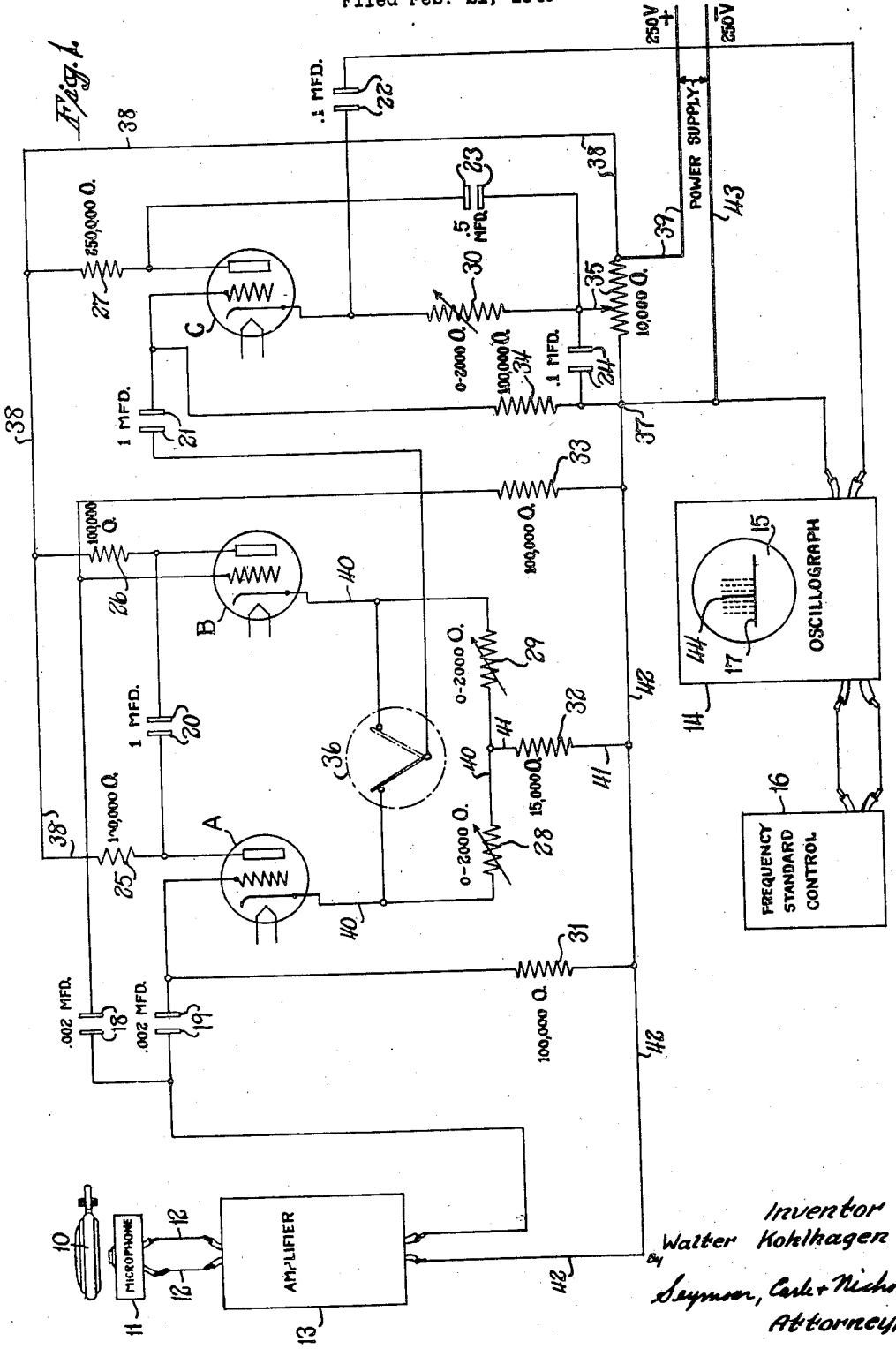
April 20, 1943. W. KOHLHAGEN 2,317,202

APPARATUS FOR TIMING IMPULSES

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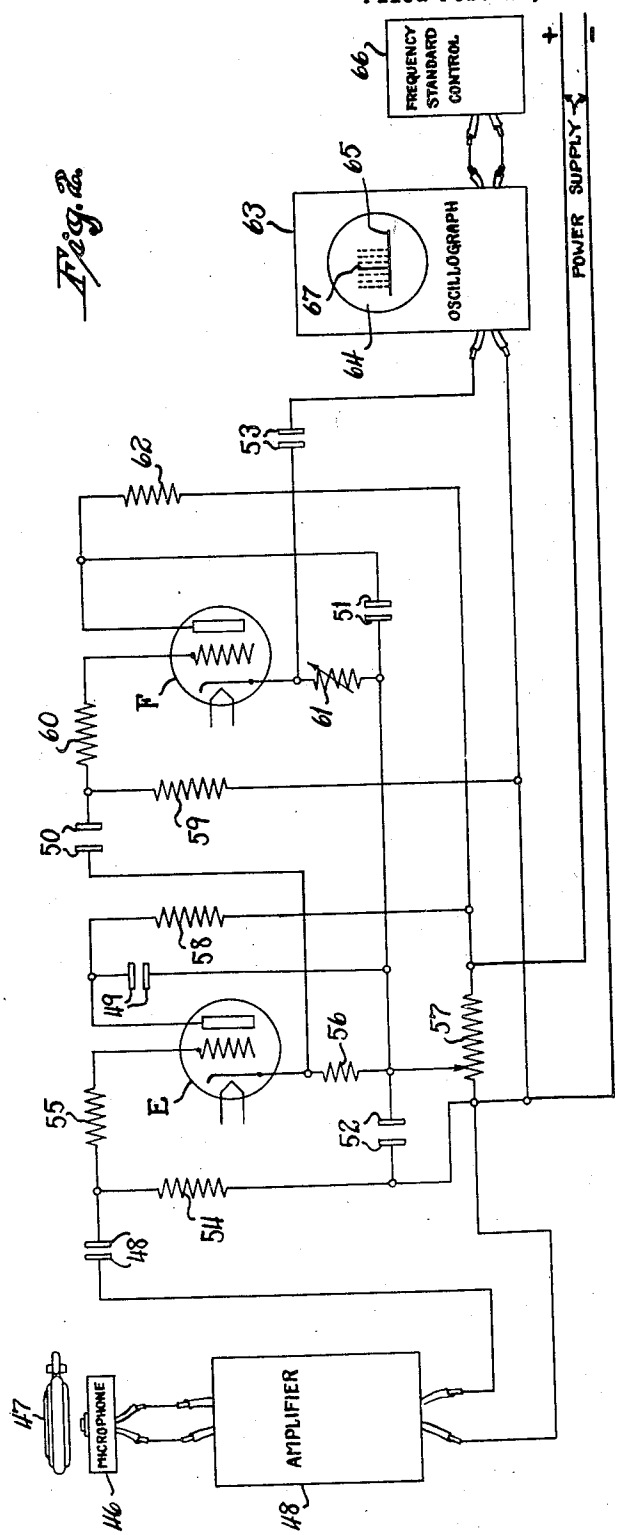
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APPARATUS FOR TIMING IMPULSES

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Fig. 2.



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2,317,202

APPARATUS FOR TIMING IMPULSES

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15 Claims. (Cl. 73—52)

The present invention relates to improvements in apparatus for timing impulses whereby impulses such, for instance, as those emanating from watches, clocks and the like or from the balance-wheel units thereof, may be compared to a pre-selected standard impulse—or beat frequency. For purposes of description the mentioned watches, etc., may be appropriately designated as "timepiece-units."

One of the objects of the present invention is to provide a superior apparatus of the character referred to, by means of which impulses may be conveniently and accurately timed.

A further object of the present invention is to provide a superior apparatus for timing the impulses of timepiece-units, and characterized by its provision with means whereby confusion between "ticks" and "tocks" of a timepiece-unit being tested is substantially eliminated.

Another object of the present invention is to provide a superior apparatus of the character referred to, by means of which only alternate beats of a timepiece-unit are transmitted to an oscillograph, or its equivalent.

Still another object of the present invention is to provide a superior apparatus of the character referred to, wherein the operator may, at his option, select either the ticks or the tocks, produced by the timepiece-unit, to be utilized for gauging the accuracy of performance.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure, this invention includes all features in the said disclosure which are novel over the prior art and which are not claimed in any separate application.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a schematic showing of one form of apparatus embodying the present invention; and

Fig. 2 is a schematic showing of another form of apparatus embodying the present invention.

Referring now to the apparatus which is schematically shown in Fig. 1, a watch 10, or other device to be timed, is shown as located adjacent a microphone 11 which latter is connected by suitable wiring such as 12—12 to an amplifier 13. The microphone 11 is in effect an "electrical pick-up device" which responds to each "tick" and each "tock" of the watch 10 or other device being tested by transposing the sound thereof into electrical impulses which are amplified by the amplifier 13. If desired, and especially when a bare balance-wheel unit is being tested, the electrical pick-up device may take the form of a photo-electric cell which is activated by a beam of light interrupted by each half-cycle or beat of the balance-wheel unit being tested, in a manner well understood in the art.

