Dec. 7, 1937. L. A. M. J. LABOUREUR ET AL 2,101,076

ELECTRIC TIME INDICATOR FOR SOUNDING APPARATUS

Original Filed May 11, 1932 2 Sheets-Sheet 1

Fig. 1

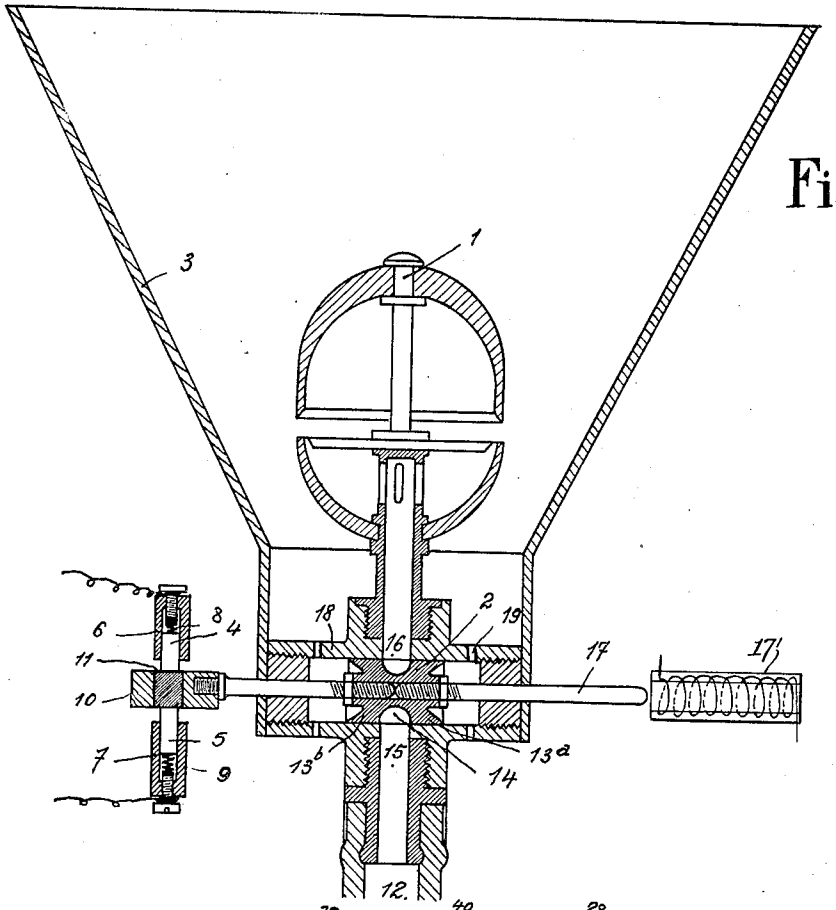
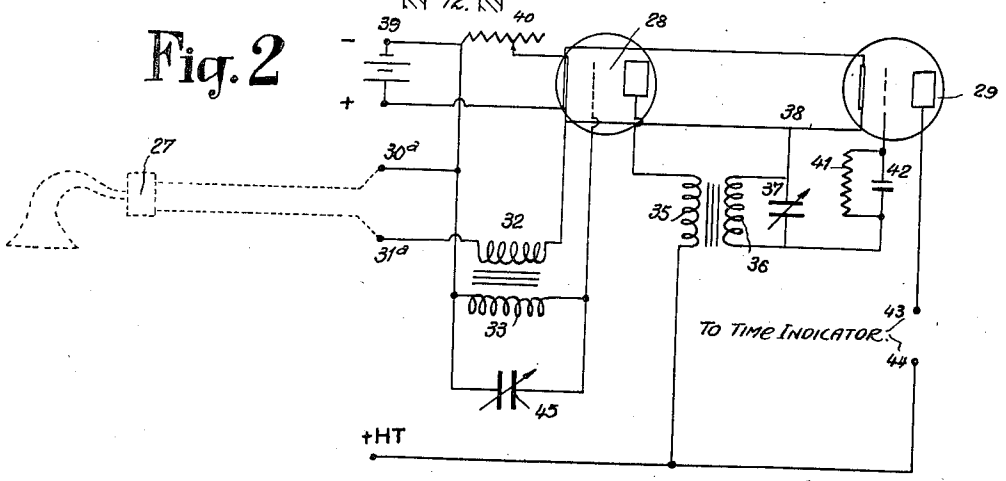


