

Dec. 5, 1961

J. A. BARING ET AL

3,012,157

RATE OF CHANGE AND INCREMENTAL CHANGE ALARM

Filed March 25, 1959

2 Sheets-Sheet 1

FIG. 1

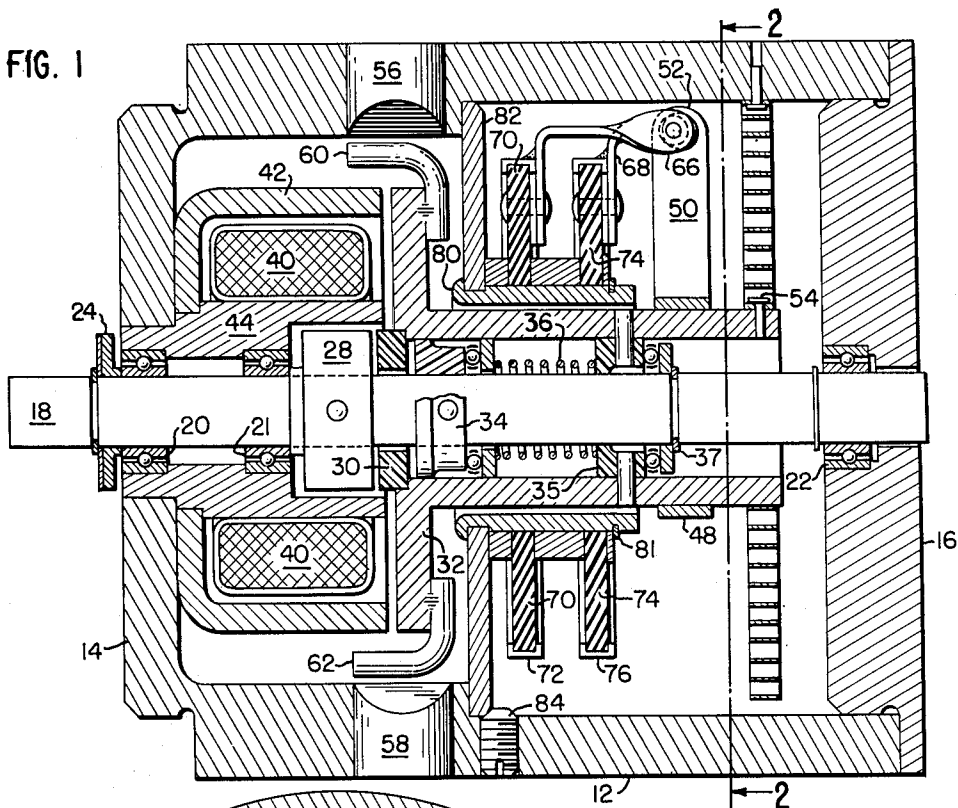
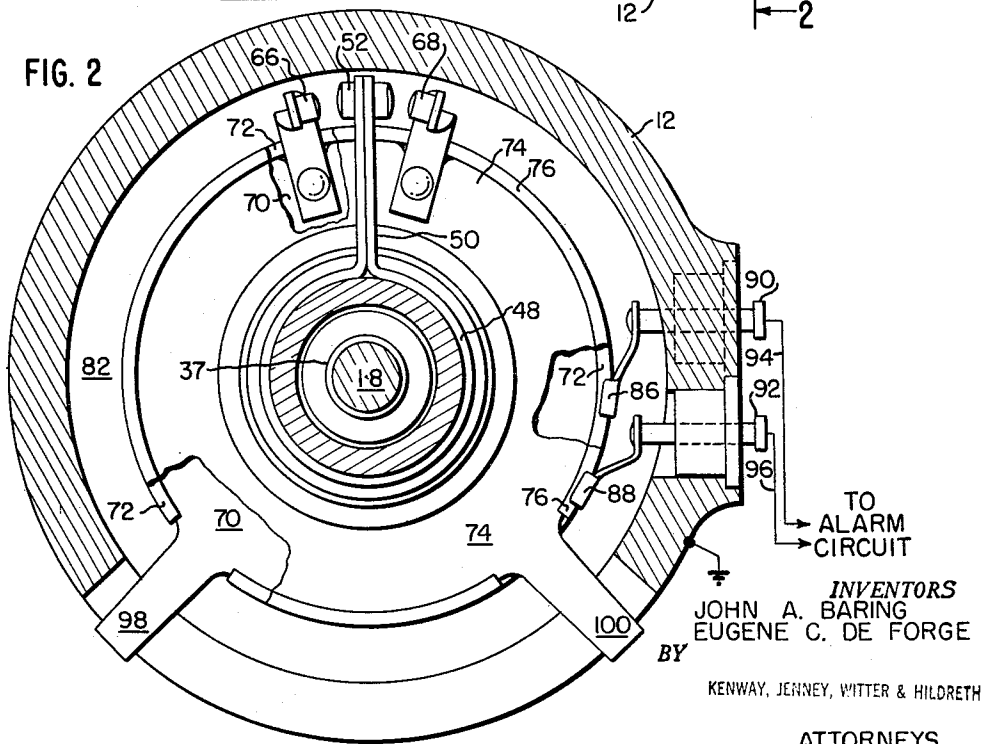