Included also in the apparatus with suitable electrical connections are three electronic tubes of the gas-discharge type respectively designated A, B and C. Each of the said tubes A, B and C is characterized by a construction and arrangement of parts whereby, when the grid thereof is maintained at a negative potential, the tube does not conduct, but when the grid becomes positive or sufficiently low in negative voltage, the tube becomes a conductor and continues as such until the plate voltage is decreased or entirely removed, or until a strong negative potential is applied to the grid.

Each of the tubes A, B and C is provided with a cathode, a grid, a plate and preferably a usual heater, all of which elements are represented in the accompanying drawings by customary symbols.

For purposes of description, the tubes A and B may be characterized as selector-tubes and the tube C may be characterized as the indicator-tube for reasons as will more fully hereinafter appear. The apparatus also includes an oscillograph 14 which requires no detailed description or illustration since it may be of any conventional type well known in the art, and provided witha usual fluorescent screen 15 upon which a beam visually appears accompanied by movements or changes in intensity. Connected to the oscillograph 14 is a frequency-standard control 16 which in a manner well understood in the art, is adapted to cause a horizontal beam 17 to appear upon the screen 15 of the oscillograph 14 in such rapid back-and-forth sweeping movement as to normally appear to be a continuous stationary line of light.

The various wires and connections between the elements diagrammatically shown in Fig. 1 do not, in the main, require individual reference characters, but for purposes of clarity of description it is to be noted that the apparatus referred to includes a plurality of condensers respectively numbered 18, 19, 20, 21, 22, 23 and 24. The apparatus also includes resistors 25, 26 and 27 respectively interposed between one leg of the power supply and the respective plates of the tubes A, B and C. An adjustable resistor 28 is in the circuit of the cathode of the tube A and, similarly, an adjustable resistor 29 is in the circuit of the cathode of the tube B. The cathode

of the tube C also has an adjustable resistor 30 connected to it as is shown at the right of Fig. 1.

The apparatus also includes resistors 31, 32, 33 and 34 connected to certain of the various elements of the apparatus in a manner as will clearly appear by reference to Fig. 1.

Electrically interposed between the power supply and the condensers 23 and 24 before referred to, is a potentiometer 35 manually regulatable in the usual manner of such instruments to control the voltage applied to the connected features of the apparatus.

Interposed in the circuit in such manner as to enable the operator to select either the tube A or the tube B for effecting the direct firing of the indicator tube C, is a control-switch 36 functioning in a manner as will more fully hereinafter appear.

For purposes of making clear one particular functioning apparatus, the various conductors and resistors above referred to have been marked in Fig. 1 with values suitable for an apparatus to time the impulses of a watch having, for instance, 240 beats per minute. Under these conditions the beats of the watch, that is to say the alternate ticks and the tocks, will occur approximately one-quarter second apart, a tick occurring each half second interspersed by tocks which occur at half-second intervals. If the watch is in perfect beat, the tick will follow a tock at exactly one-quarter-second intervals, but very often even in substantially-perfectly-operating watches, the interval between a tick and a tock may be slightly more or less than one-quarter second, in which case the interval between the tock and the tick will be commensurately smaller or greater than one-quarter second. The duration of the sound emanating from the watch 10 for each tick and each tock may, in some instances, be as high as one-twentieth of a second, though the ticks and the tocks are not usually alike in amplitude.

In the apparatus illustrated in Fig. 1, the condensers 18 and 19 serve to isolate the tubes A and B from any direct current emanating from the amplifier 13. The resistors 31, 33 and 34 are all grid resistors serving merely to maintain the grids of the respective tubes A, B and C at the potential of the point 37 of the circuit. The plates of the respective tubes A, B and C are electrically interconnected, as shown, by a conductor 38, to the plus power-supply wire 39, with resistors 25, 26 and 27 appropriately interposed as shown in Fig. 1.

The cathode of the tube A is connected by means of a conductor 40 (in which is interposed the resistor 28 and the resistor 29) to the cathode of the tube B. Intermediate the resistors 28 and 29 just referred to, the conductor 40 is connected by means of a conductor 41 (in which is interposed the resistor 32) to a conductor 42 extending between a negative power-supply wire 43 and the amplifier 13. The necessary negative voltage on the respective grids of the tubes A and B is provided by the voltage drop across the resistor 32 which is in series with the respective cathodes of each of the said tubes. Thus, negative voltage is applied to the respective grids of the tubes A and B through the grid-resistors 31 and 33 respectively, and always appears between the cathode and the grid of the tube A and the cathode and the grid of the tube B.

It will be obvious from the foregoing and from reference to Fig. 1 that the tubes A and B are in out-of-phase relationship.

The remainder of the wiring of the circuit illustrated in Fig. 1 is so clear as not to require individual reference characters for each of the conductors.

