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Published:
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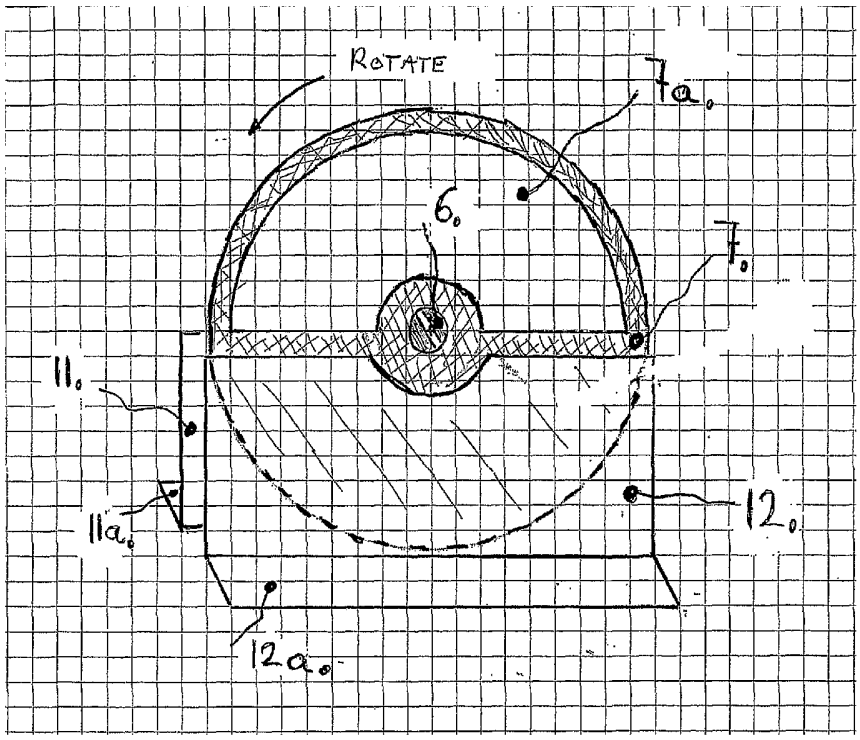
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** TUNABLE CAPACITORS



(57) **Abstract:** It is described a capacitor assembly comprising tunable capacitors where two or several fixed metal surfaces with any shape and mounting method, and one or several di electrical discs or tubes are inserted between the metal surfaces using a rotating movement.

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TUNABLE CAPACITORS

Coverage of the Invetion:

The applied invention concerns tunable capacitors used in almost all types of electronic equipment requiring tuning of capacity for a given purpose.

Technical Background:

Tunable capacitors are used in almost all electronic equipment that requires tuning of capacity in order to tune frequency or coupling factors.

Existing capacitors are based on the same principle design as the first tunable capacitors that were taken into use for approximately 100 years ago.
The first tunable capacitors were used in short wave band, i.e. low frequencies typical less than 30MHz and had large physical dimensions.
To-days requirements for tunable capacitors, facing the fact that higher and higher frequencies are taken into use, have made these components smaller in physical dimensions, but are still designed based on the same principle.

There are two main groups of tunable capacitors based on the same technique: Plate capacitors and Tube capacitors.
Plate capacitors consist of two or more plate elements whereby the plates slide between each other through a rotating movement of one of the set of plates with the other set of plates remaining fixed.
The dielectric material may be air or some other dielectric material that has a good high frequency response.

A sliding contact connects the rotating section of elements to the electric circuit. When this is rotated sufficient amount of times, it is worn and exposed to

oxidation, which results in instable contacts. The component become defective and requires replacement. To compensate for this gold connectors are often used, but the gold layer is often thin and is worn out by the repeated turns of the connectors.

Another problem is that this physical construction requires long connector leads which cause the component to change characteristic from capacitance to inductance when the frequency increases.
Another known problem is that tuning of the capacitors must be done with a non conducting tool.
The principle of the component construction causes limitations for use with high frequencies.

