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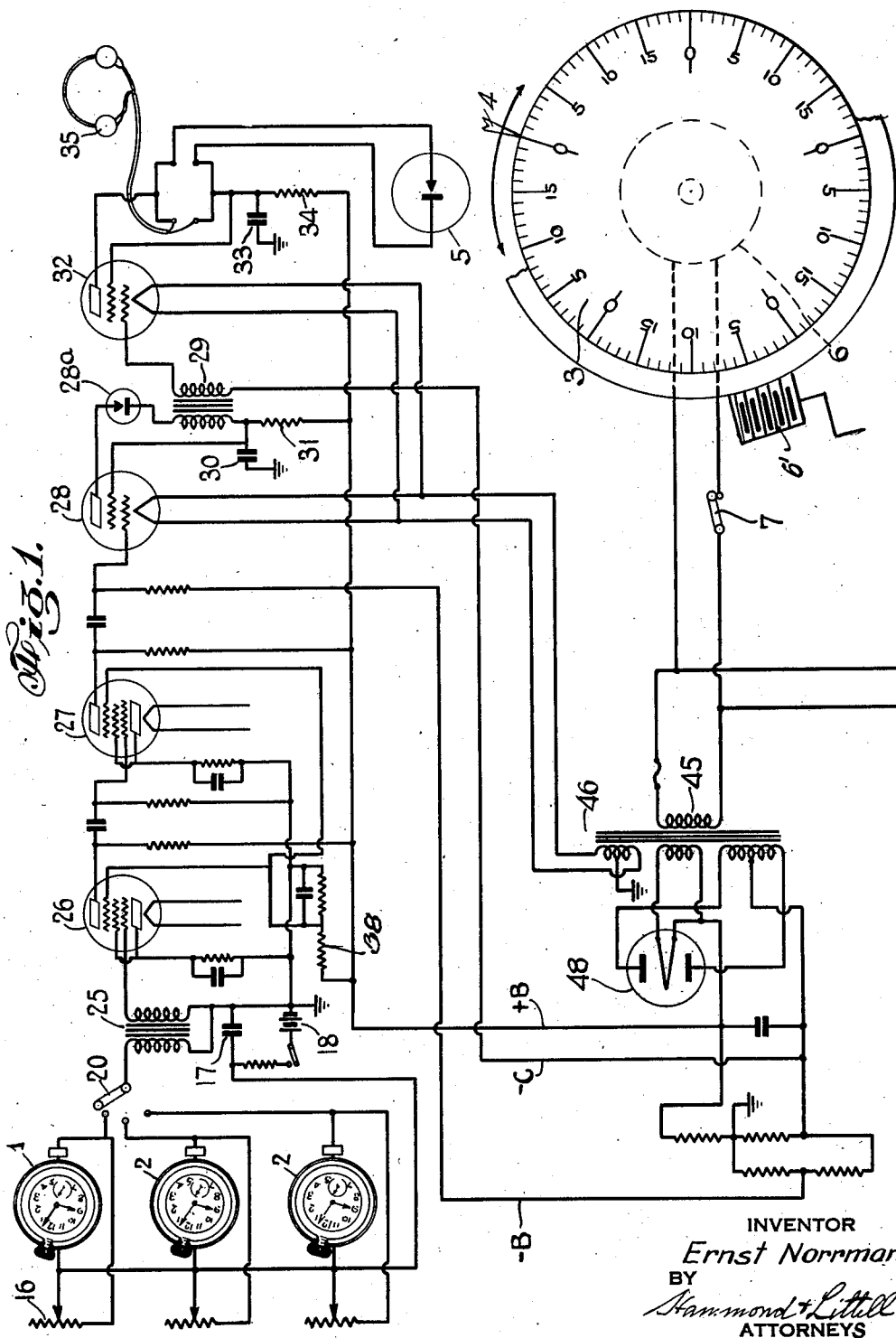
E. NORRMAN

2,058,616

APPARATUS FOR TIMING WATCHES

Filed May 10, 1933

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Fig. 2.

