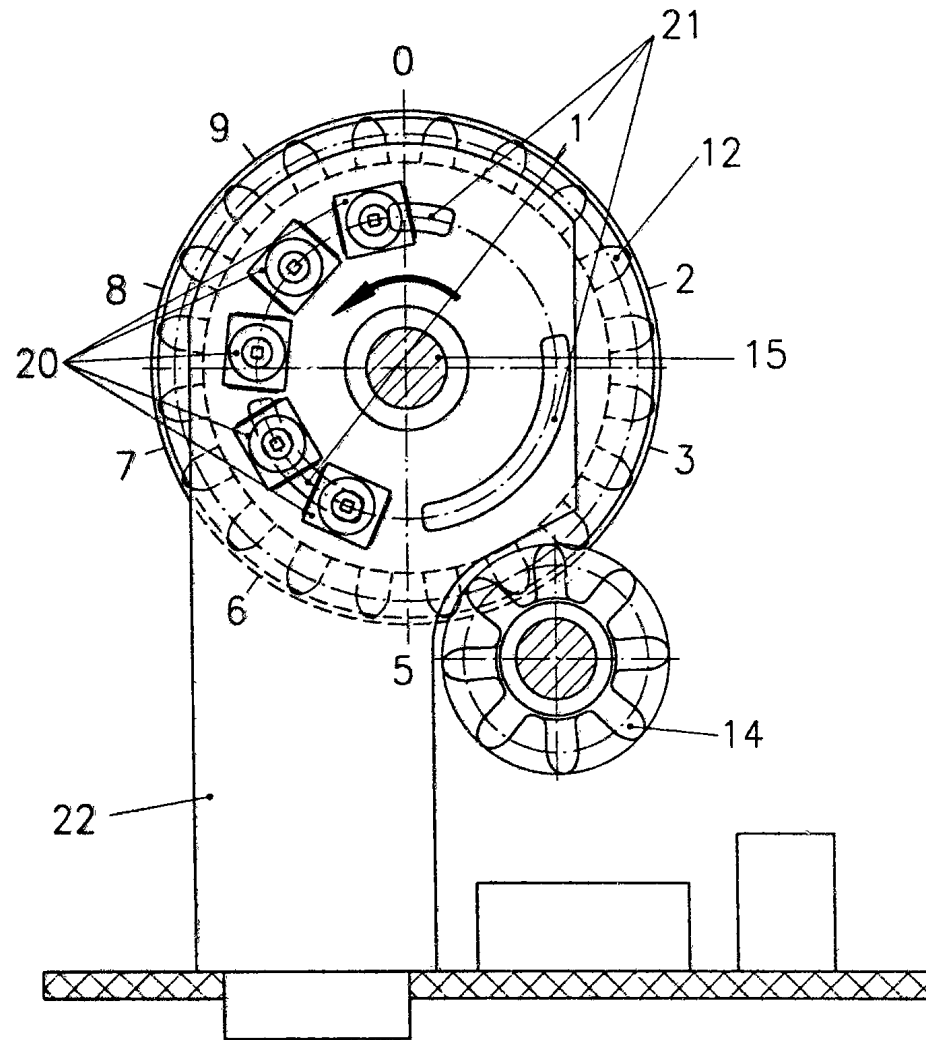


Fig. 2a

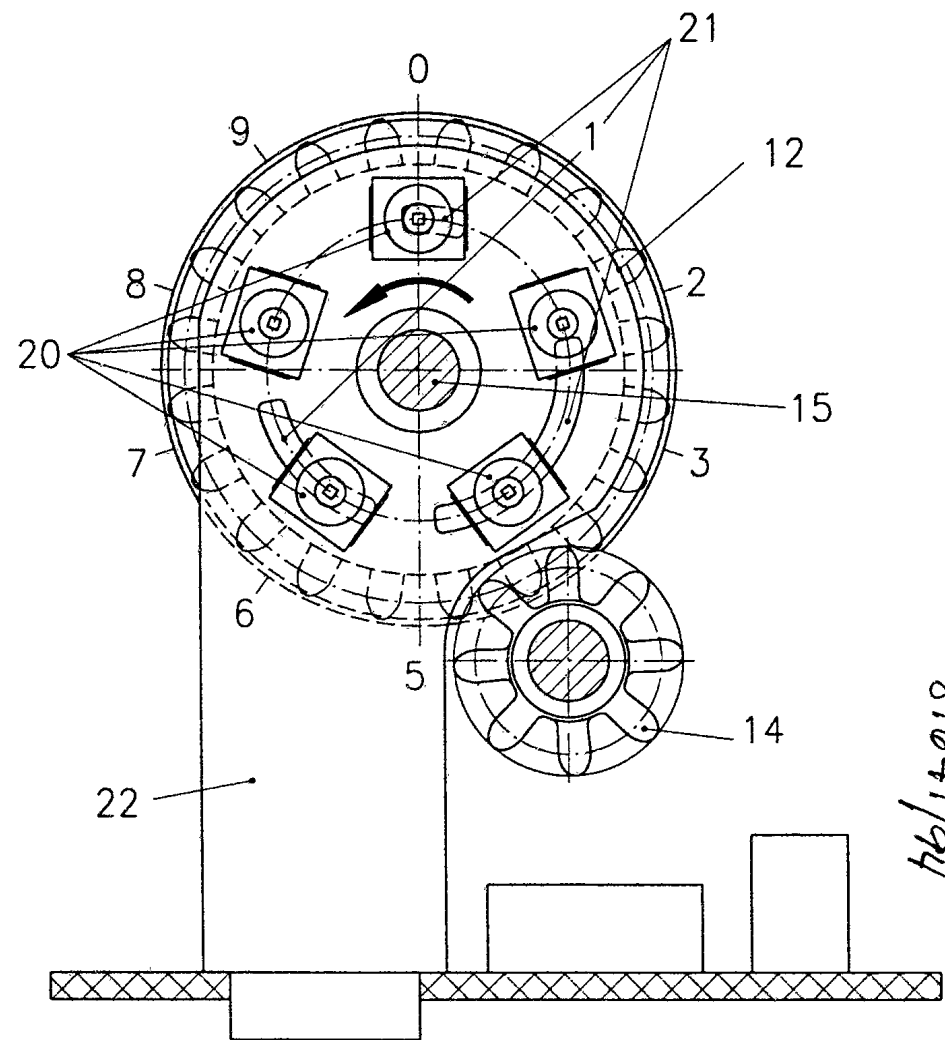


Fig. 2b

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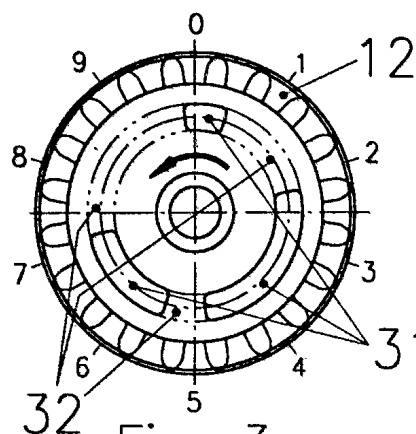


