

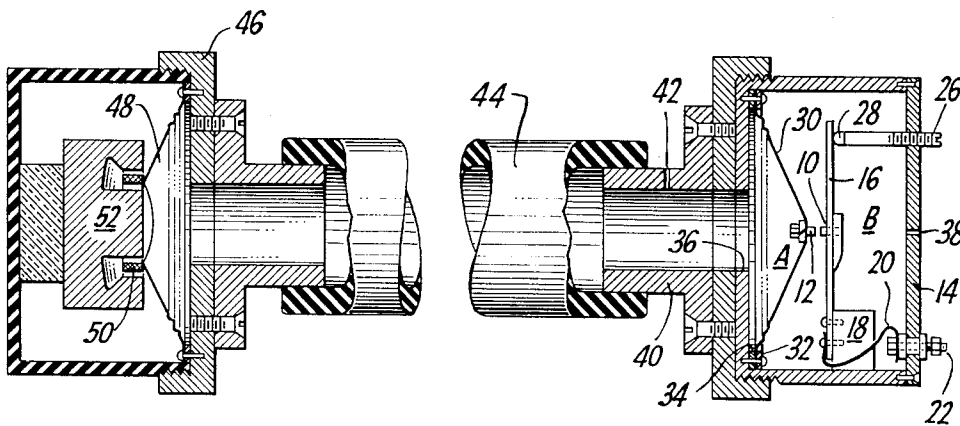
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CHOPPER

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CHOPPER

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1

The present invention relates to choppers, switching devices intended for interrupting the flow of current of low level, as is required in the amplification thereof to a more readily useful level. Usually the current is direct, or it may be slowly varying or alternating current that is herein treated as direct current because the rate of variation is so low as to require conversion to interrupted or alternating current of a frequency high enough to be readily amplified.

The need for measuring very low voltages is met in various types of test and control equipment. Some form of circuit interrupter or chopper is commonly connected to the source of voltage to be measured, enabling the use of an amplifier designed for alternating current or interrupted unidirectional signals. Commutators and vibrating contacts have been used for this purpose. For especially low-level measurements, however, disturbances or "noise" of uncertain character are introduced. An object of this invention is to enable the utilization of particularly small voltages by a chopper of reduced noise characteristics.

I have considered a factor in the noise to be the result of motion of chopper parts, through the earth's magnetic field and through stray magnetic fields such as those set up by the chopper-driving means itself. Spurious potentials, induced by motion of the contacts and metallic contact-supporting and circuit structures through the ambient magnetic field are eliminated in the embodiment described in detail below by enclosing the moving metallic parts in a shield of magnetic material.

Stray fields are inherently associated with the actuator, whether electro-mechanical or even purely mechanical. I have found the proximity of the actuator to the chopper contacts to be a significant cause of noise. The embodiment below employs a nonmetallic transmission between the actuator and the movable contact. Advantageously a fluid line where only the fluid moves in the vicinity of the contacts is used, having particularly low inertia and a negligible dielectric constant in the case of air, and being generally free of mechanical transient vibration effects inherent with solid transmission links.

An illustrative form of the invention is shown in the single figure of the accompanying drawing. Contacts 10 and 12 of silver or other low contact-resistance metal are enclosed in a case or shielding structure 14 of magnetic and electrically conductive material, conveniently soft iron that is solid or laminated. Stray varying

2

magnetic fields will harmlessly induce currents in the case; and ambient magnetic fields will be shunted about the contacts to be ineffectual in respect to the contacts when in motion. Contact 10 is carried on a metal arm 16 supported by insulating block 18, and has a lead 20 to external terminal 22 that extends through insulating bushing 24 in a small hole in the case. Adjusting screw 26, having a tip 28 of insulating material, enables convenient setting of stationary contact 10 from outside the case. Arm 16 is of leaf-spring stock as of beryllium copper, and is biased against screw tip 28.

Movable contact 12 is at once supported by diaphragm 30 and electrically connected by that diaphragm to the shielding structure 14 which thus constitutes the second terminal of the device. The diaphragm is secured by clamping ring 32 and spacing ring 34 in an air-tight connection to the inside of the shielding structure, opposite aperture 36 therein. The diaphragm thus divides the shielding structure into two compartments A and B. Pressure against the diaphragm applied via aperture 36 in the shield tends to compress the air in compartment B. The pressure changes that are gradual, over a long period, can be minimized by an appropriately small hole 38, communicating to the atmosphere. The confined space is of advantage due to the elasticity of the air that facilitates high chopping rates.