Tube capacitors are constructed such that a moving metal cylinder is inserted into a fixed metal cylinder. The di electrical material is either air or some other di electric material that has the same functionality as for plate capacitors. Tube capacitors have the same weaknesses as the plate capacitor described above.

Brief description of the Invention

The purpose of the present invention is to eliminate the above described problem areas for existing variable capacitors.

The invention consists of changes in the principle for construction of tunable capacitors. This is achieved by changing the construction of tunable capacitors as defined in the appended patent claim 1. several embodiments of the invention are possible, as covered in the appended patent claims 2-4.

Brief description of the drawings

The invention will now be described with reference to the appended drawings where:

Fig 1 shows the main principle of the invention, where the di electric material is inserted/moved between the conducting surfaces.

Fig 2 shows a tunable capacitor where a complete or half a disc is turned between the conducting surfaces. In the case of a complete disc, each half will have different di electrical constant.

Fig 3 shows a di electrical disc that is divided in two halves each with different di electrical constant.

Fig 4 shows a di electrical disc seen from a sideview.

Fig 5 shows the principle for a tunable tube capacitor.

Fig 6 shows a different shape of the principle for tunable tube capacitors.

Detailed description of the Invention

The invention solves the said problem areas as described in the technical background.

a) Wear and tear of slipring connectors is eliminated as the metal surfaces are fixed.
b) Serial inductance is reduced to the size of the metal surfaces which makes the invention suitable for very high frequencies.
c) Changing the amount of di electrical material causes the capacitor to be less affected by the tuning tool than existing components.

Fig. 1 shows the main principle of the invention. The capacitor consists of two conducting surfaces (11 and 12) with a given distance, and a di electrical material (7) between the conducting surfaces that have a given di electrical constant. The conducting surfaces (11 and 12) are fixed and the di electrical material (7) is inserted between the conducting surfaces.

The amount of di electrical material is changed by turning the disc eccentric up to 180 degrees around the shaft (6). The tuning changes the capacitance in the capacitor. The fixing of the shaft must be such that it provides sufficient friction in order to keep the di electrical material in position.

Fig. 2 shows a different principle for tuning the amount of di electric material (7 and 7a) between the conducting surfaces (11 and 12). The conducting surfaces are mounted directly on the PCB or similar using the pins (11a and 12a) to minimise serial inductance and for mounting the component. The pins (11 and 12a) may be replaced with alternative mounting devices that provide low serial inductance.

The di electrical material (7 and 7a) has different di electrical constant and the capacitance is tuned by rotating the disc up to 180 degrees using the tuning screw (6), where the fixing of the shaft must provide sufficient friction to keep the di electrical material in position.

Fig. 3 shows a disc divided into two halves with different di electrical material (7 and 7a) each having different di electrical constant. The disc is rotated up to 180 degrees around the shaft (6).

Fig. 4 shows a sideview of a disc containing two halves of di electrical material(7 and 7a), each having different di electrical constant. The disc is rotated

up to 180 degrees around the shaft (6) for tuning of the capacitance.

Fig. 5 shows the principle for a tunable tube capacitor. The fixed conducting surfaces (11 and 12) form part of a complete cylinder which is mounted directly to the PCB obtaining minimal serial inductance.

The di electrical material(7 and 7a) is shaped as a tube consisting of two of several areas with different di electrical constant, and placed between the conducting surfaces(11 and 12) and rotated up to 180 degrees using the tuning screw (6).

The di electrical material is rotated using the tuning screw (6) for tuning the capacitance, where the fixing of the shaft must be such that it provides sufficient friction in order to keep the di electrical material in position.

Fig. 6 shows another type of tube capacitor.
The capacitor consists of a outer metallic tube(11) with inner groves, a inner cylindrical conductor(12), a tube shaped di electrical material (7) with outer groves, a inner cavity(9) shaped to fit the metallic cylinder(12) and a mounting device (90) consisting of a non-conducting material with good high frequency quality.

The cylinders (11 and 12) is mounted directly to a surrounding circuit to minimise the serial inductance. The capacitance is changed by rotating the di electric material(7) with multiple turns using the turn slot(6). The amount of di electrical material (7) between the conducting surfaces(11 and 12) sets the capacitance.