FIG. 2



TO
ALARM
CIRCUIT

INVENTORS
JOHN A. BARING
EUGENE C. DE FORGE

BY
KENWAY, JENNEY, WITTER & HILDRETH

ATTORNEYS

Dec. 5, 1961

J. A. BARING ET AL

3,012,157

RATE OF CHANGE AND INCREMENTAL CHANGE ALARM

Filed March 25, 1959

2 Sheets-Sheet 2

FIG. 3

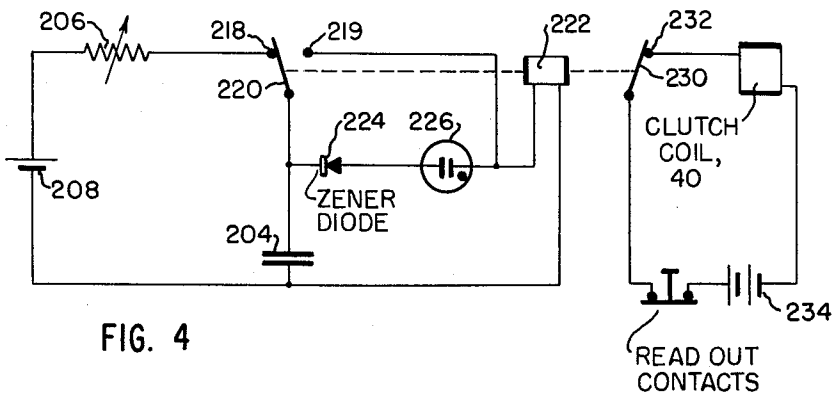
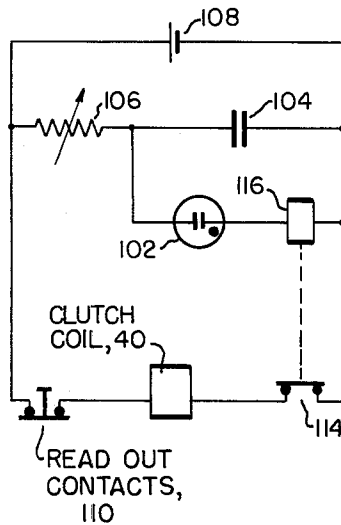


FIG. 4

INVENTORS
JOHN A. BARING
EUGENE C. DE FORGE
BY

KENWAY, JENNEY, WITTER & HINDBETH

ATTORNEYS

1

2

3,012,157

RATE OF CHANGE AND INCREMENTAL CHANGE ALARM

John A. Baring, Needham, and Eugene C. de Forge, Billerica, Mass., assignors to American Radiator & Standard Sanitary Corporation, New York, N.Y., a corporation of Delaware

Filed Mar. 25, 1959, Ser. No. 801,873

9 Claims. (Cl. 307—120)

This invention relates in general to alarm systems and in particular to rate-of-change and incremental change alarms.

In numerous control systems and particularly in data handling systems, it is desirable that some warning be given when a variable has changed excessively from a previous reading or when that variable changes too rapidly. By way of example, in telemetering systems it is quite common that periodic readouts be made of conditions at a remote location and communicated to a home station. In such situations data logging might be arranged to take place automatically, or alternatively, only in response to a command from the home station.

In either case, it is usually desirable that some alarm be given at the home station when an abnormal situation arises at the remote location. Such abnormal operation may be indicated by either an excessive change or a too rapid change in the variable being read. The occurrence of either of these conditions would desirably be noted automatically for alarm purposes and may be used automatically to initiate a data logging cycle.

It is with the provision of such a rate-of-change and incremental change alarm that the present invention is concerned. Although there are in existence some devices for similar purposes, they often lack the dependability that is essential for operation at a remote point where maintenance is difficult or in some cases impossible over extended periods of time.