Fig. 3a

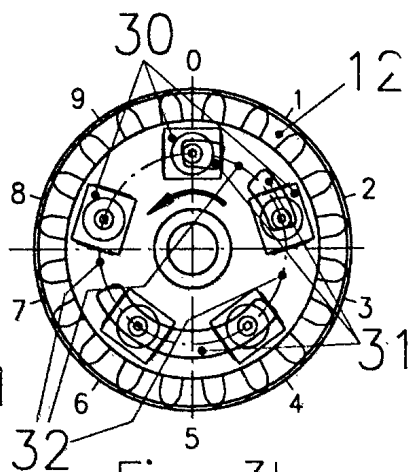


Fig. 3b

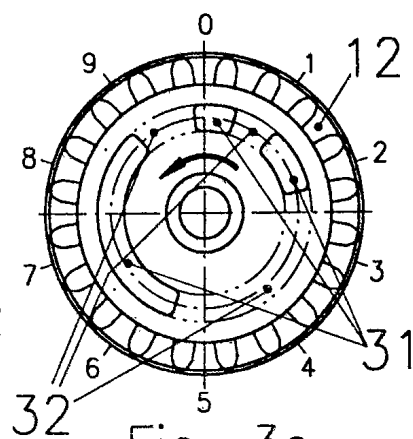


Fig. 3c

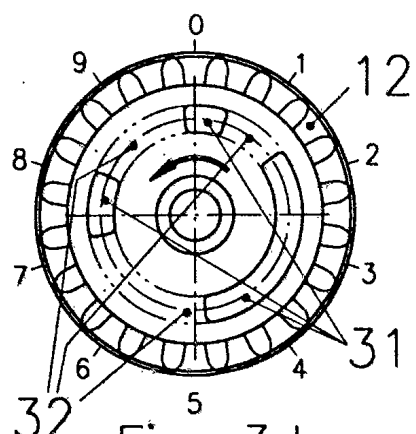


Fig. 3d

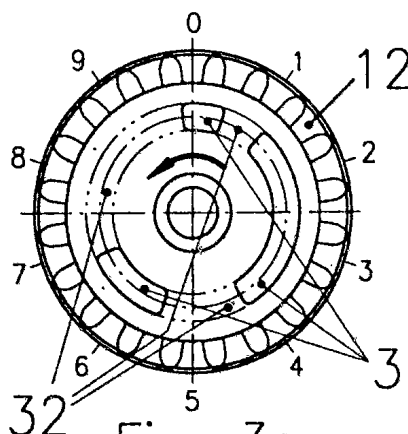


Fig. 3e

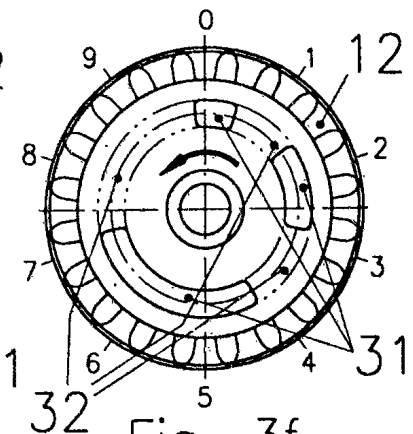


Fig. 3f