Patent claim

1. Capacitor assembly comprising tunable capacitors c h a r a c t e r i z i e d i n that two or several fixed metal surfaces(11 and 12) with any shape and mounting method, and one or several di electrical discs(7) are inserted between the metal surfaces(11 and 12) using a rotating movement up to 180 degrees around an axis (6).

2. Capacitor assembly as claimed in claim 1, c h a r a c t e r i z i e d i n that the di electrical disc comprises two or several sectors with different di electrical constant, that is , rotated centric up to 180 degrees around an axis.

3. Capacitor assembly as claimed in claim 1, c h a r a c e r i z i e d in that the capacitor is a tube capacitor.

4. Capacitor assembly as claimed in claim 1, c h a r a c e r i z i e d in that the capacitor is a tube capacitor and the tuning mechanism is a di electrical screw where the tuning is done with multi turns.

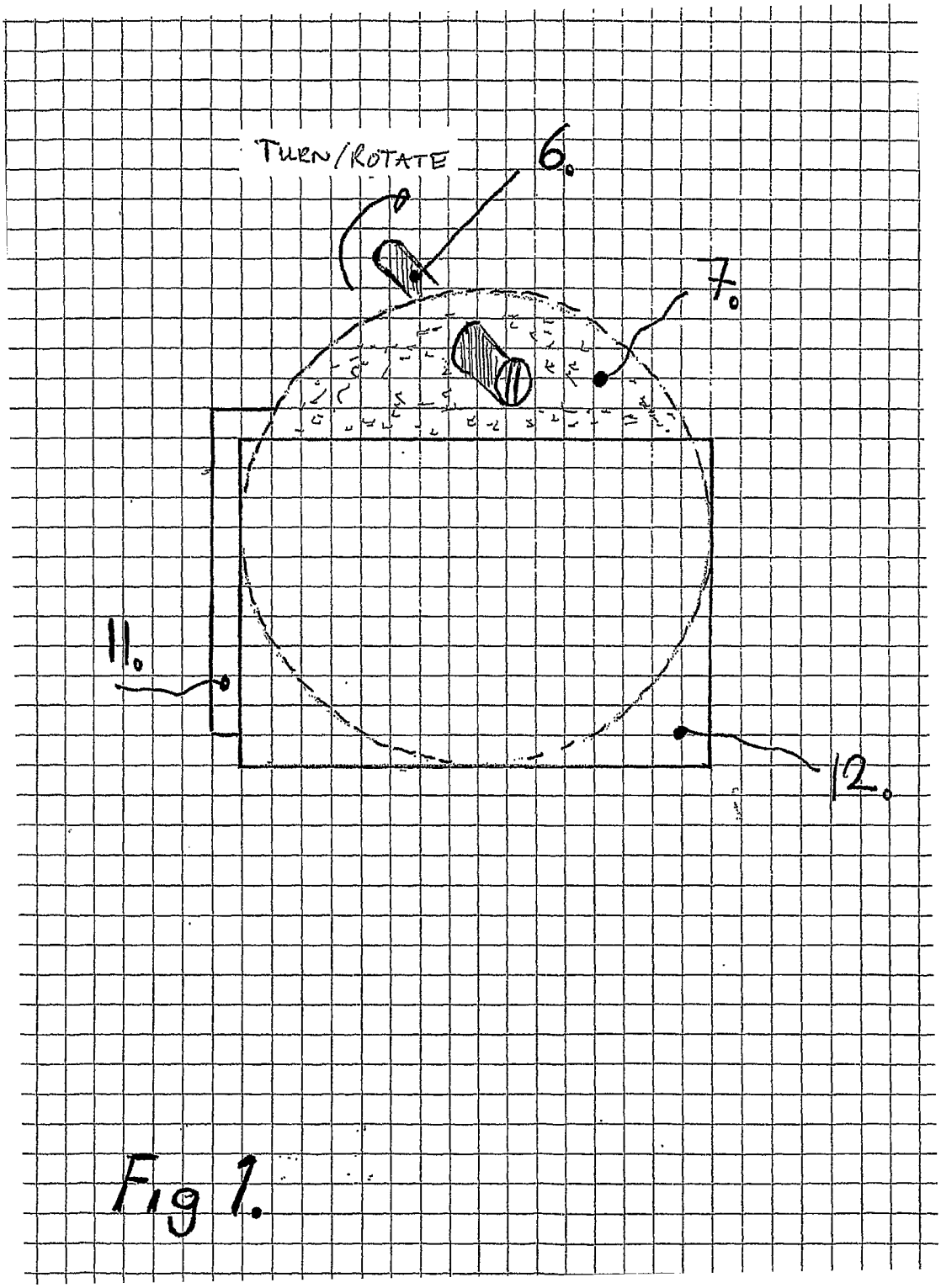

Fig 1.