It is therefore an object of the present invention to provide a simple and dependable rate-of-change and incremental change alarm system.

It is a further object of the invention to provide an automatic monitoring and alarm system for use in remote or inaccessible locations.

It is a still further object of the present invention to provide a relatively inexpensive and highly accurate alarm system for indicating excessive changes or rates of change in a variable.

It is another object of the present invention to provide an alarm system which is adjustable in operation to accommodate changes of the variable over a wide range or of relatively great rapidity.

In general, the present invention consists in a unit having an input shaft mounted for rotation in a housing and responsive in rotation to the magnitude of the variable quantity being monitored. The shaft is connected by way of a clutch to an alarm sleeve. The alarm sleeve, in the absence of clutch engagement, is normally maintained in a predetermined rotary position relative to the housing by means of a spring and a zeroing magnet. A center contact arm is carried by the sleeve and swings through an arc as the sleeve rotates. Adjustable span arms are set at angles to the zero position of the center contact arm and upon an excursion of the contact arm sufficient for it to reach either of the span arms, an alarm circuit is closed. At this point, a reading is taken or an alarm is sounded. The alarm sleeve is reset to zero following such an alarm by momentary deenergization of the clutch which permits the spring and zeroing magnet to return the sleeve to zero. In this sense, the device operates as an incremental alarm, but the same device also may function as a rate-of-change alarm by inter-

rupting the energization of the clutch on a predetermined time basis.

The clutch connecting the input shaft to the alarm shaft is preferably of the electromagnetic type, and the coil of the clutch may be so incorporated in an oscillator circuit that the current through the coil is periodically interrupted. By this means, it is made necessary that the change in variable required to give an alarm occur within the time base period of the oscillator circuit before the clutch is again de-energized. A rather wide, but none the less sensitive, adjustment of the unit is obtainable by varying the disposition of the span arms or by varying the frequency of the oscillator circuit. For a better understanding of the present invention together with further objects, features, and advantages, reference should be made to the following description of a preferred embodiment of the present invention which should be read in connection with the appended drawing in which:

FIG. 1 is a sectional side view of an embodiment of the mechanical portion of the present invention,

FIG. 2 is a cross-sectional view of the embodiment of FIG. 1 taken along the plane indicated by the line 2—2 through FIG. 1,

FIG. 3 is a schematic of a simple oscillator circuit for providing a rate-of-change time base, and

FIG. 4 is a schematic of an alternative oscillator circuit for providing a rate-of-change time base.

In FIG. 1 there is illustrated a cup-shaped housing 12 having an end portion 14 at the left side of FIG. 1. At the right side of FIG. 1, an end portion 16 is shown, and it is similar to the end portion 14 for reasons explained below.

An input shaft 18 is supported for rotation in the housing in ball bearings 20 and 21. Information in the form of rotary motion of the variable is applied to the shaft 18 through a gear train or by other suitable means. The main shaft 18 extends almost entirely through the unit and is arranged for connection to successive shafts on additional similar units if ganging is desired. The similarity in configuration of the end portion 14 to the end portion 16 indicates that the end portion 16 need not be a part of the original unit, but may be the front end of a successive similar unit. The coupling of successive input shafts may be made telescopically, and a bearing 22 is shown mounted in the end portion 16 as a support for rotation of the input shaft of the next unit in line.

A preloading device 24 is held in position between the input shaft 18 and the bearing 20 by a spring washer to establish the shaft position. A disc 28 is pinned to the shaft 18 and rotates with the shaft. Adjacent the disc 28 is a clutch member 30 which has a central opening clearing the input shaft 18. The clutch 30 is supported in position by a flared support 32 into which the clutch is pressed. The support 32 is made of magnetic material and is separated from the main shaft 18 by bearings 34 and 35. The bearings are made from a suitable low-friction material such as nylon.

A spring 36 is compressed between the bearings 34 and 35 by means of a snap ring 37 fitted to the shaft 18 to lock the spring assembly against the bearing 34. The bearing 34 is pinned to the input shaft 18, and the bearing 35 is pinned to the support member 32 as shown. The effect of the spring 36 is to force the assembly which consists of the clutch 30 and support member 32 to the right as shown in FIG. 1 to normally separate the disc 28 and the clutch 30 in the absence of other forces. Suitable rotary bearing structures are provided at various pressure points in the spring assembly for reasons which will become apparent from the description of the operation of the device below.