Fig. 2



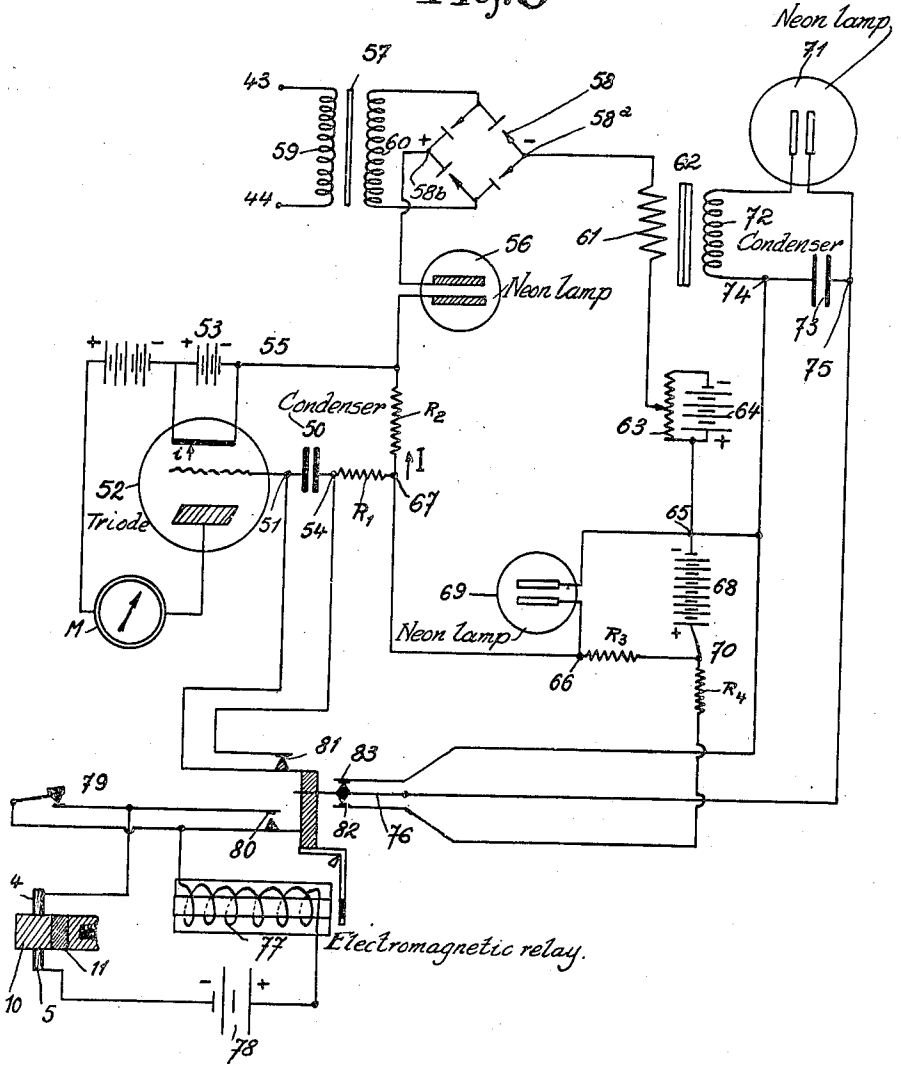
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Fig. 3



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2,101,076

ELECTRIC TIME INDICATOR FOR SOUNDING APPARATUS

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Original application May 11, 1932, Serial No. 610,676. Divided and this application August 7, 1933, Serial No. 684,110. In France May 20, 1931

6 Claims. (Cl. 161—15)

This invention relates to an electric time indicator for air and submarine sounding apparatus which is based upon the measuring, by means of a triode, of the charge acquired by a condenser between the emission of a sound and the receiving of the echo of said sound, said charge representing the measure of the time elapsed between said emission and said reception and consequently the distance between the sending point and the surface of the soil or the bottom of the sea which has generated the echo.

This application is a division of our application Serial No. 610,676, filed May 11, 1932.

A first characteristic feature of the invention consists in that the condenser is included in a circuit which comprises: a resistance fixing the charging speed, a potential difference serving for the charging and the grid-filament space of the triode, the latter acting as a one way conductor which allows the charging of the condenser but not the discharging thereof.