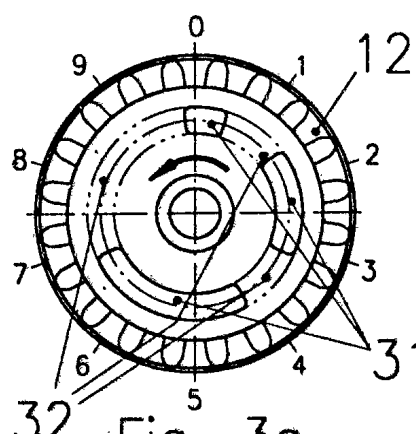


Fig. 3g

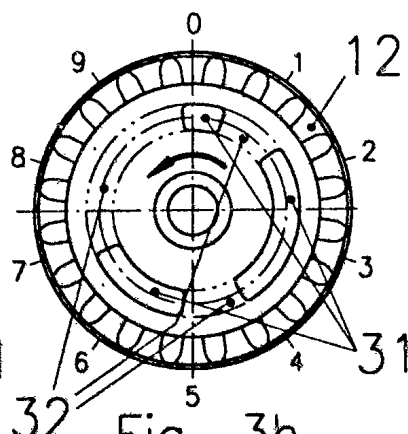


Fig. 3h

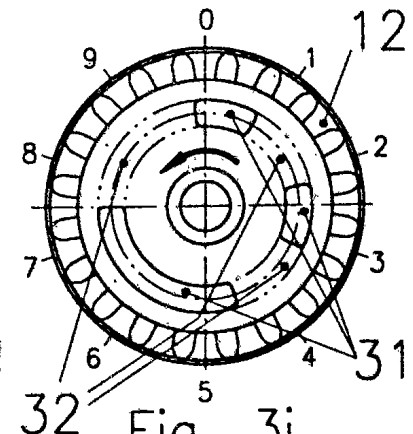


Fig. 3i

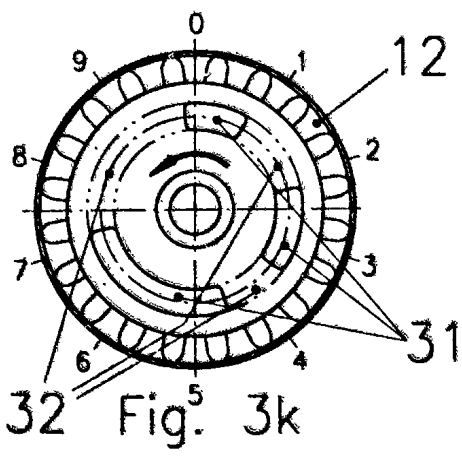


Fig. 3k



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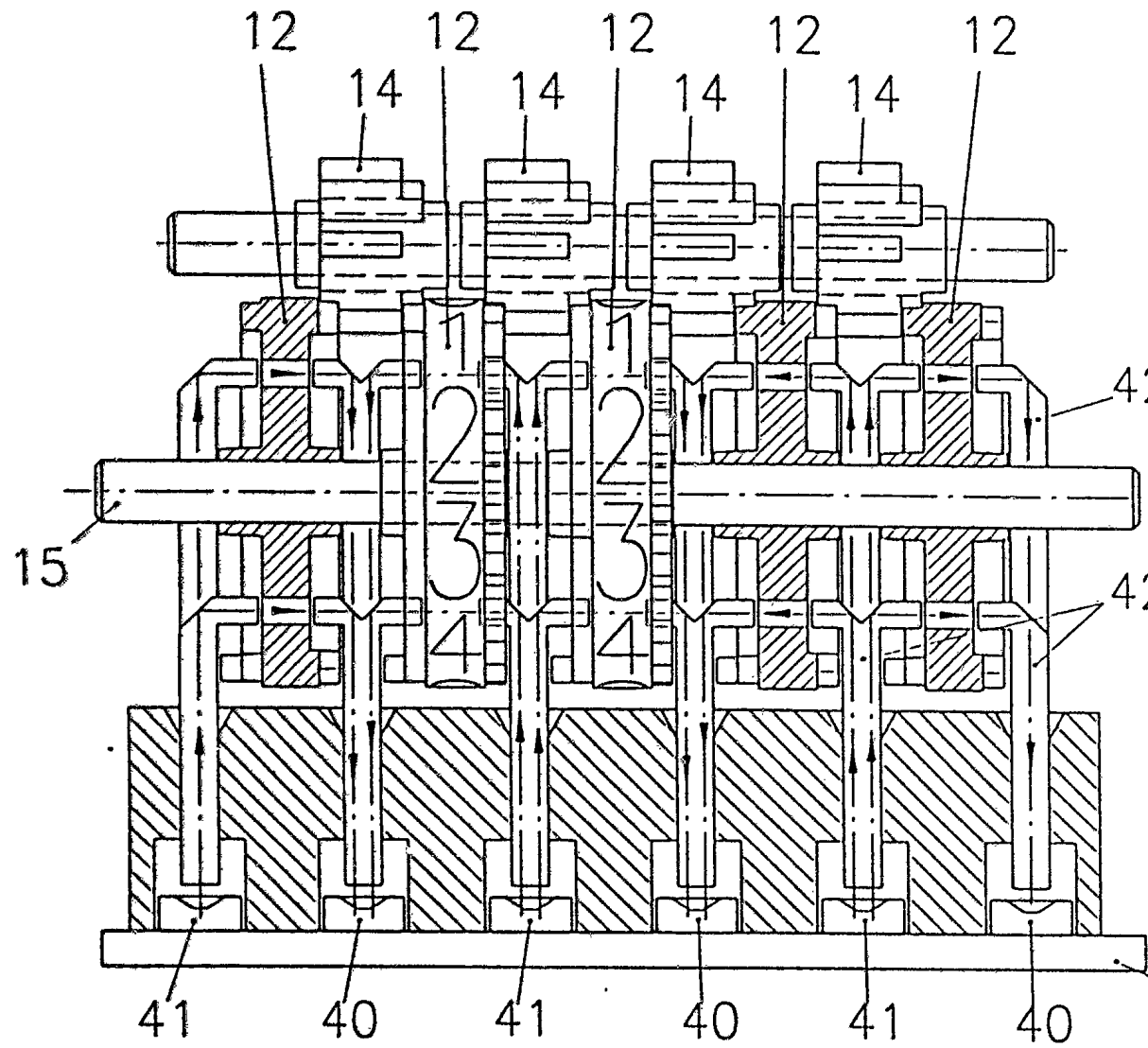