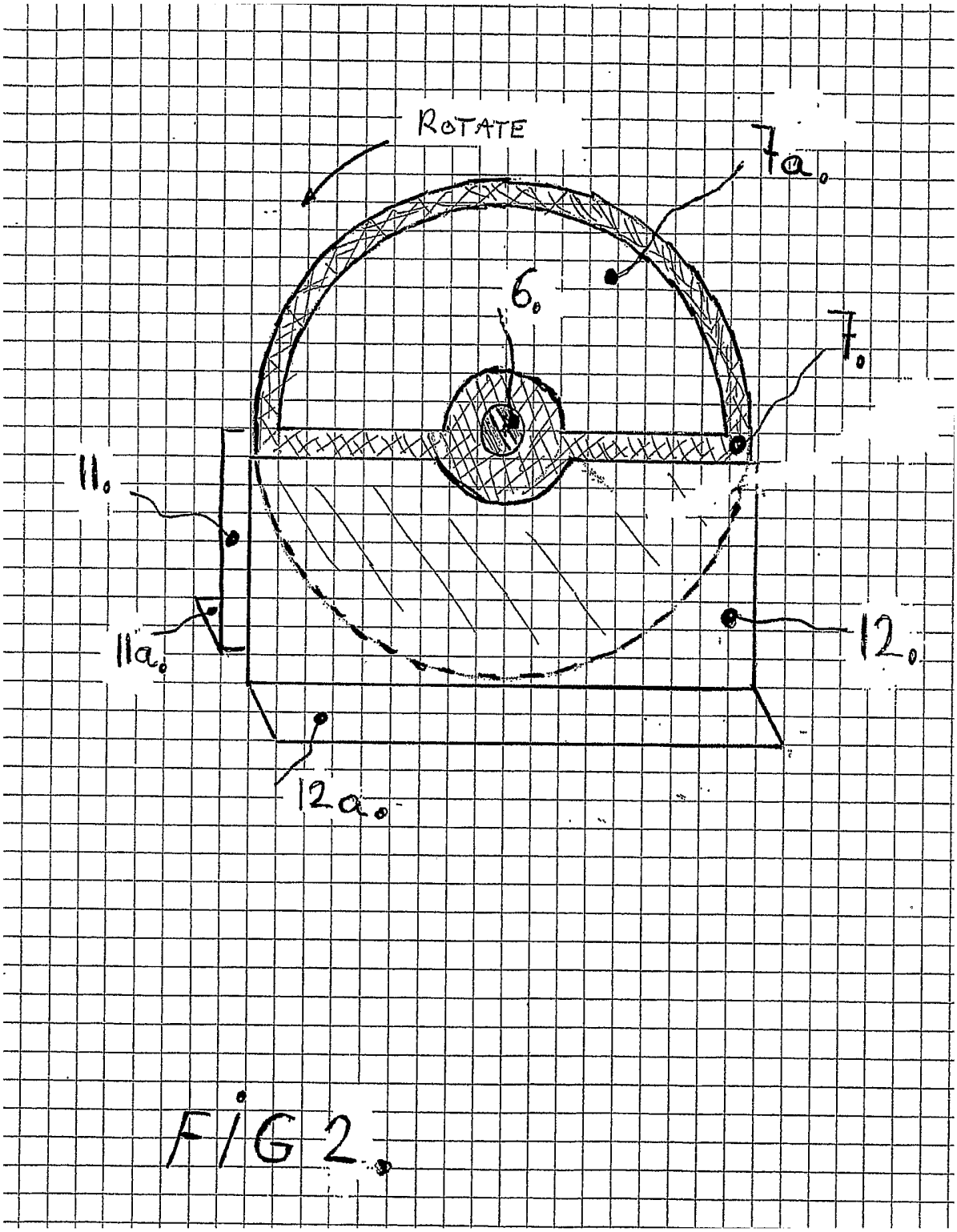

FIG 2.