In the apparatus shown in Fig. 1, the tubes A and B are normally maintained at cut-off conditions, due to the voltage drop across the resistor 32, which is common to the cathodes of both tubes A and B. This is a practice well known in the art, since a voltage drop across the resistor 32 places the cathodes of the tubes A and B at a higher positive potential than the potential in the line wire 42, and the resistors 31 and 33 connect the respective grids to the line wire 42, thereby making both of the said grids less positive than the cathode, which, in other words, is the same as making the grids negative relative to the cathodes. The voltage drop across the resistor 32 presumes, of course, that one of the two tubes A or B is in a "fired" or "conducting" condition. This condition will always obtain when the apparatus is energized, since when neither tube is fired no voltage appears across the resistor 32 for the reason that a voltage drop depends upon current flow. If no bias voltage appears, one of the tubes will discharge and provide such current flow. The two tubes A and B will not normally fire at the same time, as it is exceedingly remote or improbable that any two tubes would be absolutely identical in characteristics. When one tube does fire, however, voltages are set up which affect the other tube so that it is not capable of firing for a predetermined time-interval with ordinary in-put voltages.

In considering the circuit now under discussion, it must be borne in mind that both static (steady) conditions and also transient (dynamic) conditions are involved. Under these conditions of providing impulses, the tubes A and B will function properly, even though a considerable variation of in-put voltage is encountered. The fact that one tube effectively "blocks up" or "stifles" the other for a brief period of time after it has been fired, prevents undesired impulses due to changes in input.

For purposes of an understanding of the operation of the apparatus shown in Fig. 1, let it be assumed that the tube A is in a conducting condition and that current is flowing through the resistors 25, 28 and 32.

Since the tube A has fired as a result of an impulse from the amplifier 13 and has reached a steady state of conduction, it may be said by way of example that approximately .002 ampere is flowing through the resistor 25, the tube A, resistor 28 and the resistor 32. The voltage drop across each member mentioned then is respectively 200 volts, 15 volts, 4 volts and 30 volts as normal values when the gas in the tube A is ionized. With no current flowing through the tube B, no voltage drop occurs across the resistor 26, and the condenser 20 charges up to 200 volts, which appears across the resistor 25. The voltages just referred to are "IR" drops which depend upon the values of current ("I") and the resistor ("R") through which the current flows. The 30-volt potential across the resistor 32, blocks up the tube B due to the bias effect already explained.

Now when the next impulse comes from the amplifier 13 as a result of one beat of the timepiece 10, the tube A is at this time insensitive, owing to the fact that it is already ionized, but the impulse will be sufficient to make the grid

of the tube B positive so that the said tube conducts, and current will flow through the cathode-anode circuit of the tube B. This current-flow sets up an IR drop in the resistor 26 of 200 volts, due to the current-flow through this leg of the circuit. It should be noted that the plate of the tube B, instantly upon that tube becoming conductive as just described, drops in potential and that the plate-connection of the resistor 26 is negative with respect to the conductor 38. Furthermore, it is to be noted that the plate-connection of the tube B is common with the positive side of the condenser 20. Thus, when the tube B becomes conductive, the condenser 20 discharges through the tube B, the resistors 29 and 32, and the power supply, all of which features constitute a circuit in parallel with the resistor 26, and the discharge current also passes through the resistor 25. This discharge current in passing through the resistor 25 increases the IR drop therein to a value in excess of the original 200 volts and thereby lowers the plate-potential of tube B to a degree sufficient to deionize and snuff out the tube A. The plate-connection of the tube A is in common with the negative side of the condenser 20 which thus reduces the potential of the plate of the tube A when the tube B becomes conductive.

When the tube A becomes de-ionized and snuffed-out as above described, the condenser 20 will discharge through the resistors 25 and 26 and recharge in the opposite direction, until the voltage appearing across the said condenser 20 is equal to the IR drop across the resistor 26. At this time steady conditions will obtain. The circuit is symmetrical and when the steady conditions occurs with the condenser 20 fully charged, the circuit is in such condition that the next impulse from the amplifier 13 will cause the tube A to ionize, to both itself become conductive and to snuff-out the tube B, for reasons of a character already explained in connection with the snuffing-out of the tube A.

From the foregoing it will be seen that when a tick or tock is picked up by the microphone 11, the amplifier 13 will send out an electrical impulse which will cause the previously-idle tube (A or B, as the case may be) to become conductive and to snuff-out the companion tube which has just previously been conducting. As each of the tubes A or B is snuffed-out, it will cause the companion tube to "reset" itself, so to speak, in preparation for being fired by the next impulse from the amplifier 13.