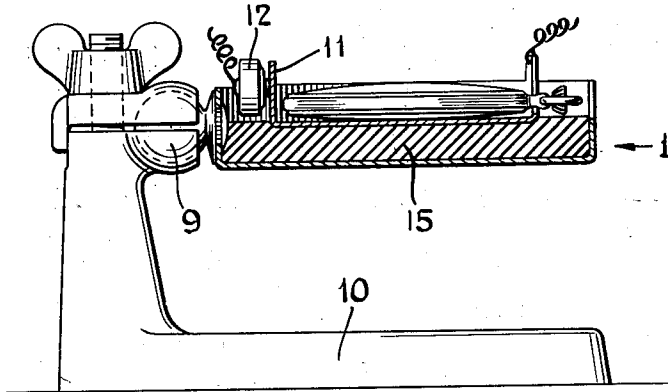


Fig. 5.

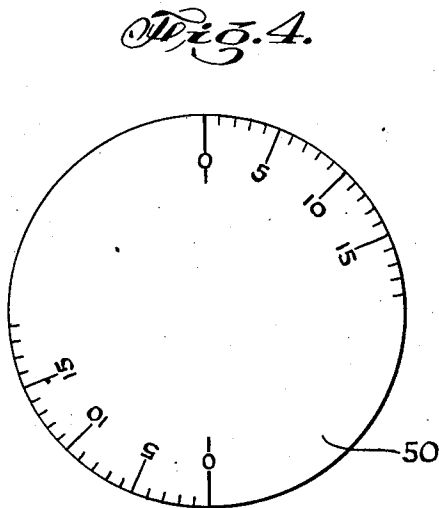
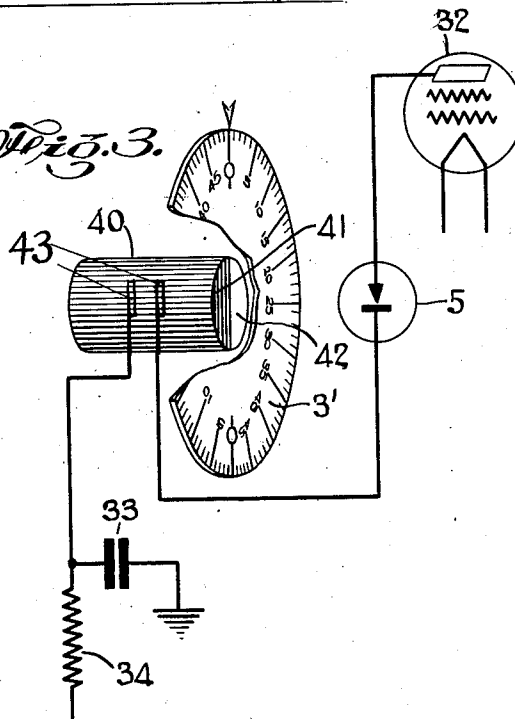


Fig. 4.

Fig. 3.



INVENTOR

Ernst Norrman

BY

Hammond & Littlell

ATTORNEYS

UNITED STATES PATENT OFFICE

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APPARATUS FOR TIMING WATCHES

Ernst Norrman, Brooklyn, N. Y.

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4 Claims. (Cl. 73—51)

The present invention has for an object to provide an improved apparatus for testing chronometers as compared with a master chronometer.

5 In the course of the manufacture of chronometers of all kinds various adjustments are necessary if accuracy under the varying conditions is to be secured. This is particularly true of watches which, if the maximum accuracy is to be maintained must be adjusted for changes in temperature and for the changes in the position in which they may be carried. For example, a watch can be so adjusted that it will vary less than five seconds per day when held in any one of five positions. When it is noted that the adjustment to such accuracy requires repeated testing of the running and repeated stoning of the bearings until by the cut and try method the required accuracy is obtained, it is obvious that without precision instrumentalities a long time may elapse after a watch is assembled before it is ready for delivery. In a watch repair shop such time requirement delays return of the watch to the customer. In a factory such a time interval means a tie-up of capital and unavoidable delay in filling orders, particularly special orders.