Further, according to the present invention the charging of the condenser is started by a connection characterized by a discharge neon lamp connected firstly to a source of electrical potential, secondly to a transformer, causing it to light by the effect of the sending of the short signal, thirdly to a resistance included also in the transformer charging circuit and at the terminals of which the potential difference utilized for charging the condenser exists, said difference being due to the ohmic drop in the resistance brought about by the current passing through the neon lamp.

Another characteristic of the invention consists in that the end of the charging period of the condenser is controlled by an excess voltage in opposition to the electromotive force of the source that feeds the neon lamp and consequently starts the extinction of the lamp.

The excess voltage is produced by the rectifying of the alternating current (having the same frequency as the sharp sound emitted as the signal) due to the sound effect of the echo which has been received; the rectifying device being connected in series in the circuit which comprises the neon lamp and its feeding source.

Another characteristic of the invention consists in the use of a delaying connection constituted by a neon lamp placed at the terminals of a condenser which is charged through a resistance from the moment of emission and which causes the lighting of the lamp when its charging pressure reaches the critical ignition value, the lamp circuit comprising a primary transformer winding the secondary of which is connected in the circuit of the first neon lamp whose ignition starts the charging, so that it cannot begin before the direct reception of the emitted sound.

This avoids the untimely extinction of the first neon lamp which would be caused by the direct reception of the emitted sound if said lamp was lighted as soon as the sound is emitted.

The appended drawings show diagrammatically a mode of construction of a time indicator according to the present invention. In order to facilitate the understanding the drawings illustrate also a sound emitter and an echo receiving device.

Fig. 1 is a vertical sectional view of the sound emitter.

Fig. 2 illustrates diagrammatically the echo receiving connections.

Fig. 3 is a diagrammatic view of the time indicator which is joined to the connection shown in Fig. 2.

Referring to the embodiment of the invention illustrated in Fig. 1 the sound emitter comprises a whistle 1, a balanced valve 2, a horn 3 and contact pieces constituted by two conducting rods 4, 5 retained in recesses 6, 7 by means of springs 8, 9, in contact with the end portion 10 of the rod of the valve 2.

An insulated part 11 is set in the valve stem end 10 in order to avoid all electrical contact between the parts 4 and 5 when the valve stem is in the position corresponding to open.

The object of the contact, which is consequently closed when the valve itself is closed and opens when the valve is open, is to start the operation of the time indicator hereinafter described. 12 is an inlet pipe for the admission of compressed air from a tank (not shown).

The valve is constituted by two cylindrical elements operating as pistons 13^a, 13^b between which is formed a chamber 14 allowing the passage of compressed air when the valve is in the position shown in Fig. 1 where it uncovers the openings 15, 16. When the valve is displaced to the right or to the left it closes the openings 15, 16. This movement of the valve may be produced either by actuating the rod 17 by means of an electromagnet 17', or by means of a percussion hammer which has not been represented in the drawings as it may be of ordinary construction. The rod 17 ensures also the guiding without wedging of the pistons 13^a, 13^b in a cylinder 18 which is perforated with holes 19 to avoid compressing a useless air cushion at the ends.

It will be noted that at starting the valve is closed either towards the right or the left and

that the whistling is produced by the displacement of the valve from one of its end positions, for example from the left to the right.

During this movement, the air pressure delivery can take place only when the valve passes its middle position.

The sound emitted by the airship or the submarine boat is reflected back by the ground or the sea bottom, the echo being received by a microphone **27** (Fig. 2) which is connected at **30e** and **31a** with the amplifier illustrated in Fig. 2.

In this apparatus the connections between the vacuum tubes are effected by transformers having a high coefficient of magnetic leakage produced by placing side by side a primary coil **35** and a secondary coil **36** a bundle of straight ferromagnetic plates passing through them and connecting them together.

The secondary coil is designed so as to be resonant to the signal frequency when it is connected across a condenser **37** having a capacity of the order of 0,1 to 5/1000 microfarad.

The primary coil **35** comprises a number of windings such that its self reactance may be compared to the internal resistance of the vacuum tube that feeds it but preferably lower.

