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(71) Applicant and
(72) Inventor: **STOJANOVIC, Boban** [RS/RS]; Andje Rankovic 10/4/8, 35230 Cuprija (RS).

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(54) **Title**: HORIZONTAL CAPACITATIVE SENSOR

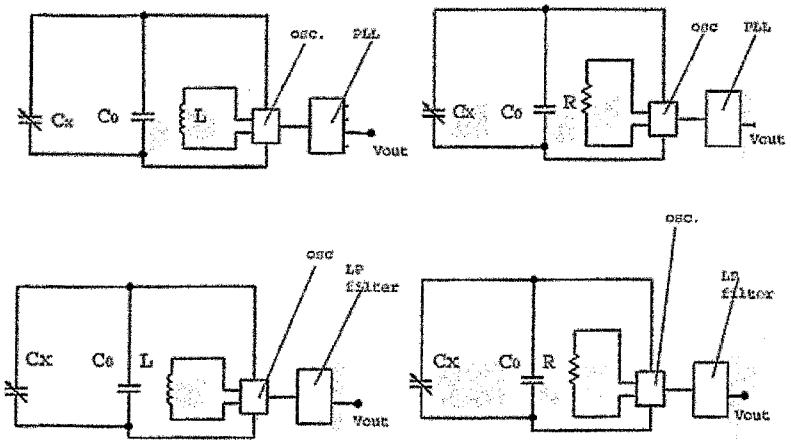

FIG 6

(57) **Abstract**: Horizontal capacitive sensor consists of two electrodes, which are in the same plane, and most often, are carried out on the printed plate as two surfaces of conductor. In case there is no object of detection and since the distance between the electrodes is relatively long, capacity that is made of electrodes approximately equals zero. Because the electrodes are extremely thin less than 0.1mm and the area between them relatively large about 1cm, the capacity which these electrodes make can be considered as 0. When there is no object the surface of the equivalent condenser is somewhere near 1cm therefore C, proportionally 0.0001 times dialectic air constant plus parasitive condenser made of two plates in the same plane which have isolator on one side (printed plate), and on the other thin varnish which coats conductor and the air picture 1 and picture2. When the object is near electrodes of size about 1cm and less it is formed between the first electrode E1 and the object condenser as between the body and the second electrode E2. Total capacity between E1 and E2 is in line connection of these two condensers. Since the surface between the electrodes and the object is now about 1 cm x 1 cm and the distance is 1cm, capacity of the equivalent condenser is proportional to 0.01 times dialectic air constant or some other isolator, in case electrodes are in an isolator. From the picture 1 it is seen that amplification of the capacity is about 100 times. The amplification can be even greater in case the distance between the object and electrodes is smaller, about lm m and in that case the amplification of

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the capacity is 1000 times. Equivalent capacity Cx is about 1 pF. That equivalent condenser is being connected to easily induced oscillator which oscillates with frequency proportional to 1/(R1 x Cx) or 1/(SQR(LCx)). Depending on frequency, the outlet capacity is logical 1 in picture 4 when the sensor is used as a switch, Vi analogue voltage when the sensor is used as a meter.

HORIZONTAL CAPACITATIVE SENSOR

TECHNICAL FIELD

The subject of the invention, generally observed, is belonging to the field of basic electric elements, namely to horizontal capacitive sensor which is used in electronic circuit arrangements for the detection of conductors, electrolytes as well for the detection of bad insulators which have certain conductivity on small distances.

Under International Patent Classification (Int.Cl.[8]), the subject of the invention is classified by basic classification symbol H01G 7/00 (2009.01) which relates to capacitors in which the capacitance is varied by non-mechanical means. Since the sensor according to the invention enable obtaining output voltages which may switch-on or switch-off devices connected to them, it may be classified by secondary classification symbol H01H 21/86 (2009.01) which relates to tapping keys.

TECHNICAL PROBLEM

Technical problem which has to be resolved by subject invention consists in structure of sensor with corresponding electronic arrangement intended for the detection if extremely low capacitance, which will be distinguished by its simplicity, effectively and reliability, which is nearby enough consistent, with a low manufacturing price and extremely low consumption so that may find a large applications in the protection of home appliances, in manufacture of toys, etc.