If, for example, it is possible to read the time of the watch to an accuracy of only one second then a period of twenty-four hours is necessary to detect this variation but if the watch can be read to an accuracy of 1/100 of a second fifteen minutes is sufficient to determine a variation of this amount.

35 The present invention in its preferred embodiment provides an apparatus for timing watches as compared with a rotating dial, one graduation of which represents a variation of 1/100 of a second, and inasmuch as it is possible ordinarily to read to a fraction of the graduation it is possible to detect even smaller variations.

40 The present invention has been developed more particularly in producing an apparatus for testing watches for adjustment or regulation and for the purposes of disclosure of the principles of the invention such an apparatus will be described, reference being had to the accompanying drawings forming a part hereof and in which:

Figure 1 is an electrical diagram showing an illustrative circuit,

50 Fig. 2 is a detail view showing a suitable holder for a watch to be tested,

Fig. 3 is a detail view showing an alternative arrangement whereby certain ticks of the watch may be caused not to energize the circuit,

55 Fig. 4 is a view showing an alternative form of

reference member, and Fig. 5 is a view showing an alternative arrangement whereby the index 4' is movably connected adjacent the periphery of the dial 3.

The apparatus to be described for the purposes 5 of illustration comprises a support 1, for a master chronometer with which the watches to be tested are to be compared, a series of supports 2, for watches to be tested, a constantly driven graduated dial 3, adjustable index 4 adjacent the dial, 10 a lamp 5 positioned to illuminate the dial adjacent the index and an amplifier circuit arranged to cause a momentary flash responsive to the tick as either the master chronometer or a selected one of the watches to be tested is connected to 15 the circuit.

The dial which is selected as a convenient type of constantly driven reference member may be driven at the rate of one rotation per second as by means of a synchronous motor 6. The dial 20 shown is divided into five similar sections, each section being graduated in twenty parts. Since the watch for the testing of which this apparatus is particularly designed ticks five times per second, the zero reading of each section will be 25 in the same position for each tick of the watch.

The index 4 adjacent the dial and the momentary flashing of the lamp to illuminate both make possible the accurate reading of the dial to determine whether the watch is fast or slow and how much. It is desirable to make provision for relative adjustment between the rotating dial and the index. Ordinarily when only small adjustment is desired it is more convenient to provide this adjustment by making the index adjustable 35 along the edge of the dial as indicated in Fig. 1, than to provide adjustment of the dial itself to bring the index and the zero of the dial, at the moment of flashing, together. If greater adjustments are to be made it may be more convenient 40 to provide for adjustment of the dial itself. Such adjustment may be made in various ways. In the arrangement illustrated the dial is driven from the line current and for purposes of adjustment a switch 7 is arranged to permit momentary opening of the circuit thereby to permit the dial to lose a portion of a rotation. As shown diagrammatically in Fig. 1 a worm 6' is connected to rotate the base supporting the motor 6 through a gear formed on the motor base. The motor may 50 be turned on its base to make the adjustment.

The lamp 5 is arranged to be illuminated momentarily as the watch ticks. The type of lamp and the electrical circuits are such that the lamp flashes to illuminate the dial adjacent the 55

index 4, for a period of the time of the order of 1/1000 or 1/10,000 of a second at each tick, or at selected ticks of the watch; such instantaneous flash permitting one to read the dial as if it were stationary.

Inasmuch as the dial rotates from one graduation point to another corresponding point in another section during the one-fifth second between ticks, the dial will be read easily by a few repeated illuminations by the flash lamp 5.

For the purposes of illustration the watch supports 2 are indicated as carried by ball and socket joints 9 on fixed bases 10, the ball and socket connection permitting movement of the support to any of the desired positions in which the running of the watch is to be tested. Ordinarily the master chronometer or watch support need not be adjustable for obvious reasons.