Fig. 4a

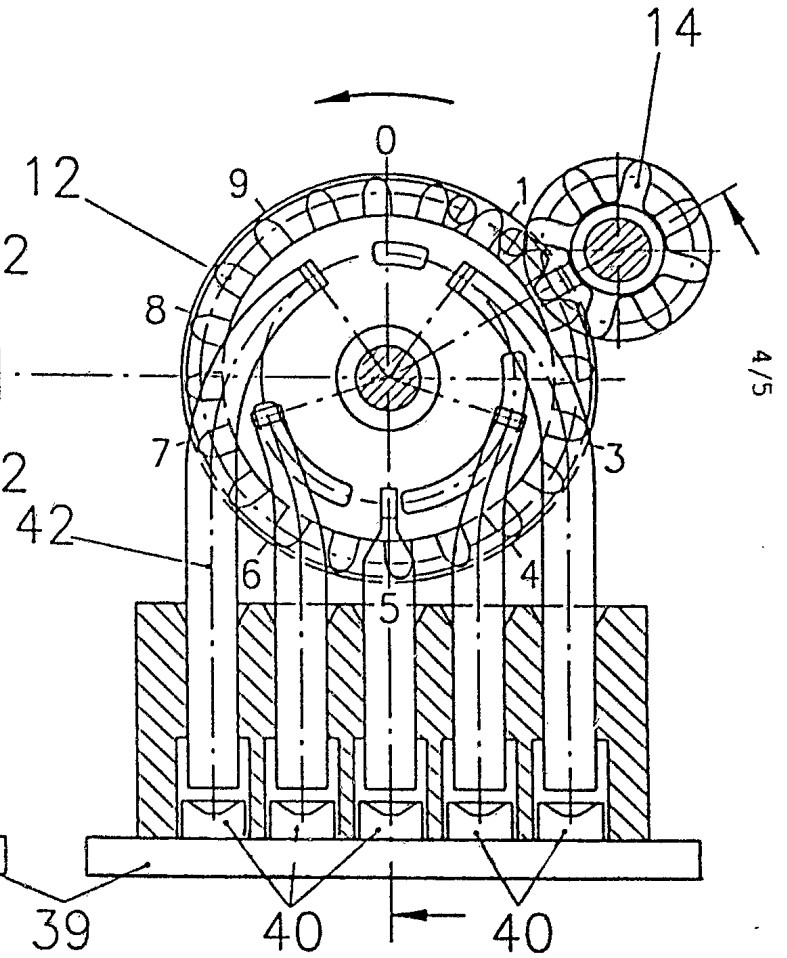


Fig. 4b

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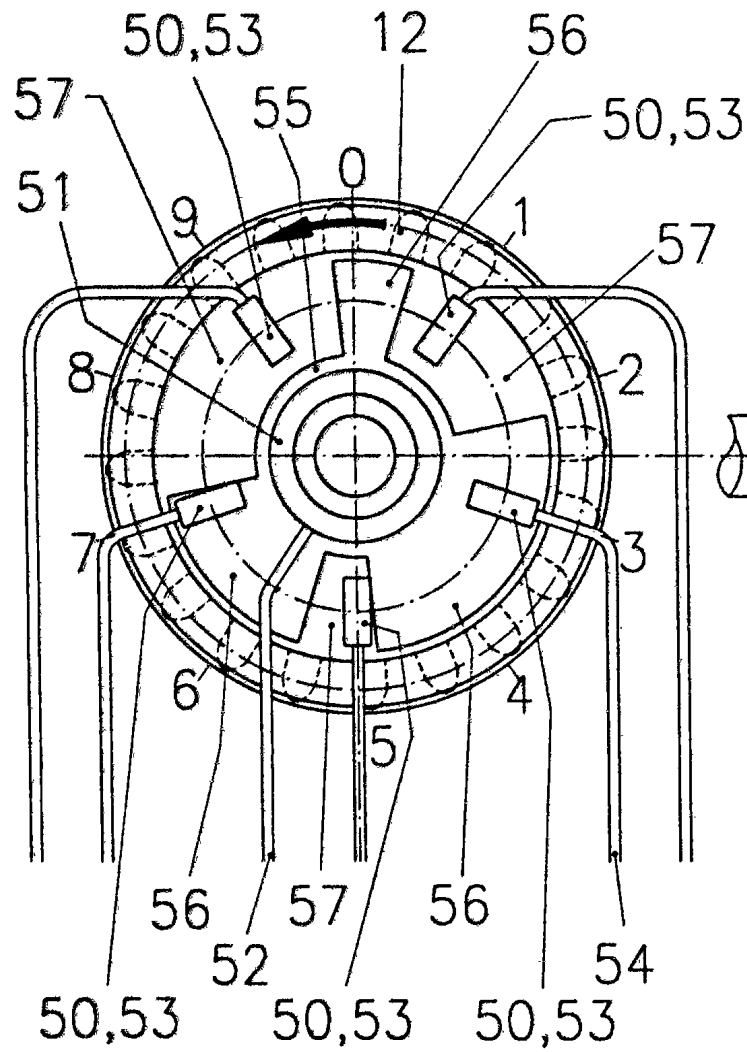