TECHNICAL BACKGROUND

Sensors are broadly used in the cases of general appliances, where nearby other usage are used as switches and tap keys. It is easy to be determined that there exist a large number of technical solutions for their realization, where are also used a different ways of their activation (by heat, mechanically, electromagnetically, by ionization, etc.). All sensors known to the author are technically rather complicated and as per a rule are used in devices which are manufactured in a considerable series therefore are reasonably expensive. Exactly these two elements were a reason to the author for his try to find a

new sensor which will depreciate manufacture, but without loses in its reliability and effectively to detect changes necessary to be registered. In his earlier solution disclosed in the Serbian patent application P 2006-0439, published as WO 2008/010739 A2 24.01.2008, under title MUSIC FOR CHILDREN'S EDUCATIONAL POTTY, also is described a sensor activated by change of the capacitance between the electrodes, but in this invention were found some imperfections wherefore the author has decided on new, more current but much reliable structure, for which, after careful search through patent documentation he found that it is new, because the search, within the professional literature and within patent documentation funds, has revealed that there do not exist technical solution relevant to the subject invention.

SUMMARY OF INVENTION

The substance of the invention is a capacitive sensor consisting of two electrodes realized on the printed chip, which electrodes are overlaid by lacquer and bonded in the corresponding electric circuit consisting of six NOT inverters, resistors R1 and R2 and capacitor C2, which are mutually connected so that in case that there is no object near the sensor the output is a logic 0, respectively when we have an object near the sensor the output will be logic 1.

Novelty of this invention is represented by sensor so structured that in the interdependence of the distance between the object and the sensor are formed two serial condensers which therefore are changing the electrode capacitiveness Cx of sensor, causing excitation of an easy actuating oscillator which will oscillate with frequency proportional to 1/(R1 x Cx) and, in dependence of frequency in the corresponding electronic arrangement is formed an output voltage Vi which is used as a switch or as a tap key.

BRIEF DESCRIPTION OF DRAWINGS

For better understanding of the invention, as well for showing its practical embodiment, author refers, only for a way of an example, to the enclosed drawings related to the subject application, where:

Fig. 1 represent the outlook of the subject sensor

Fig. 2 represent the cross-sectional view of the sensor

Fig. 3 represent the cross-sectional view for bed conductors

Fig. 4 represent electric scheme of the subject sensor as tap key

Fig.5 represent electric scheme of the subject sensor as meter

Fig. 6 represent the flowchart of the subject sensor

DISCLOSURE OF THE INVENTION

Horizontal capacitive sensor consists of two electrodes that flush and is most often carried out on the printed plate as two surfaces of the conductor. In case there is no object of detection and since the distance between the electrodes is relatively long, the capacity consisted of the electrodes approximately equals zero. Because the electrodes are extremely thin, thinner than 0.1mm, and the distance between them relatively long, about 1cm, the capacity made by the electrodes can be considered as zero.

In case there is no object, the surface of the equivalent condenser is 0.1mm x 1 cm, and space between electrodes 1cm, therefore C, proportionally 0.0001 times dielectric air constant plus parasitive condenser made of two plates that flush which on one side have isolator (printed plate) and on the other thin varnish that coats the conductor and the air Picture 1 and picture 2. When the object is near the electrodes of about 1cm and less, it is formed between the first electrode E1, the object condenser, also the body, and the other electrode

Total capacity between E1 and E2 is in line connection of two condensers. Since the area between the electrodes and the object is now 1cm x 1cm, and the distance is 1cm, capacity of the equivalent condenser is proportional to 0.01 dielectric air constant or some other insulator in case electrodes are in an insulator.

In the Picture 1 you can see that the accretion of the capacity is a hundred times. The accretion can be higher if the distance between the object and the electrodes is smaller about 1mm, then the accretion of the capacity is 1000 times.

Equivalent capacity Cx is somewhere 1pF. That equivalent condenser is connected to the easily inducing oscillator which oscillates with a frequentation proportional to 1/(R1 x Cx) or 1/(SQR(LCx)). Depending on the frequency, the output voltage is log on 1 in the picture 4 when the sensor is used as a switch, Vi analogue voltage when the sensor is

used as a meter. Depending on the configuration of the circuit, Horizontal capacitive sensor is consisted of a parasitive condenser Co which in case of oscillating oscillator (6) gives some f max frequency and when the capacity emerges gives some frequency which is in range NF filter or PLL and in that way gives proportional capacity.