A coil 40 and a magnetic structure 42 are supported about the input shaft 18 by means of a stepped collar 44 pressed into and supported from the end portion 14 of the housing. Both the magnetic structure 42 and the support member 32 are made of magnetic material to provide a flux path through the structures 42 and 32 and the air gap existing therebetween. The member 32 is surrounded by a clamping strip formed into a collar 48 from which a radial arm 50 extends. At the extremity of the member 50, a double center contact 52 is provided. A spiral clock spring 54 is pinned to the member 32 and to the housing 12 to return the center contact to a given zero position.

Additional centering means for member 32 and center contact 52 are provided by a pair of permanent magnets 56 and 58 having wedge-shaped ends which cooperate with wire armatures 60 and 62 respectively. A pair of adjustable span arm contacts 66 and 68 are disposed on either side of the center contact 52 as may be best seen in FIG. 2. The contact 66 is supported upon an L-shaped arm which is riveted to a disc 70, about most of the periphery of which is a channel-shaped slip ring 72. Contact 68 is similarly supported upon a disc 74, on the major portion of the periphery of which is a slip ring 76. The discs are preferably made of insulating material and are held in separated position upon a flanged collar 80 by means of a snap ring 81. The flanged collar 80 is supported from the housing 12 by means of a plate 82. The plate 82 is locked in position against a shoulder in the housing 12 by means of radially disposed set screws of which screw 84 is typical.

Electrical contact to the slip rings 72 and 76 is provided through brushes 86 and 88 respectively, which are spring-mounted from insulating bushings 90 and 92. The bushings pass through the housing 12 and contain leads 94 and 96 which are connected to brushes 86 and 88 respectively. The leads 94 and 96 are connected into the alarm circuit and the center contact, in common with the housing, is normally grounded as shown in FIG. 2.

The position of the span contacts 66 and 68 relative to the zero position of the center contact 52 is adjustable by means of a pair of radial arms 98 and 100, which are connected to the discs 70 and 74 respectively. The arms 98 and 100 extend through an arcuate slot in the housing 12 to permit contact adjustment from outside the housing. The mounting of the discs upon the flanged collar 80, however, is such that the setting of the contacts, once made, will remain fixed.

The applicability of the present invention to rate-of-change alarm service has previously been mentioned. It was stated that such a function may be obtained by interrupting the energization of the clutch of the device on a predetermined time basis. FIG. 3 illustrates a convenient and simple circuit for providing the desired clutch interruption.

A relaxation oscillator which includes a gas discharge tube 102, a condenser 104, and a variable resistor 106 provides the necessary time base. A source of direct voltage 108 is connected in shunt with the resistor 106 and the condenser 104. There is also connected in shunt with the condenser and the resistor the read-out contacts 110, the coil of the magnetic clutch 40, and the relay contacts 114. The relay coil 116 is itself connected in series with the gas discharge tube 102 and the two elements are in shunt with the condenser 104.

In the circuit of FIG. 3, the read-out contacts 110 are normally closed as are the relay contacts 114. Current flows through the clutch coil 40, and the contacts 110 and 114, maintaining the clutch in engagement. Simultaneously, current flows in the branch of the circuit which includes the condenser 104 and the variable resistor 106. Until the voltage on the condenser 104 exceeds the breakdown potential of the gas discharge tube 102, no current flows through the relay coil 116. However, when the breakdown voltage is exceeded, the condenser 104 dis-

charges through the tube 102 and the relay coil 116. It is during this period of condenser discharge that the relay coil 116 is energized, and the relay contacts 114 are opened. The clutch is then momentarily de-energized as the circuit branch containing the clutch coil 40 is broken. The center contact arm 50 returns to zero during this interval.

When the voltage remaining on the condenser is insufficient to maintain ionization of the tube, the tube cuts off, and the charging cycle again begins. During the charging cycle current again flows through the clutch coil 40, and the clutch is engaged permitting the contact arm 50 to follow the variable.

In FIG. 4, there is illustrated a more sophisticated time-base oscillator. In this instance, a voltage source 208, a variable resistor 206 and a condenser 204 make up the basic charging circuit. A fixed relay contact 218 and a swinging relay contact 220 normally maintain the charging circuit closed. The swinging contact 220 is controlled by a relay coil 222 as indicated by the broken line, and during periods when that coil is not conducting current, the contact 220 remains normally closed against the contact 218.