A cap 40 as of aluminum is secured to the iron case 14. Cap 40 has a small hole 42 bored through it. This hole and hole 38 tend to prevent the build-up of unbalanced pressures on the diaphragm that might keep the contacts permanently open or closed.

A line of tubing 44 (of metal or insulation) provides a confined air passage through aperture 36 for a column of air to operate or drive the diaphragm in a vibratory motion. The air column is energized by actuator 46 that takes the form of a moving-coil speaker having a diaphragm that is of the same air-tight construction as diaphragm 30. Actuator 46 includes coil 50 on the diaphragm and stationary permanent magnet 52, and is energized from an alternating current source (not shown) of frequency corresponding to the desired chopping frequency. One thousand cycles per second is illustrative. This particular type of actuator is effective in both strokes, toward and away from circuit-closing position. Because it does not require a stiff spring for a return stroke, the amount of energy required is comparatively small, and the actua-

3

tor can consequently be of small, light-weight construction. By using an air line, the actuator can be mounted in any desired position almost without regard to a particular position of the contacts that may be required. The form of actuator shown is distinctly superior to usual rotary electric motors and ordinary buzzers in that the operating frequency can be regulated over a very wide range to meet diversified installation requirements.

The air column in tube 44 may be replaced by a liquid, in which case hole 42 would not be provided. Other changes in detail will no doubt occur to those skilled in the art, as will other applications of the novel device. Consequently it is appropriate that the appended claims be accorded that broad interpretation that is consistent with the spirit and scope of the invention.

What is claimed is:

1. A chopper for converting direct current of low level into intermittent current to facilitate amplification, including a stationary contact and a movably mounted contact, a shielding structure of magnetic material substantially enclosing said contacts, an electromechanical vibratory actuating device external of said shielding structure, and means transmitting actuating stress from said actuating device to said movably mounted contact, said means including electrical insulating material penetrating said shield.

2. A chopper for converting direct current of low level into intermittent current to facilitate amplification, including a stationary contact and a movable contact, a shielding structure of magnetic material substantially enclosing said contacts but provided with an aperture, an electromechanical vibrator external of said shield, and an air-tight diaphragm carrying said movable contact and dividing said shielding structure into two compartments one of which communicates to said aperture, the other of said compartments having a fluid pressure transmitting line connected to said vibrator.

3. A chopper for converting direct current of low level into intermittent current to facilitate amplification including a pair of relatively movable contacts, an electromechanical vibratory actuator, a tube providing a fluid transmission column interposed between said actuator and said contacts for providing mechanical connection while affording electro-magnetic isolation of the contacts from the vibratory actuator, and a shield of magnetic material penetrated by the fluid transmission column substantially enclosing said contacts, said vibratory actuator being positioned external of said magnetic shield.

4

4. A circuit interrupter including a shield of magnetic material, a pair of contacts enclosed in said shield, one of said contacts being movable in relation to the other, said one contact being supported by a diaphragm, a length of tubing having one end fluid-coupled to said diaphragm, a second diaphragm fluid-coupled to the opposite end of said tubing, a coil attached to said second diaphragm, and means for establishing a constant magnetic field for said coil, said tubing, said coil, said second diaphragm and said magnetic field means being situated external of said magnetic shield, whereby electrical excitation of said coil at any desired frequency will operate said contacts via the electrically isolating fluid coupling afforded by said diaphragms and said tubing, and whereby said moving contact is protected against induction of spurious potentials therein while in motion which would otherwise occur due to the ambient magnetic field including that produced by the coil and the magnetic field means.

5. A chopper for converting direct current of low level into intermittent current to facilitate amplification, including a pair of switch contacts, an electromechanical vibrator, a magnetic shield enclosing said switch contacts but excluding said vibrator, and vibration transmission means interconnecting said vibrator and one of said switch contacts and reciprocally penetrating said shield, said transmission means including an electrical insulating portion between said vibrator and said one switch contact.

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