In the picture 1 you can see the outlook of the sensor in space above which is placed an object. In the picture a1 is the width of the first electrode E1, a3 the width of the second electrode E2, a2 distance between the electrodes, b the length of electrodes, c thickness of the carrying insulator. Horizontal capacitive sensor is described with: c- (thickness of the printed plate) about 1mm, d- thickness of the electrode from the conductor) copper on the printed plate 0.1mm, e-thin varnish which coats electrodes 0.1mm. the thickness of the conductor c and carrying insulator –d do not influence substantially on the operating of sensor. Object O can be conductor, electrolyte-liquid or bad isolator.

In picture 2 you can see cross-sectional cut of the sensor whereas the L is the distance between the object and electrodes, which is for the electrodes 1cm or less.

In picture 3 you can see the cross-sectional cut of sensor for bad isolator whereas L is the distance between object and electrodes for conductors about 0.5 cm, and for bad isolators 1m m and less(human body, wood, ceramics and the like) and (various salts as kitchen salt NaCl- which changes its conduction depending on moisture and the like). Sensor does not detect thin plastic, glass, air and low specific transparency materials with different dialectic constant from the air. Sensor detects thicker plastic depending on geometry and size.

Picture 4 shows electric scheme of the device as a tap key. E1 electrode Cx is connected to the input of NOT1 inverter and R1 resistor. The output of the NOT1 is connected to the input of the input NOT2 and Rc. The output of the NOT2 is connected to the input of NOT3 and the electrode E2 of the condenser Cx. The output of the NOT3is connected to the other end of the resistor R1. NOT1,NOT2,NOT3 are also inverters and with the R1 and Cx make astabile multivibrator which oscillates with a period proportional 1/R1Cx. Logic circuits of all CMOS series, which have enough amplification in transitional mode between logical levels, can be used as inverters. Resistor R2 and condenser C2 with inverter NOT4 make an integrator or NF filter. The output of the R2 is connected to the input of the NOT4 and the condenser C2. The other end of the condenser C2 is connected

to the output of the inverter NOT4 and to the input of the Not5. NOT5 and NOT6 are inline connected and serve as an amplifier so that there is a logic 0 or logic 1 at the end of the circuit. When there is no object O, it's logic 0 at the input and when an object emerges Cx rises and oscillator starts to oscillate thereby if the period of oscillation is less than pass band of the integrator of NF filter of size range 1\RC at the end is logic 1. In case there is no capacity or it is too small, oscillator oscillates with a high frequency however; such signal does not pass through NF filter.

Picture 5 shows electric scheme of the device as a meter .Electrode Cx is connected to the input of the NOT1 inverter and PLL input of phase-controlled loop. The output of the NOT1 is connected to the NOT2 input and Rc. NOT2 output is connected to the NOT3 input and electrode e2 of the condenser Cx. The output of the NOT3 is connected to the other end of resistor R1. NOT1,NOT2, NOT3 are inverters and with R1 and Cx make astabile multivibrator which oscillates with a period proportional to 1/R1Cx. Logical circuits of all CMOS series, which have enough amplification in transitional mode between logic levels, can be used as inverters. Central frequency of PLL loop f is set to be in rang of 1/R1Cx therefore at the output of the PLL loop it would be from 0 to Vcc. Change in oscillation frequency of the astabile multivibrator caused by change in capacity Cx, changes the output voltage Vi at the output of PLL loop.

INDUSTRIAL OR ANOTHER USE OF INVENTION

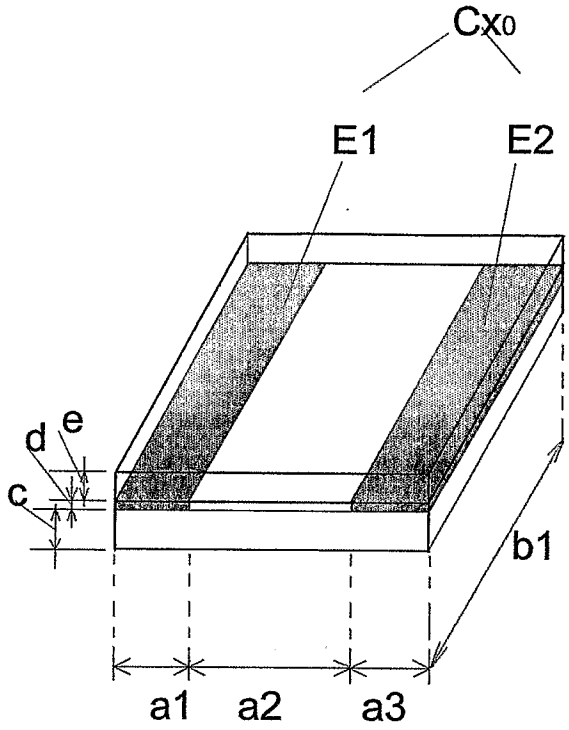
Industrial manufacture of the subject invention is entirely possible in electronic workshops based on technical documentation which the persons skilled in the art may easy to prepare using the specification and drawings disclosed in the subject application.