The vacuum tube **28** shown in Fig. 2 is an amplifier and the vacuum tube **29** is both an amplifier and a detector. **30a** is a terminal connected to the microphone and to the negative terminal **39** of the filament heating source. The return from the microphone is through terminal **31a** to the primary **32** of a transformer of the kind shown in Fig. 3 having a secondary **33** tuned by the condenser **45**.

The anodic current passes through the primary **35** of another tuned transformer (secondary **36** with tuning condenser **37**) connected to the positive heating terminal **38** and to the detecting grid by a condenser **42** of a few thousandths microfarad shunted by a resistance of about 1 to 4 megohms.

The time indicator system is connected to the terminals **43—44** in the plate circuit of the tube **29**.

The terminals **43—44** of the time indicator system are also shown in Fig. 3. In this figure the condenser, the charge of which will serve to measure the intervals of time, being the condenser **50**, its electrode **51** is connected to the grid of a triode lamp **52** which is very thoroughly exhausted and insulated. The filament of this lamp is heated by a source of voltage **53** of 4 volts.

The other electrode **54** of the time indicator condenser **50** is connected to the negative end **55** of the filament of the triode lamp **52** by means of a resistance R_1 having a well determined value and whose function is to determine the constant of the charging period of the condenser.

Between this resistance R_1 and the negative end **55** of the filament is placed another resistance R_2 put in a hereinafter described circuit which comprises neon lamps.

The operation of the time indicator part of the system is as follows:

During the whole interval of time to be measured, a continuous current I (delivered by the circuit in which the neon lamps are placed) flows through the resistance R_2 and causes at its terminals an ohmic drop of the value $R_2 \times I$ such that it tends to make the grid positive relatively to the filament and for this reason said voltage $R_2 \times I$ is applied to condenser **50** owing to the conductivity of the space grid-filament of the triode.

During the time to be measured, owing to the selected value of the resistance R_1, the condenser **50** has time to take only a small portion of the maximum charge, the grid is brought relatively to point **55** (negative pole of the filament) to a potential $+R_2 \times I - R_1 \times i$, i being the charging current for the condenser **50** at a given moment, this current passing through the grid-filament space to flow between points **55** and **51** of which the latter is the point of junction between the condenser and the grid.

The grid potential is necessarily positive because if it were not so the lamp being well insulated would not be the seat of any grid current and as the latter is precisely the loading current i itself, the term $R_1 \times i$ would be nil, so that the grid tension would be the same as $R_2 \times I$ which is very positive and generally rises to several scores of volts and would therefore with stronger reason be positive.

It is well known that when the grid of a triode lamp is positive a current which may reach several milliamperes, passes inside the triode between the filament and the grid.

For positive tensions of about a fraction of a volt, the grid current is sufficient to prevent the charging current being limited by the inner grid-filament resistance, but rather by the outer resistance R_1 placed in the condenser charging circuit.

This results more especially from the fact that when the grid is positive the grid-filament space may be likened to a resistance inferior to 100.000 ohms and even for existing lamps, inferior to 50.000 ohms.

Consequently when the outer resistance R_1 is of the order of several megohms it may be said (as a first approximation) that everything takes place as if the lamp were used as a short circuit and connects to the point **55** of the filament the electrode **51** of the condenser **50** which is connected to the grid.

During the time interval to be measured the condenser **50** charges itself according to an exponential law and as at the end of the time to be measured I becomes equal to zero, the potential difference $R_2 \times I$ disappears. The grid potential which had been made positive owing to the tension R_2 I only, immediately becomes negative. The discharging current stops itself immediately because the space grid-filament acquires too great a resistance. The discharging current being nil, there is no longer any ohmic drop in the resistances R_1, R_2, so that the grid tension becomes absolutely equal to that at the terminals of the condenser **50**, the latter being exactly the charge acquired by this condenser during the time to be measured.

The triode grid having thus acquired a negative potential measuring the condenser's charge, the anodic current of the lamp acquires a value which corresponds to said potential and remains stationary, the grid potential itself remaining unchanged as no discharging takes place.

The relation that determines the value of the plate current in function of the grid tension is well known and remains unchanged for a given lamp (this being the anodic characteristic of the lamp). Consequently the deviations of the milliamperemeter M are characteristic of the charge acquired by the condenser and are consequently a function of the time during which the current I passed through the resistance R_2.

The connections which allow of sending the current I in the resistance R_2 during the interval to be measured will now be described.