Fig. 5a

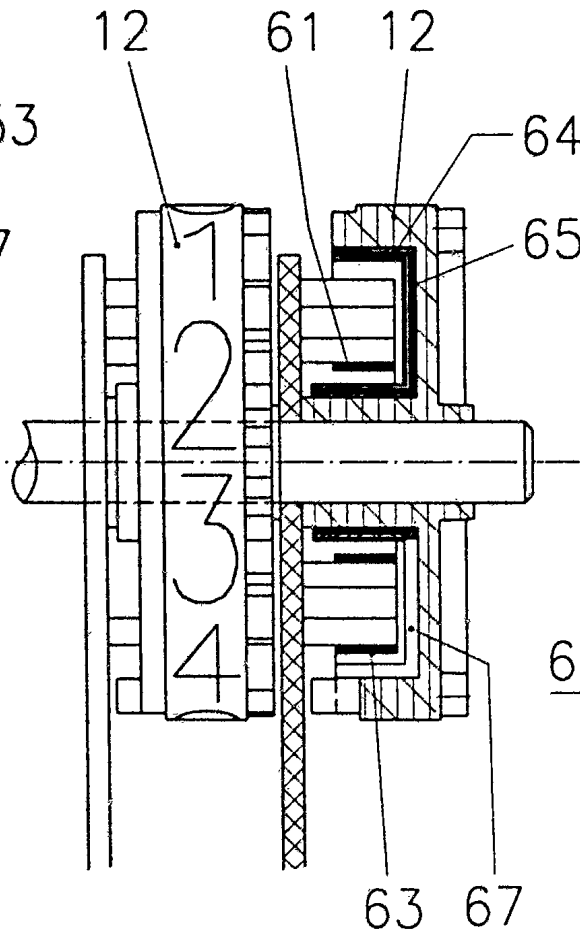


Fig. 5b

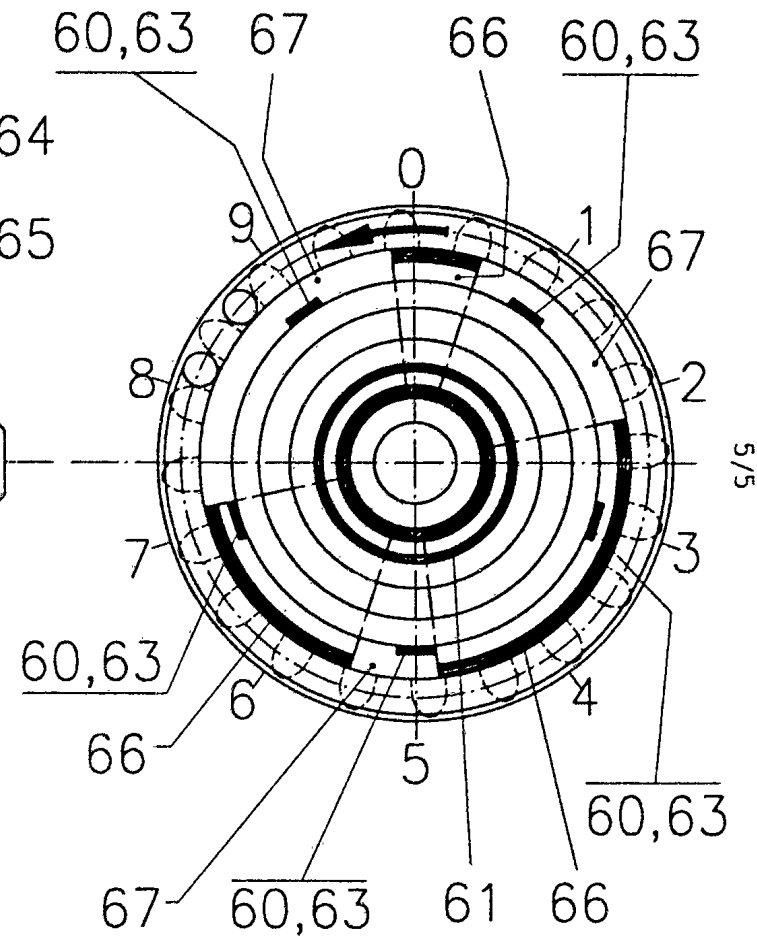


Fig. 5c

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