The invention is also suitable for mass production in series and tests made on prototypes have shown great rationality in using the subject sensor in home appliances, toys etc.

Boban STOJANOVIĆ

CLAIMS

1. Horizontal capacitive sensor Cx (1) is **characterized by** the fact it consists of two plate shaped electrodes E1 and E2, which are not parallel but in the same plane that without the object O(1) have minimal capacity, and with the object O(2) give certain capacity which induces astabile multivibrator (4) which generates fixed (4) or univocal voltage Vi (5).
2. Horizontal capacitive sensor Cx (1) is **characterized by** the fact it detects object from the conductor (2) at distance at which the effective capacity Cx is sufficient to induce oscillator by which it makes in line condenser Cx (2) that induces oscillator(6)(4)(5) and gives certain voltage Vi.
3. Horizontal capacitive sensor is **characterized by**the fact that it detects object O from isolator made of wood, plastic, ceramics, human body.(3) at distance at which the effective capacity Cx is sufficient to induce the oscillator by which it makes in line condenser Cx (2) which induces oscillator (6)(4)(5) and thereby it gives certain voltage Vi.
4. Horizontal capacitive sensor Cx (3) is **characterized by**the fact it detects object and at the output it gives fixed voltage when used as a switch.
5. Horizontal capacitive sensor Cx (3) is **characterized by**that it detects object and at the outlet it gives variable voltage in case a change of frequency is detected.