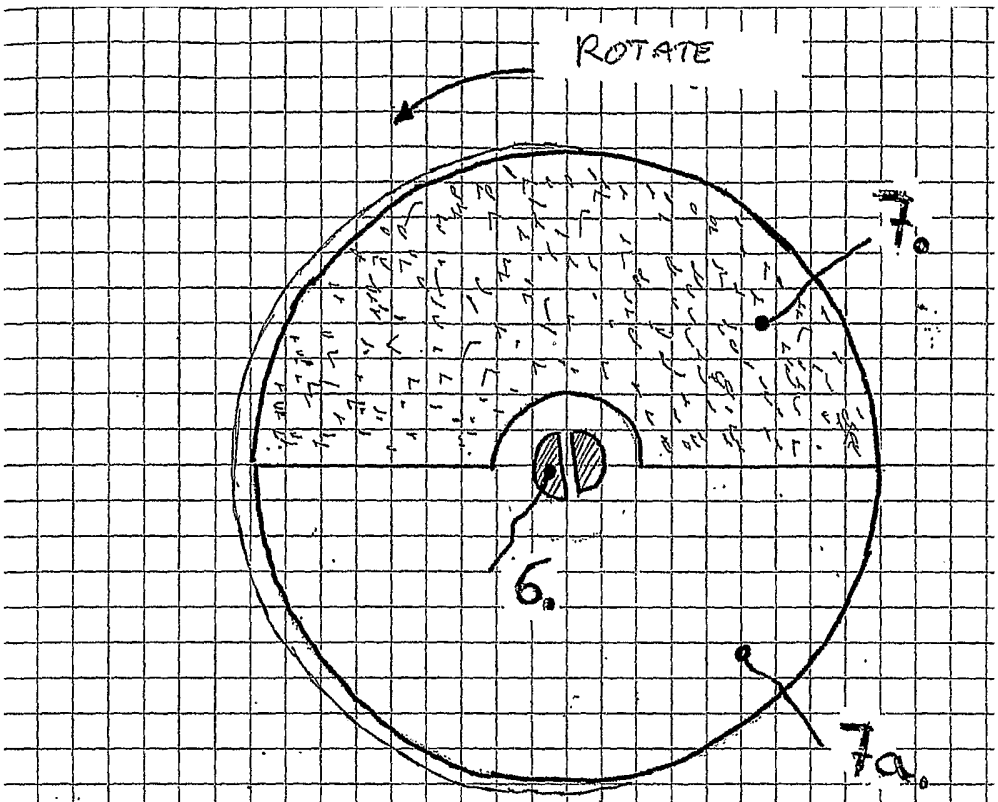

FIG 3.