With the switch 36 in the position shown by full lines in Fig. 1, each time the tube A fires or becomes conductive, it causes the tube C to fire or become conductive, so that the latter tube, in turn, affects the oscillograph 14 and diverts or deflects a portion of the normally-horizontal-appearing beam 17 into a substantially-vertical flash 44 which fades and reappears alternately with each alternate beat of the watch 10. Should the switch 36 be shifted into the position shown by broken lines in Fig. 1, then it will be the tube B which will fire the tube C.

If, following a given appearance of the vertical flash 44, the next appearance of the said flash should be to the left of the position in which it previously appeared, such change of position would indicate that the watch being tested is not keeping correct time and may, for instance, indicate that the watch is running slow. If the vertical flash 44, upon its subsequent occurrences, following its first occurrence just above referred to, should appear more to the right of the position of its first appearance, this will also indicate that the watch is not in beat with the frequency-standard as determined by the frequency-standard control 16. When, however, the vertical flash 44 appears and reappears at the same location on the screen 15 of the oscillograph 14, the indication is that the beat of the watch 10 is in consonance with the frequency-standard supplied by the frequency-standard control 16.

In instances where the timepiece being tested is very close to keeping correct time as determined by the unit 16, the sequential vertical flashes 44 will appear to very gradually drift either to the left or right.

From the foregoing it will be seen that the resistances, condensers, etc., of the circuit shown in Fig. 1 are such that the tube A is fired by every alternate beat of the watch 10 to effect the firing the tube C and the actuation of the oscillograph 14. The tube B becomes activated by each beat intermediate the beats which activate the tube A and, under the conditions shown in Fig. 1, the tube B acts as a shut-off or snuffer for the tube A, to cause the said tube A to cease functioning shortly after each activation thereof in order that the said tube A may be set for becoming active on each alternate beat of the watch 10.

Since, as before noted, the beat of the watch 10 is made up of alternate ticks and tocks, for purposes of description let it be assumed that the tube A is activated by each tick and the tube B by each tock. Thus, each tick acts through the tubes A and C to create a vertical flash such as 44 upon the screen 15 of the oscillograph 14. Meanwhile each tock of the watch 10 activates the tube B to cause the said tube B to snuff out the tube A and "reset" the same, so to speak, for activation by the next tick. The tube B does not fire the tube C, but acts only as a snuffer for the tube A.

Let it be assumed for purposes of description that the impulse provided by each tick of the watch 10 is not quite satisfactory for the actuation of the oscillograph 14 and that the operator decides, therefore, that the watch should be tested on each tock. To shift over and time each tock, all that the operator need do is shift the movable contact of the switch 36 from the position in which it is shown in full lines in Fig. 1 to the position in which it is shown by broken lines.

This shifting of the switch 36 causes the tube B to become the tube which controls the firing of the indicator-tube C and thus the oscillograph 14 will be activated by each tock of the watch 10 rather than each tick as has previously been the case. The role of the tube A has also been changed by the shift-over of the switch 36 so that the said tube A acts as a snuffer for the tube B to reset the tube B intermediate each pair of tocks. Under these conditions, the tube A does not directly affect the tube C.

Referring now to the apparatus illustrated in Fig. 2, it will be noted that a microphone or other impulse-generator 46 is employed which is activated by a watch 47 or other instrument being timed. Like the apparatus of Fig. 1, the apparatus of Fig. 2 includes an amplifier 48. The apparatus also includes two gas-discharge electronic-tubes E and F which may correspond to the tubes A, B and C in general characteristics.

The circuit shown in Fig. 2 has incorporated therein condensers 48, 49, 50, 51, 52 and 53. The

apparatus also includes resistors 54, 55, 56, 57, 58, 59, 60, 61 and 62.

The circuit also includes an oscillograph 63 or other suitable indicator corresponding to the oscillograph 14 before described, and having a fluorescent screen 64 upon which appears a substantially-horizontal flash or beam 65 corresponding to the beam 17 referred to in connection with the apparatus of Fig. 1. The flash or beam 65 is produced by the action of a frequency-standard control 66 which may correspond to the frequency-standard control 16 referred to in connection with the description of Fig. 1.

The individual wires connecting the various tubes, condensers, resistors, etc., above described, do not require detailed description herein as the circuit connections are made plain by Fig. 2.

Each beat (both ticks and tocks) of the watch 47 will be picked up by the microphone 46, and the energy produced thereby will be strengthened by the amplifier 48 with the result that each of the said beats will apply positive voltage to the grid of the tube E. The application of positive voltage to the grid of the tube E will, in each instance, cause the same to conduct or fire.