A closed circuit is formed which comprises a neon lamp 56 connected to the resistance R_2, an alternating current rectifier constituted by a transformer 57 and a system of copper oxide rectifying rings forming a Wheatstone bridge 58.

The primary 59 of transformer 57 is fed by the current coming from the selecting amplifier shown in Fig. 2 to which the receiving microphone 27 is connected.

The reception of the echo signal is expressed by an alternating current in primary 59 which produces in the secondary 60 an alternating tension then rectified in the rectifier 58 and applied between the terminals 58^a, 58^b in the direction that tends to render the neon lamp 56 positive relatively to the terminal 58^a of said rectifier.

The leading-out terminal 58^a is connected to the secondary 61 of a transformer 62, which is connected in its turn to a potentiometer 63 fed by a battery 64 and allows the introduction into the circuit of a potential difference which may vary from about 0 to 24 volts. This voltage is applied in the direction opposite to the continuous voltage produced by the rectifier 58.

Between two terminals 65, 66 of which the first is connected to the positive terminal of the potentiometer 63 and the other to the terminal 67 of resistance R_2, there is applied a constant voltage of the order of 80 volts which may be produced by a storage battery for which a lighter battery 68 may be substituted in order to reduce the weight of the plant in view of its utilization upon airships.

Considering that the voltage of a battery may not be quite constant and that the value of the current I passing in this circuit must be strictly constant, it has been found advantageous to stabilize the voltage produced between the terminals 65, 66 by the utilization of the steadying properties of a discharge neon lamp. That type of lamp having the well known property of maintaining a constant voltage at its terminals from the moment of its ignition when a current which may vary from a few microamperes to a few milliamperes is caused to pass through it.

Consequently electric current from the battery 68 of about 120 volts in series with a resistance R_3 of the order of 100.000 ohms will be sent through the regulating lamp 69. A current of about 4/10 of a milliampere for which the voltage at the terminals is substantially constant and of the order of about 84 volts is thus caused to pass in this neon lamp. This voltage depends moreover on the neon lamp used, but is well defined for every lamp.

The battery 68 is comprised between the terminals 65, 70, the negative end being connected to the terminal 65 and the positive to the terminal 70 which is connected to the resistance R_3 connected itself at 66 to the regulating neon lamp 69.

Considering now the circuit 56, 58, 61, 63, 65, 66, 67, 56 it will be seen that it is the seat of a constant electromotive force tending to cause a current I to flow in the direction shown by the arrow through the resistance R_2.

This constant voltage is equal to $E+V$, E being the constant voltage at the terminals of the neon lamp 69, and V the voltage at the terminals of the potentiometer 63.

When the neon lamp 56 is out this voltage $E+V$ is wholly applied upon its terminals. Now it is well known that a neon lamp ignites at a certain voltage U^a and goes out at another voltage U^e lower than U^a.

Consequently if the total voltage $E+V$ is between U^a and U^e the lamp will remain lighted as long as no circumstance outside the circuit has caused one of both limit voltages to be overstepped.

In order to operate the time indicator at the beginning of an interval of time, an excess voltage will be produced in the neon lamp circuit 56 in the direction which increases the existing voltage. The critical ignition voltage U^a will thus be bridged over and the neon lamp will light up acquiring then a very weak inner resistance which may be considered small relatively to the resistance R_2 which may be chosen without inconvenience of the order of about 200.000 ohms.

In these conditions a permanent current will flow in the resistance R_2 under the action of the permanent electromotive force $E+V$ which still exists when the sudden disturbance which started the ignition has disappeared.

This disturbance is caused as will be further explained by the sending of the sharp signal but with a certain delay, which is always the same.

When the echo caught by the microphone, selectively amplified by the amplifier and rectified by the rectifier 58 reaches the apparatus, it produces an opposing voltage in the circuit of the neon lamp 56. This excess of voltage reduces the electromotive force $E+V$ to the point of making it lower than the extinction voltage U^e of the lamp 56. This results in the lamp being extinguished; and the current passing through R_2 ceases.

Having now indicated how a constant current I may be started in the interval of time to be measured, that is between the instant when the emission is started and that when the echo stops, it, we now describe the part of the connection which produces the excess of voltage due to emission and the ignition of the neon lamp 56.