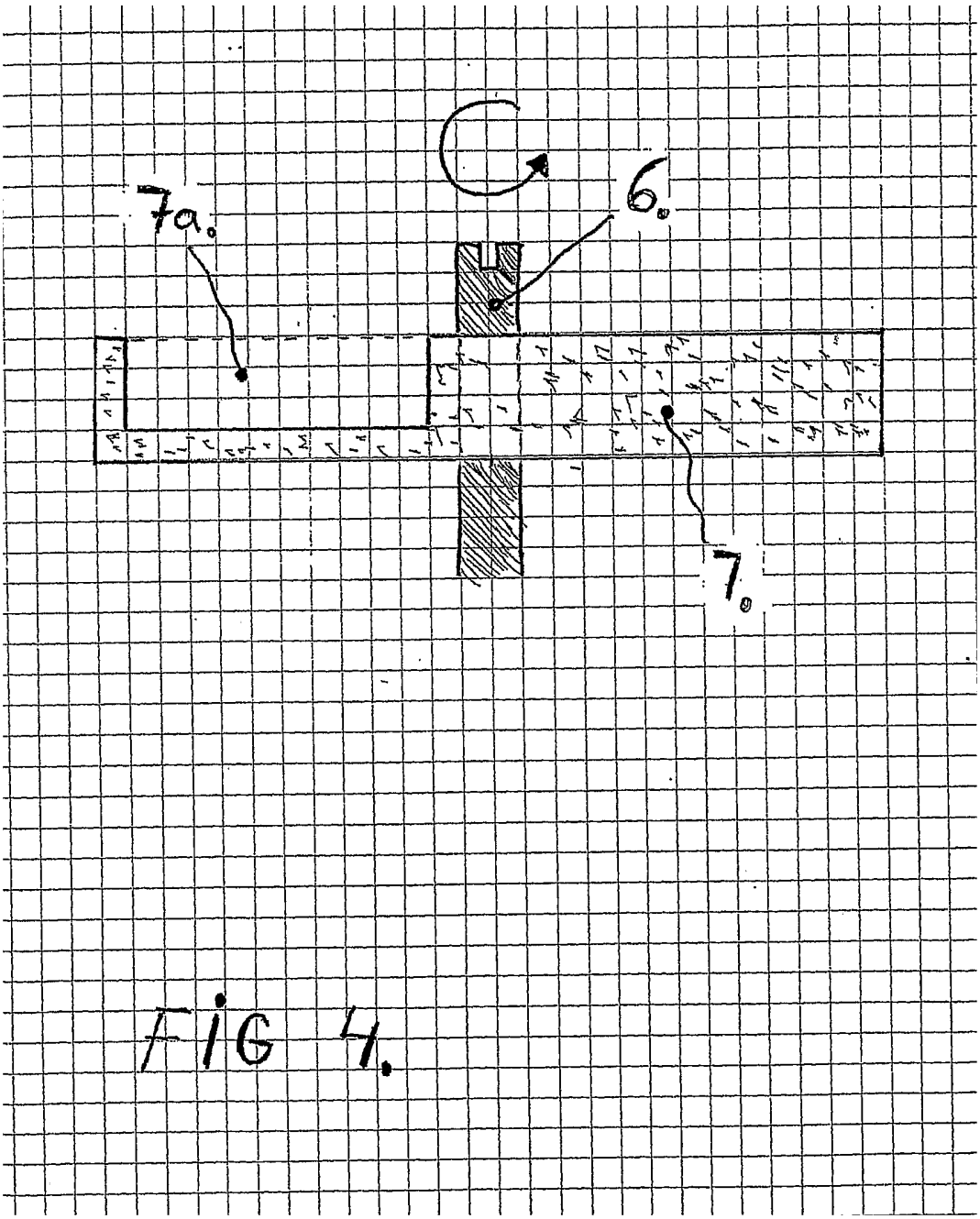

FIG 4.