It is well to halt the description of operation at this point to explain that the condenser 49 and the resistor 56 and also the condenser 51 and the resistor 61 provide a timed discharge-constant respectively. The combination of the resistor 56 and the condenser 49 is so proportioned and valued as to provide a time-constant somewhere in the vicinity of the interval between each beat of the watch 47. Under these conditions, the tube E will fire in step with the beats of the watch 47 (once for each tick and tock) owing to the fact that the amplifier voltage will apply a varying voltage to the grid of the tube E. When the grid of the tube E becomes positive, it fires the tube and discharges the condenser 49 through the resistor 56. When the discharge described takes place, the voltage across the condenser 49 decreases to such a value that the tube ceases to conduct and resets itself for the next cycle of operations.

The condenser 51 and the resistor 62 are adjusted and related so that the timing of the tube F is in frequency approximately one-half of that of the tube E.

The impulse from the tube E when the same discharges or fires as above described, is of proper phase relation to drive the grid of the tube F to such a value that it will be caused to fire through the condenser 51, but will not fire until such condition is reached. Thus, the discharge time-constant of the tube F depends on the values of the condenser 51 and the resistor 61, and is preferably of such value that the discharge occurs in the vicinity of .001 second.

From the foregoing it will be seen that the watch 47 will cause the tube E to fire in step with each beat (both ticks and tocks) and provide an impulse across the resistor 56 which in turn is applied to the tube F to cause the latter to fire with every other discharge of the tube E, and hence with every other beat of the watch 47. The transient appearing across the resistor 61 is transferred through the condenser 53 to the oscillograph 63 to cause a flash or transient 67 extending perpendicularly with respect to the flash or beam 65 before referred to on the screen 64.

The out-of-timing, if any exists, of the watch 47 being tested will vary the position of the vertical flash or transient 67 on the screen 64 of the oscillograph 63 in a manner similar to that described in connection with the apparatus of Fig. 1.

From the foregoing, it will be seen that the apparatus of Fig. 2 is such that only every other beat (each tick or each tock, but not both) is caused to become visible or otherwise apparent by means of the oscillograph 63 or such other indicator as it may be desired to employ and which will properly respond to the impulses supplied by the circuit.

By providing an apparatus in which every other beat of the escapement of a time-instrument may be eliminated, as is the case with both of the forms of the present invention shown in Figs. 1 and 2, the confusion which would arise, were every beat to be thrown upon the fluorescent screens, or their equivalents, is avoided. The confusion referred to might occur from several different causes, such, for instance, as the fact that more often than not each succeeding beat of the timepiece-movement does not occur at the same time-interval, though each complete cycle of two beats each (one tick and one tock) would occur at regularly-timed intervals. Thus, if both the ticks and tocks were impressed upon the fluorescent screens, or their equivalent indicating-means, the jumping-in position between the tick-impulses and the tock-impulses would ordinarily be of such confusing nature as to preclude the reasonably-accurate judgment as to the timekeeping properties of the watch.

Another cause for possible confusion, if both ticks and tocks are indicated, would, under some circumstances, arise from the fact that the sound produced by a tick might very markedly differ from the sound produced by the tock.

Thus, by means of the present invention, an apparatus is produced which serves to accurately indicate the timekeeping properties of a time-instrument being tested.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

I claim:

1. An apparatus for timing impulses including in combination: an electrical pick-up device constructed and arranged to respond to each beat of a timpiece-unit; an indicator; an electrical circuit interconnecting the said electrical pick-up device and the said indicator; a pair of interacting electronic-discharge gas tubes both connected by the said electric circuit to the said pickup-device for activation thereby; means causing the said pair of electronic-discharge tubes to assume an out-of-phase relationship with respect to each other and causing one thereof to act as a snuffer for the other; and a third electronic-discharge gas-tube connected to the said electric circuit and in position to be actuated by one of the said pair of tubes and to actuate the said indicator.

2. An apparatus for timing impulses including in combination: an electrical pick-up device constructed and arranged to respond to each beat of a timpiece-unit; an indicator; an electric circuit interconnecting the said electrical pick-up

device and the said indicator; two interacting electronic-discharge gas-tubes both connected by the said electric circuit to the said pick-up device for activation thereby; means causing one of the said discharge-tubes to act as a snuffer for the other thereof; and means independent of the timpiece being tested and constructed and arranged to time the said discharge-tube in out-of-phase relationship.

3. An apparatus for timing impulses including in combination: a microphone constructed and arranged to respond to each beat of a timepiece-unit; an oscillograph; an electric circuit interconnecting the said microphone and the said oscillograph; two interacting electronic-discharge gas-tubes connected by the said electric circuit to the said microphone for activation thereby; means independent of the timepiece being tested and causing one of the said discharge-tubes to act as a snuffer for the other thereof; and means independent of the timepiece being tested and constructed and arranged to time the said discharge-tubes in out-of-phase relationship.