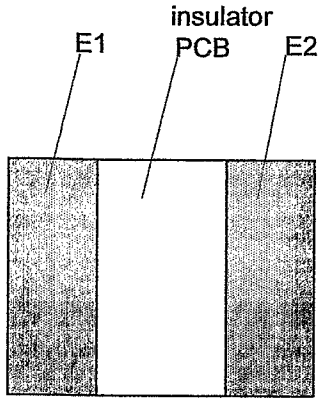


FIG 1

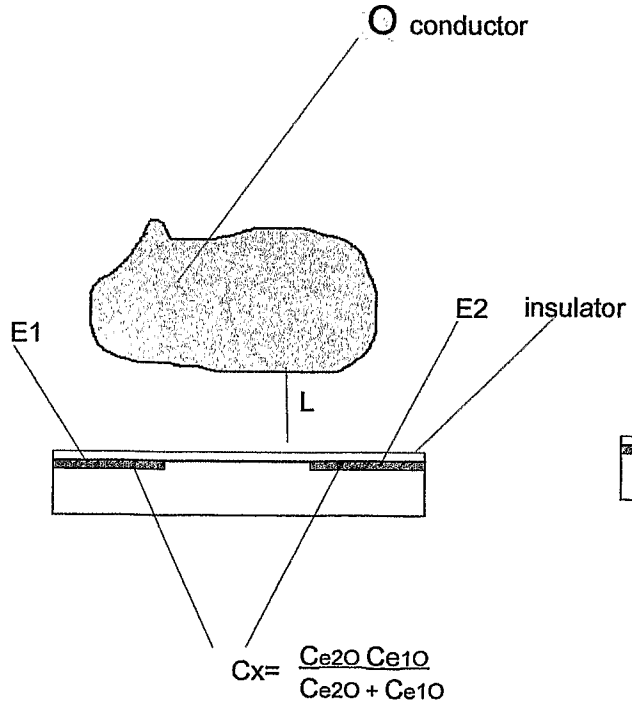


FIG 2

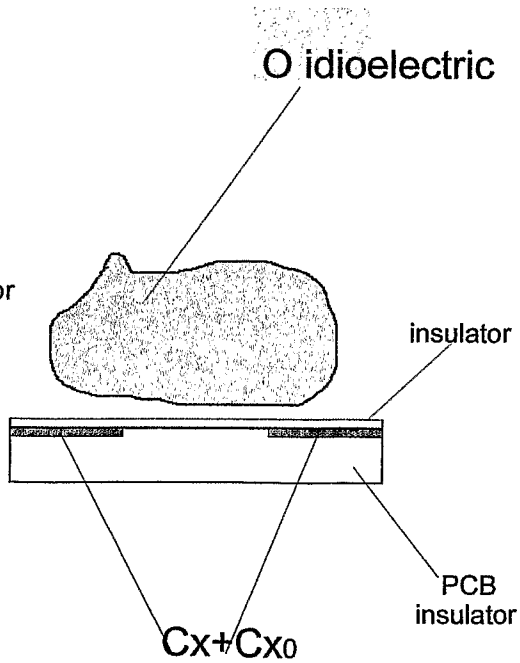


FIG 3

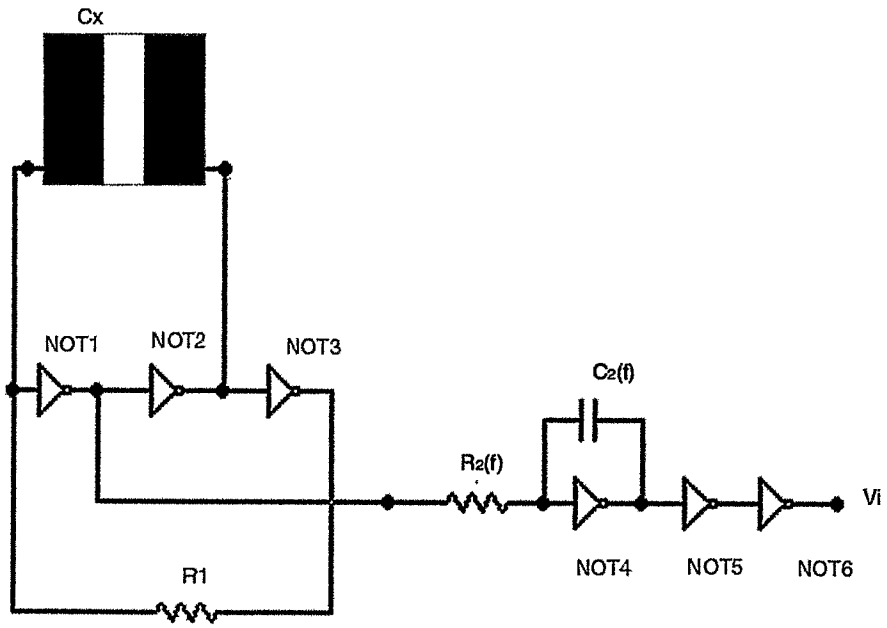
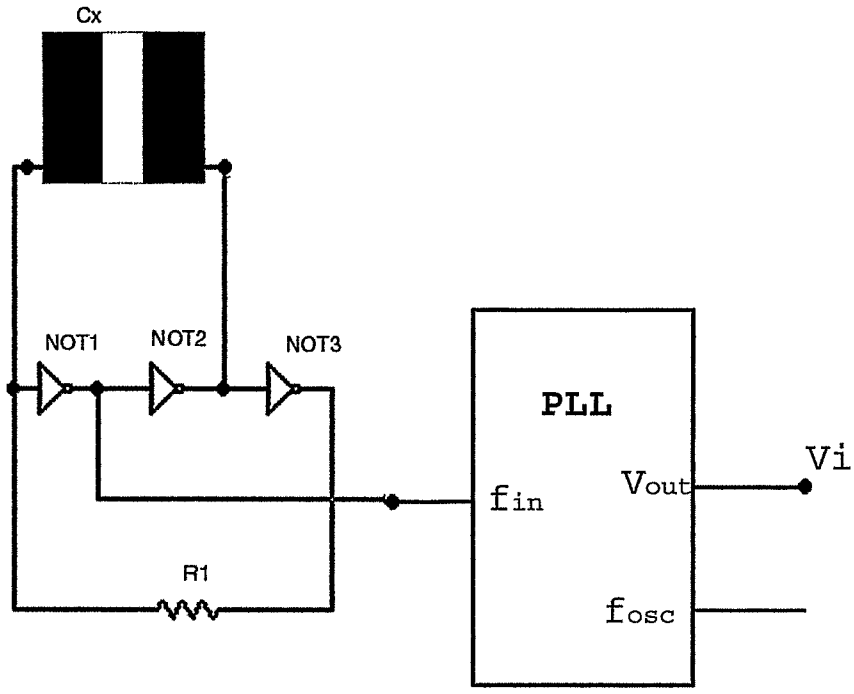