The neon lamp 56 will be lighted with a constant delay which is determined once for all relatively to the sending of the sharp sound; thus the direct reception of the whistle signal will be without inconvenience because as the neon lamp is not lighted its extinction cannot be produced.

Moreover, the system designed to delay the igniting excess of voltage will be such that it will produced it during the time of measurement but will not produce any reverse excess of voltage.

This result is obtained by the ignition of a third neon lamp 71, mounted in series with the primary winding 72 of the transformer 62, by the action of a source of current which may be the same as that 68 already mentioned between the terminals 65, 70.

In order to delay the ignition of the neon lamp 71, the progressive charge of a condenser 73 interposed between the terminal 74 of the transformer 72 and the terminal 75 of the neon lamp 71 will be utilized. The terminal 74 is connected to the terminal 65, negative end of the battery 68.

The terminal 75 connects the other plate of the condenser 73, on the one part to the neon lamp 71 and on the other part to the blade contact 76 of a relay 77 fed by the current from a source 78, the circulation of which is controlled by the contact 4, 5 carried by the whistle valve.

The relay 77 is of the multi-contact-telephone type and comprises a locking contact 80 which closes when the current closes the relay and thus keeps it constantly energized.

The valve contact 4, 5 is mounted in series with the source 78 which feeds the relay so that the opening of the contact 4, 5 completely interrupts

the current and consequently the relay is no longer operative.

A push button 79 which shunts the operating contact 80 allows when the whistle is not operating, the closing of the circuit to the source 78 through contacts 4, 5 and causes operation of the relay 77 which could not otherwise be operated as the open contact 80 by which it is operated is in series with the source 78.

Consequently the closing of the relay may take place before the sounding operation and this relay will thus remain operating until a sudden interruption of the contact 4, 5 will cause the interruption of operation of the relay 77 which will not be capable of re-operating itself.

When operating the relay 77 closes another contact 81, completely independent of the others and short-circuits the condenser 50 placed in the grid circuit of the measuring triode 52, so that the latter is always completely unloaded before any measuring takes place and it remains short circuited up to the very moment of starting said measuring.

The relay 77 also actuates in the aforesaid manner the blade 76 which reciprocates between two abutments, one of them, 82, upon which the blade rests when the relay is deenergized, being connected to the positive terminal 70 of the source 68 by a resistance R_4 having a value of the order of 25.000 to 50.000 ohms.

When the relay is operating the blade 76 engages the other abutment 83 which is connected to the terminal 74 of condenser 73, while said blade is connected to the other terminal of said condenser.

When the relay is operating which is the case before the beginning of a sounding operation, the contact 76—83 short circuits the condenser 73 which is thus completely discharged.

At the instant when a sound is emitted owing to the displacement of valve 2 (Fig. 1) its contact 4—5 interrupts the passage of the current in the relay 77 and de-energizes it, this breaking on the one part the contact 81 which short circuited the time indicator condenser 50 and causes on the other part the displacement of the blade 76 which moves away from the abutment 83 against which it was pressed by the permanent closing of the relay, to come to rest upon the abutment 82 where it will remain as long as the re-energization of the relay is not effected positively by means of the push button 79.

From the moment when the blade putting the condenser 73 in short circuit has engaged the contact 82, this condenser begins charging through the resistance R_4 under the action of source 68.

The charging voltage acquired by the condenser 73 increases according to an exponential law up to the moment when it reaches the ignition voltage of the neon lamp 71.

At that instant the lamp lights up instantaneously producing in the winding of the transformer 62 a current inflow which thus produces the excess voltage that starts the ignition of the neon lamp 56 (beginning of the time interval measured by the time indicator).

The lamp 71 then remains lighted, the voltage of the source 68 which is higher than the ignition voltage being sufficient to keep the lamp 71 lighted.

Consequently no opposing excess voltage caused by the transformer 62 can be produced during the sounding operation, the current produced in the neon lamp circuit remaining constant. The incoming of the echo causes the extinction of the neon lamp 56.

As above stated, the milliamperemeter M indicates the anodic current of the triode and by its deflection, shows the time during which the time indicator condenser has been charged when the measuring is ended.