4. An apparatus for timing impulses including in combination: an electrical pick-up device constructed and arranged to respond to each beat of a timepiece-unit; an indicator; an electric circuit interconnecting the said electrical pick-up device and the said indicator; a pair of interacting electronic-discharge gas-tubes connected into the said circuit to respectively receive only selected beats picked up by the said electrical pick-up device; means independent of the timepiece being tested and interconnecting the two said gas-tubes and constructed and arranged to give the two said electronic-discharge gas-tubes an out-of-phase relationship and to cause one thereof to act as a snuffer for the other thereof which latter is connected into the aforesaid circuit in a manner to cause its discharge to actuate the said indicator.

5. An apparatus for timing impulses including in combination: an electrical pick-up device constructed and arranged to respond to each beat of a timepiece-unit; an indicator; an electric circuit interconnecting the said electrical pick-up device and the said indicator; two interacting electronic-discharge gas-tubes connected by the said electric circuit to the said pick-up device for activation thereby; means causing one of the said discharge-tubes to act as a snuffer for the other thereof; means independent of the timepiece being tested and constructed and arranged to time the said gas-tubes in out-of-phase relationship; and a frequency-standard control-unit electrically connected to the said indicator and providing a standard-frequency indication thereon for comparison with the effects of beats of the timepiece-unit upon the said indicator.

6. An apparatus for timing impulses including in combination: a microphone constructed and arranged to respond to each beat of a timepiece-unit; an oscillograph; an electric circuit interconnecting the said microphone and the said oscillograph; two interacting electronic-discharge gas-tubes connected by the said electric circuit to the said microphone for activation thereby; means causing one of the said gas-tubes to act as a snuffer for the other thereof; means independent of the timepiece being tested and constructed and arranged to time the said gas-tubes in out-of-phase relationship; and a frequency-standard control-unit electrically connected to the said indicator and providing a standard-frequency indication thereon for comparison with the effects of beats of the timepiece upon the said indicator.

7. An apparatus for timing impulses including in combination: a microphone constructed and arranged to respond to each beat of a timepiece-unit; an oscillograph; an electric circuit interconnecting the said microphone and the said oscillograph; a frequency-standard control-unit connected to the said oscillograph and providing upon the screen thereof an oscillating beam of predetermined frequency; a pair of interacting electronic-discharge gas-tubes connected by the said electric circuit to the said microphone for activation thereby; and means independent of the timepiece being tested and causing one of the said gas-tubes to assume an out-of-phase relationship with respect to the other of said gas-tubes and to cause one thereof to act as a snuffer for the other, one of the said gas-tubes responding to only the ticks and the other thereof responding to only the tocks of a timepiece-unit being tested and only one thereof affecting the said oscillograph to periodically deflect the oscillating beam thereof provided by the said frequency-standard control-unit.

8. An apparatus for timing impulses including in combination: a microphone constructed and arranged to respond to each beat of a timepiece-unit; an oscillograph; an electric circuit interconnecting the said microphone and the said oscillograph; a frequency-standard control-unit connected to the said oscillograph and providing upon the screen thereof an oscillating beam of predetermined frequency; a pair of interacting electronic-discharge gas-tubes connected by the said electric circuit to the said microphone for activation thereby; means causing one of the said gas-tubes to assume an out-of-phase relationship with respect to the other of said gas-tubes and to cause one thereof to act as a snuffer for the other, one of the said gas-tubes responding to only the ticks and the other thereof responding to only the tocks of a timepiece-unit being tested and only one thereof affecting the said oscillograph to periodically deflect the oscillating beam thereof provided by the said frequency-standard control-unit; and means for selectively causing either one or the other of the said discharge-tubes to deflect the oscillating beam of the said oscillograph.

9. An apparatus for timing impulses including in combination: electrical pickup means constructed and arranged to respond to each beat of a timepiece-unit; an indicator; an electric circuit interconnecting the said electrical pickup means and the said indicator; a frequency-standard control-unit connected to the said indicator and providing upon the screen thereof an oscillating beam of predetermined frequency; a pair of electronic-discharge tubes connected to the said electric circuit; and means causing one of the said discharge-tubes to assume an out-of-phase relationship with respect to the other of said discharge-tubes and to cause one thereof to act as a snuffer for the other, one of the said discharge-tubes responding to only the ticks and the other thereof only the tocks of a timepiece-unit being tested and only one thereof affecting the said indicator to periodically deflect the oscillating beam thereof provided by the said frequency-standard control-unit.