FIG 4



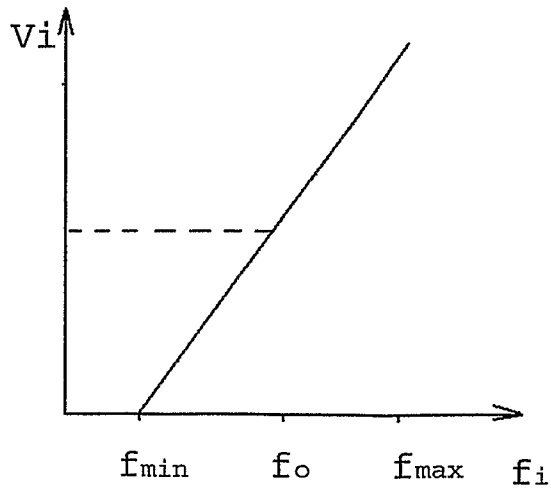


FIG 5

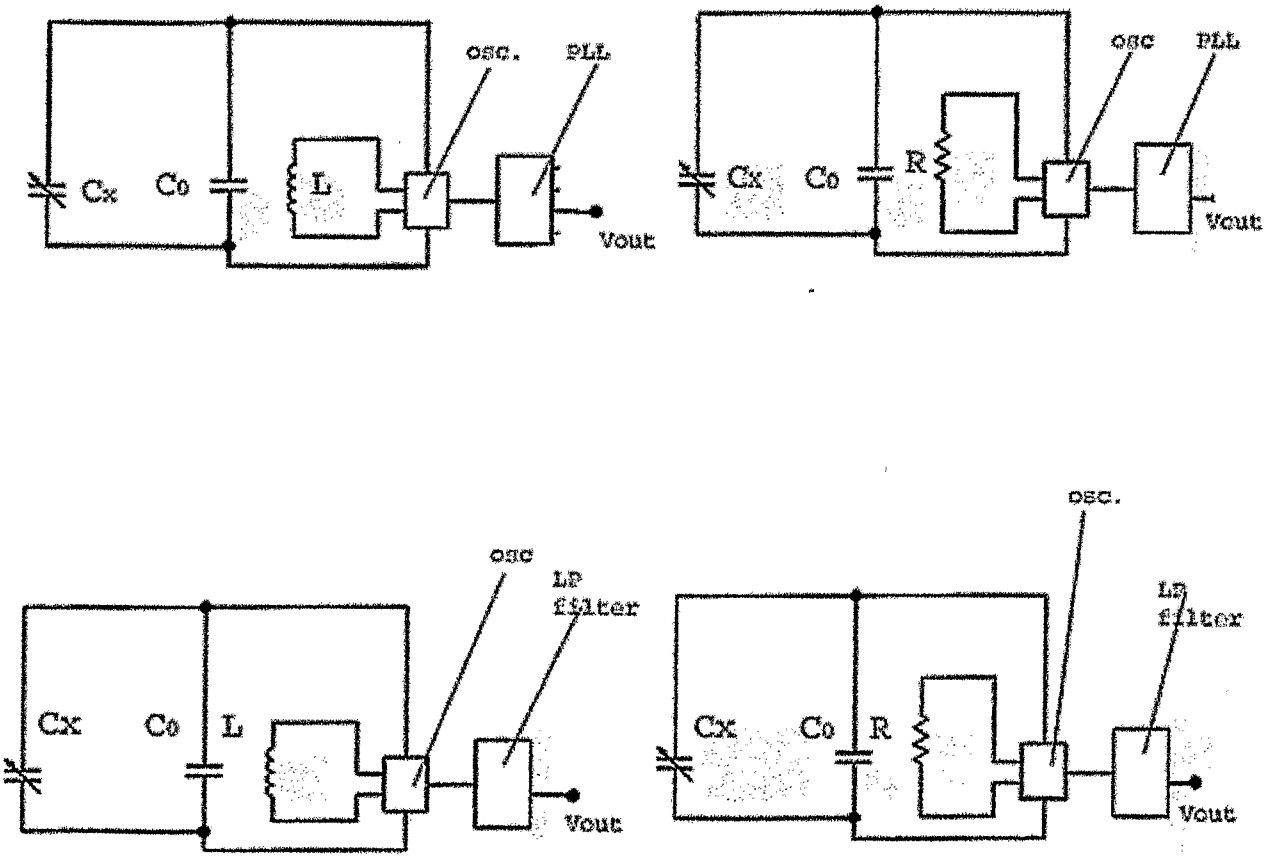

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FIG 6