When it is desired to return the whole system to its starting state it will be necessary only to actuate the button 79, this operation re-starting the feeding of the relay 77, short circuiting again the time indicator condenser through contact 81, returning the milliamperemeter index to its starting position, while the blade 76 which was in contact with the abutment 82 again puts the condenser 73 in short circuit by its coming in contact with the abutment 83 thus restoring the circuit of condenser 73 to its first state.

In this waiting period before a new measuring operation the lamp 71 is again put out like the lamp 56.

It will be noted that the measure of the charging time of the time indicator condenser differs from the time which has elapsed between the emission of a signal and the reception of its echo only by the time during which relay 77 operates and the charging period of condenser 73.

Both intervals of time are constant and it will be sufficient to take them into account once for all by fixing them separately. In practice the calibration or marking of the time indicator is determined wholly by experiment.

The milliamperemeter graduation giving the measure of the anodic current may be given directly in time intervals or in meters when measuring the distance.

In stating the principle of the time indicator a certain number of numerical values chosen so as to allow operation of such an apparatus have been mentioned but these values are not limiting as their choice depends on the individual properties of different types of discharging lamps as well as on the time intervals to be measured. They may be calculated according to the principles above stated and may consequently be modified without departing from the limits of our invention.

What we claim and desire to secure by Letters Patent of the United States is:—

1. An electric time indicator comprising: a condenser, a triode lamp having a filament, a grid, and a plate, a source of plate tension, a source of filament tension, a condenser charging circuit comprising a resistance, a source of constant potential difference and the filament to grid space of the said triode lamp and including said condenser, said space functioning as a unilateral conductor permitting the charge of the condenser but preventing its discharge; means for starting the charging of the condenser, means for stopping said charging at the end of the phenomena to be measured, and means for measuring the variation in anodic current of the triode lamp under the action of the charge acquired by the condenser, from the variation of which the time is measured.

2. An electric time indicator according to claim 1, characterized in that the means utilized for establishing the constant potential difference in the condenser charging circuit comprise: a fixed resistance through which passes a constant current, said resistance being interposed in a circuit which compries a neon discharging lamp, means to prevent said lamp from lighting until a

predetermined interval following the beginning of the phenomenon to be measured, and means for causing it to be extinguished at the end of said phenomenon.

3. An electric time indicator according to claim 1, characterized in that said means for starting the charging of the condenser comprise a neon discharging lamp which is situated in said condenser-charging circuit; a transformer, said means for starting the charging of the condenser including the secondary winding of said transformer, which is situated in said condenser-charging circuit; a primary-transformer circuit comprising the primary winding of said transformer, and means for producing a current therein at a predetermined interval following the beginning of the phenomenon to be measured; said source of constant potential difference comprising a fixed resistance through which passes a constant current, said fixed resistance being situated in said condenser-charging circuit; said means for stopping the charging of the condenser at the end of the phenomenon to be measured causing an extinguishment of said neon lamp at the end of said phenomenon.

4. An electric time indicator according to claim 1, characterized in that said means for starting the charging of the condenser comprise a neon discharging lamp which is situated in said condenser-charging circuit; a transformer, said means for starting the charging of the condenser including the secondary winding of said transformer, which is situated in said condenser-charging circuit; a primary-transformer circuit comprising the primary winding of said transformer, and means for producing a current therein at a predetermined interval following the beginning of the phenomenon to be measured; the last-mentioned means comprising a second neon lamp, a contact for closing the primary-transformer circuit and a relay to close said contact; a condenser connected in parallel with said secondary winding and said second neon lamp; said source of constant potential difference comprising a fixed resistance through which passes a constant current, said fixed resistance being situated in said condenser-charging circuit; said means for stopping the charging of the condenser at the end of the phenomenon to be measured causing an extinguishment of said neon lamp at the end of said phenomenon.

5. An electric time indicator according to claim 1, characterized in that said means for starting the charging of the condenser comprise a neon discharging lamp which is situated in said condenser-charging circuit; said means for stopping the charging of the condenser at the end of the phenomenon to be measured comprising a rectifier which is situated in said condenser-charging circuit and which is adapted to supply said lamp with current at the end of the phenomenon to be measured to cause an extinguishment of said lamp.

6. An electric time indicator according to claim 1, characterized in that said source of constant potential difference comprises a battery and a fixed resistance, said battery and said resistance being situated in said condenser-charging circuit; and a neon lamp connected in parallel with said battery and said resistance and supplied with current from said battery.

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