10. An apparatus for timing impulses including in combination: an electrical pickup device

constructed and arranged to respond to each beat of a timepiece-unit; an indicator; an electric circuit interconnecting the said electrical pickup device and the said indicator; a first electronic-discharge gas-tube interposed in the said circuit in such manner as to be fired by impulses picked up by the said pickup device; a second electronic-discharge gas-tube also interposed in the said circuit intermediate the said first tube and the said indicator and connected to the said first tube to be fired thereby and connected to the said indicator to fire the same; and means constructed and arranged to cause the said second tube to respond only to predetermined ones of the impulses of the said first tube.

11. An apparatus for timing impulses, including in combination: an electrical pickup device constructed and arranged to respond to each beat of a timepiece unit; an indicator; an electric circuit interconnecting the said electrical pickup device and the said indicator and including two interacting electron tubes each having a filament, a grid and a plate, both of the said electron tubes being interconnected by the said electric circuit to interact each one upon the other and to be each activated independently of the other directly by the said pickup device; and capacitance-means connected in the said electric circuit and constructed and arranged therein to alternately act in conjunction with each of the said tubes to cause the conductive condition of either one of the said tubes to automatically render the other nonconductive to thereby substantially suppress selected beats of the timepiece unit picked up by the said electrical pickup device and to transmit to the said indicator remaining beats of the said timepiece unit.

12. An apparatus for timing impulses, including in combination: a microphone constructed and arranged to respond to each beat of a timepiece unit; an oscillograph; an electric circuit interconnecting the said microphone and the said oscillograph and including two interacting electron tubes each having a filament, a grid and a plate, the two said tubes being interconnected by the said electric circuit to interact each one upon the other and to be each activated independently of the other directly by the said microphone; and capacitance-means connected in said circuit and constructed and arranged therein to alternately act in conjunction with each of the said tubes to cause the conductive condition of either one of the said tubes to automatically render the other nonconductive to thereby substantially suppress selected beats of the timepiece unit picked up by the said microphone to transmit to the said oscillograph remaining beats of the said timepiece unit.

13. An apparatus for timing impulses, including in combination: an electrical pickup device constructed and arranged to respond to each beat of a timepiece unit; an oscillograph; a frequency-standard control apparatus electrically connected to the said oscillograph to provide an oscillating light-line thereon of predetermined frequency; an electric circuit interconnecting the said electrical pickup device and the said oscillograph and including two interacting electron tubes each having a filament, a grid and a plate, the two said electron tubes being interconnected by the said electric circuit to interact each one upon the other and to be each activated independently of the other directly by the said pickup device; and capacitance-means connected in the said circuit and constructed and arranged therein to alternately act in conjunction with each of the said electron tubes to cause the conductive condition of either one of the said tubes to automatically render the other nonconductive to thereby substantially suppress selected beats of the timepiece unit picked up by the said electrical pickup device and to transmit to the said oscillograph remaining beats of the said timepiece unit to periodically deflect the oscillating light-line appearing on said oscillograph under the control of the said frequency-standard control.

14. An apparatus for timing impulses, including in combination: a microphone constructed and arranged to respond to the sound produced by each beat of a time-piece unit; an oscillograph; a frequency-standard control electrically connected to the said oscillograph and producing therein a visual oscillating light-line of predetermined frequency; an electric circuit interconnecting the said microphone and the said oscillograph and including two interacting electron tubes each having a filament, a grid and a plate, the two said electron tubes being connected by the said electric circuit to interact each one upon the other and to be each activated independently of the other directly by the said microphone; and capacitance-means connected in the said circuit and constructed and arranged therein to alternately act in conjunction with each of the said electron tubes to cause the conductive condition of either one of the said tubes to automatically render the other nonconductive to thereby substantially suppress selected beats of the timepiece unit picked up by the said microphone and to transmit to the said oscillograph remaining beats of the said time-piece unit to periodically deflect the oscillating light-line appearing on said oscillograph under the control of the said frequency-standard control.

15. An apparatus for timing impulses including in combination: an electrical pickup device constructed and arranged to respond to each beat of a timepiece unit; impulse-receiving means; an electric circuit interconnecting the said electrical pickup device and the said impulse receiving-means and including two primary interacting electron tubes each having a filament, a grid and a plate, both of the said primary electron tubes being interconnected by the said electric circuit to interact each one upon the other and to be each activated independently of the other directly by the said pickup device, and capacitance-means connected in the said electric circuit and constructed and arranged to alternately act in conjunction with each of the said primary tubes to cause an increase of current through either of the said primary tubes to decrease the current through the other thereof and to thereby cause each of the said primary tubes to respond only to alternate beats of the timepiece unit; and a secondary tube electrically connected to one of the two said primary tubes; and second circuit-means electrically connecting the said secondary tube to the said impulse-receiving means to transmit to the latter impulses passing the one of the said primary tubes to which the said secondary tube is connected.

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