The discharge circuit for the condenser 204 is made up of a Zener diode 224, a gas tube 226 and the relay coil 222. A second fixed contact 219 is connected to the junction of the gas discharge tube 226 and one end of the relay coil 222. The other end of the relay coil 222 is connected to the junction of the condenser 204 and the voltage source 208.

The relay coil 222 also controls a second swinging contact 230 as is also indicated by a broken line. A single fixed contact 232 is connected to one end of the clutch coil 40 and the other end of the clutch coil is connected to a second voltage source 234. The read-out contacts, which are normally closed, are connected in series between the swinging contact 230 and the second voltage source 234.

With the swinging contact 220 in the position illustrated, that is, closed against the fixed contact 218, the condenser charging circuit is operative. The condenser 204 charges exponentially until its voltage reaches a point slightly in excess of the combined breakdown voltage of the Zener diode and the gas tube. When this point is reached, the gas tube fires, and the condenser 204 discharges through the diode, the gas tube and the relay coil 222. Energization of the relay coil 222 thus provided causes the swinging contact 220 to close with the fixed contact 219. This places the condenser 204 directly across the relay coil 222, and the minimum resistance now in the discharge circuit allows the condenser to discharge almost its entire energy into the relay coil. Positive relay action is assured and a longer relay closure period is obtained than would be obtainable in a circuit such as illustrated in FIG. 3, where the capacitor discharges through a gas tube in series with a relay coil. Moreover, in circuits of the type shown in FIG. 3, the condenser discharges only to the point where the extinction potential of the tube is reached. In the circuit of FIG. 4 on the other hand, the condenser continues its discharge until the voltage falls to the drop-out potential of the relay, which is, of course, much lower. Another advantage resulting from this additional circuitry is the ability to obtain lower frequencies of operation. This stems from the fact that greater voltage changes take place and the charging time for circuits having a given resistance is necessarily lengthened.

The addition of the Zener diode 224 to the circuit results in a high degree of firing voltage stability. Gas tubes in general are unpredictable and vary considerably in their firing potential. The Zener diode, on the other hand, is a very stable circuit element. Its connection in series with the gas tube raises the voltage necessary to cause firing. Although the variation in firing potential

is not itself changed, it now constitutes a considerably smaller percentage of the total breakdown voltage.

The swinging contact 230 breaks from the fixed contact 232 as soon as the condenser discharge through the relay coil 222 takes place. The connection of the clutch coil 40 with the voltage source 234 is thus broken, causing disengagement of the clutch in the alarm unit. The moving arm in the unit is then, of course, reset to zero in the manner previously described. Manual interruption of the clutch coil circuit and resetting of the moving contact to zero may be effected by opening the readout contacts if such operation is desired.

When the alarm system is used simply as an incremental change alarm, the magnetic clutch is maintained normally energized. If the variable changes sufficiently to bring the center contact 52 against either the adjustable contact 66 or the adjustable contact 68, the alarm is given. A reading is then taken, the clutch is de-energized automatically or manually, and the contact arm is returned to its zero position under the influence of the spiral spring 54 and the magnets 56 and 58 cooperating with the armature wires 60 and 62 respectively.

Where the system is utilized for a rate-of-change alarm, one of the illustrated oscillator circuits, preferably that of FIG. 4, provides the necessary time base. By adjustment of the resistor 206, this time base may be varied considerably. An appreciable length of time is required for the condenser 204 to become charged, and it is during these charging periods that changes of the variable are monitored by reason of the energization of the clutch coil then obtaining. If the changes in the variable during the charging period are insufficient to carry the center contact 52 against either of the adjustable contacts 66 or 68, no alarm is given. If, on the other hand, changes in the variable are occurring at such a rapid rate that a circuit is closed between the center contact and one of the adjustable contacts of the unit, the alarm is given.

Although specific embodiments of the invention have been described and shown, the invention should not be limited to the details and the applications thereof disclosed herein. Various modifications within the purview of the invention and numerous applications in the field of control systems and in data handling will suggest themselves to those skilled in the art. The invention should be limited only by the spirit and scope of the appended claims.

What is claimed is:

1. In an incremental change and rate-of-change alarm apparatus the combination of a first member rotatable in response to changes in a variable, a second member normally connected to and rotatable with said first member from a predetermined fixed position, and means for disconnecting said first member from said second member and returning said second member to said predetermined fixed position in response to an excursion of predetermined angular magnitude of said second member from said predetermined fixed position.