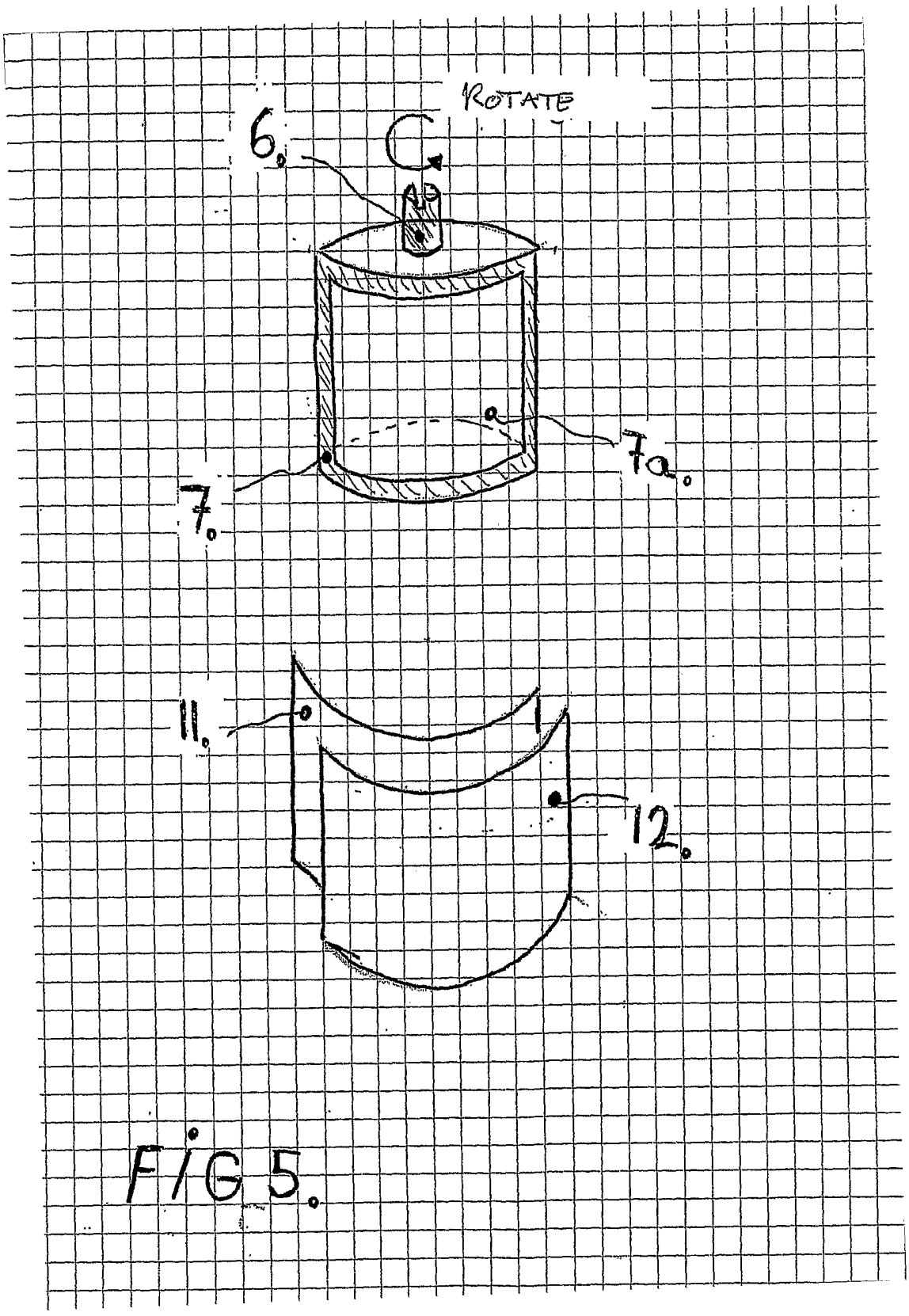

FIG 5.