2. In an incremental change and rate-of-change alarm apparatus the combination of a housing, first and second members disposed for rotation within said housing, means normally connecting said first member to said second member for rotation therewith from a predetermined fixed position, means connected to said second member for sensing excursions of predetermined angular magnitude of said second member relative to said housing in a predetermined time, and means responsive to said sensing means for disconnecting said second member from said first member and returning said second member to said predetermined fixed position relative to said housing.

3. Incremental change and rate-of-change alarm apparatus comprising a housing, a first member disposed for rotation within said housing in response to changes in a variable, a second member also disposed for rota-

tion within said housing, means for connecting said second member to said first member for predetermined periods of time, fixed contacts supported within said housing adjacent said second member, a movable contact carried by said second member, said movable contact being disposed relative to said fixed contacts to touch one of said fixed contacts upon an excursion of predetermined angular magnitude of said second member, means responsive to the touching of one of said fixed contacts by said movable contact during any one of said predetermined periods of time for disconnecting said second member from said first member and means for returning said second member to a predetermined fixed position within and relative to said housing upon disconnection thereof from said first member.

4. Rate-of-change and incremental change alarm apparatus comprising a housing, an input shaft mounted for rotation within said housing in response to changes in a variable, a sleeve disposed within said housing in concentric relationship to said input shaft, a magnetic clutch disposed between said input shaft and said sleeve, said sleeve being connected to and rotatable with said input shaft upon energization of said magnetic clutch, a spring connected between said housing and said sleeve for normally maintaining said sleeve in a predetermined angular position relative to said housing, a center contact arm mounted upon and extending radially from said sleeve, a pair of fixed contacts supported by said housing and disposed at either side of said center contact arm, means for adjusting the position of said fixed contacts relative to said predetermined angular position of said sleeve, said adjusting means extending through said housing, means for periodically energizing said magnetic clutch for periods of predetermined length, and means for de-energizing said magnetic clutch upon occurrence of excursions of said sleeve sufficient to bring said center contact arm against one of said fixed contacts during one of said periods of predetermined length.

5. Rate-of-change and incremental change alarm apparatus as defined in claim 4 including oppositely disposed magnets mounted in said housing, and armatures carried by said sleeve, said armatures moving in circular paths with rotation of said sleeve and cooperating with said magnets normally to maintain said sleeve in said predetermined angular position.

6. In rate-of-change and incremental change alarm apparatus, a circuit for providing a reference time base during which a magnetic clutch may be periodically energized to cause rotation of a member in response to changes in a variable comprising a first voltage source, a variable resistor and a condenser connected in series circuit relationship, a relay having a coil and two sets of contacts, one contact of said first set being normally closed and connected between said condenser and said variable resistor to permit charging of said condenser from said first voltage source, a Zener diode, a gas tube and said relay coil being connected in series circuit relationship across said condenser to provide a preliminary discharge path therefor, the other of said first set of contacts being normally open and connected to the junction of said gas tube and said relay coil, said condenser charging to a voltage in excess of the breakdown voltage of said Zener diode and said gas tube from said voltage source, and discharging first through said Zener diode, said gas tube and said relay coil whereby said relay coil is energized and said normally open contact of said first set becomes closed causing said condenser to discharge only through said relay coil, said second set of relay contacts being normally closed, a second voltage source, a coil for said magnetic clutch, a set of manually operable contacts and said second set of relay contacts being connected in series circuit relationship, discharge of said condenser through said relay coil causing said normally closed second set of contacts to open de-energizing said magnetic clutch to discontinue rotation of said member in response to changes in said variable.

7

7. In a rate-of-change and incremental change alarm apparatus, the combination of a first member rotatable in response to changes in a variable, a second member, and means for periodically connecting said first member to said second member to rotate said second member from a predetermined fixed position, said means including a magnetic clutch disposed between said first and said second members and an oscillator for providing periodic energization of said magnetic clutch, said second member returning to said predetermined fixed position during periods of de-energization of said magnetic clutch.

8. Apparatus as defined in claim 7 wherein said oscillator includes a condenser and means for periodically charging and discharging said condenser and wherein said

8

magnetic clutch includes a coil, said coil being incorporated in the discharge path of said condenser.

9. Apparatus as defined in claim 8 wherein said oscillator is of the relaxation type, the discharge path of said condenser including a gas tube and a Zener diode connected in series circuit relationship in said discharge path.

References Cited in the file of this patent

UNITED STATES PATENTS

10	1,690,132	Rosenzweig	Nov. 6, 1928
	2,598,631	Wood	May 27, 1952
	2,801,351	Calvert et al.	July 30, 1957