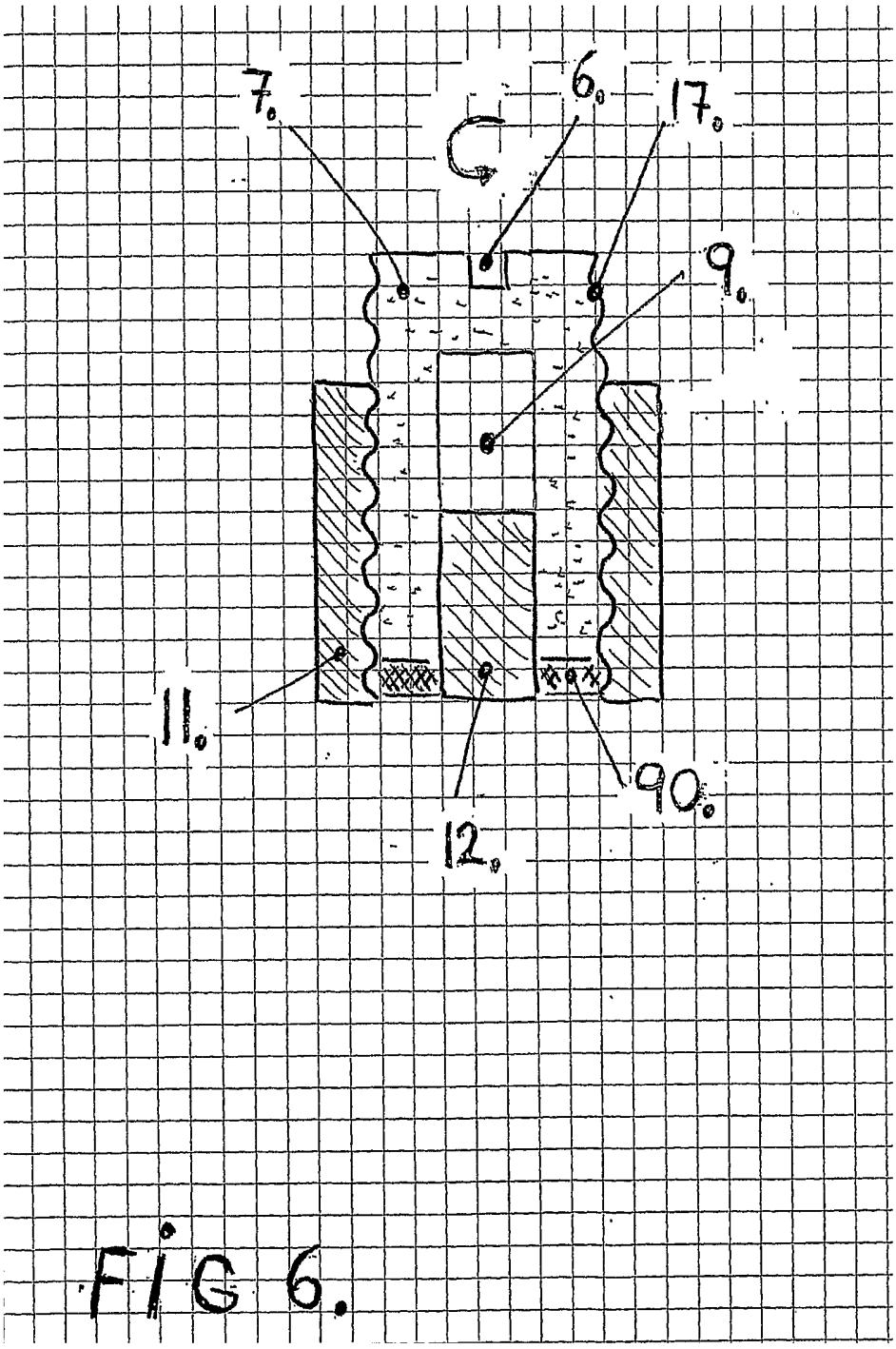

Fig 6.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2004/000112

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01G 5/06, H01G 5/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPO-INTERNAL, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1396703 A2 (DELPHI TECHNOLOGIES, INC.), 10 March 2004 (10.03.2004), figures 1,6,7, [0004]-[0018]	1-4
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X	SU 480123 (KAUSHANSKII E M), 5 August 1975 (05.08.1975), figure 1	1-4
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A	US 5099386 A (BRIAN P. STOKES ET AL), 24 March 1992 (24.03.1992), abstract	1-4
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 November 2004	25 -11- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Erik Miliander/MN Telephone No. +46 8 782 25 00

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EP	1396703	A2	10/03/2004	US	6774642 B	10/08/2004
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				US	20040085079 A	06/05/2004
SU	480123		05/08/1975	NONE		
US	5099386	A	24/03/1992	NONE		