Each support including the master support 20 comprises a rather heavy metal plate holder 11 for the watch and against the holder a microphone button 12 which is responsive to each tick of the watch. The watch holder is carried by a sponge rubber or other suitable packing or damping element 13 in order to avoid the effect of extraneous noises and jars which might otherwise excite the microphone button. This microphone is sensitive to the ticks of the watch but insensitive to room noises or jars. Across each microphone circuit a rheostat 16 for adjusting its sensitivity is connected.

There are certain advantages in introducing into the microphone circuit a condenser 17 and a resistance through which the condenser is charged somewhat slowly between ticks from the battery 18, the condenser serving as the principal source of voltage at the instant of the impulse. A switch 20 is arranged to connect any of the microphone buttons to the amplifying circuit by simply swinging the switch to the corresponding terminal of the respective circuits.

The first two stages of amplification including the input transformer 25 and amplifier tubes 26 and 27 may be arranged in accordance with standard practice for a resistance coupled amplifier. The third vacuum tube 28 employs a special circuit which may be called the time limiting circuit. The control grid of this tube preferably is biased to such a high negative potential that no plate current or at least a very weak one, is flowing through the tube as long as the grid is not disturbed by impulses from the previous stage. A small condenser 30, which serves as a source of voltage is slowly charged through a very high value resistor 31. A glow discharge tube 28a or a spark gap may be included in the plate circuit as shown. This tube is usually not necessary but is of value if it is desirable to eliminate response to alternate ticks of the watch from the output the arrangement making this possible will be described hereinafter. The first amplifier tube may also be biased approximately to "cut off" if desired.

The operation of the time limiting circuit is as follows. When the condenser 30 has been charged the circuit is at equilibrium, no current flowing in any part. When an impulse in a positive direction is impressed on the control grid of the tube 28, this tube will pass current and the condenser 30 discharges through the primary of the transformer 29. The time it takes for the condenser to discharge depends on its capacity and on the impedance of the primary winding of the transformer 29 and also on the plate impedance of the tube. By choosing the proper

constants, impulses of very short duration may be obtained. After the condenser 30 is discharged practically no current will flow through the tube on account of the high value of the resistor 31, through which the condenser 30 is charged relatively slowly.

By this circuit arrangement impulses (A. C. or D. C.) of a relatively long duration will give output impulses of very short duration of the order of 1/1000 or 1/10,000 of a second. The condenser 30 is slowly charged through the resistor 31, during the silent interval between the impulses and so the cycle repeats itself. The auxiliary grid of the vacuum tube 28 is connected to the plate side of the resistor 31. Thus this member has no voltage applied to it unless the condenser 30 is charged. This improves the time limiting action of the circuit.

The control grid of the output tube 32 is biased to or near "cut off" in order that it should not pass any current except when the grid is excited from the previous amplifier stage. A blocking resistor 34 and a storage condenser 33 are connected as shown to supply operating voltage to the lamp 5 in this circuit. The lamp 5 herein shown is a neon lamp suitably designed to provide the desired instantaneous flash to illuminate the dial.

If desired earphones 35 may be added to the circuit to make audible the tick induced impulse.

It is seldom that the time interval between two successive ticks is exactly the same, perhaps because the escapement is not perfectly centred. For this reason if the flash lamp 5 is lighted in response to each tick of the watch the device will show an apparent hunting the range of which will indicate the extent to which the escapement is inaccurately centred and whether correction is necessary. For timing purposes it is preferable to avoid this hunting and this may be accomplished by a provision whereby the lamp 5 is energized by alternate ticks only. This can be accomplished by varying the time of recharging of one of the condensers, for example, condenser 30. For this purpose, the several constants of the circuit are suitably chosen and the resistor 31 is made sufficient to prevent charging of condenser 30 between two successive grid impulses caused by the watch ticks while permitting an adequate charge during two intervals. Furthermore, this resistor is made adjustable in order that operation in either way may be possible, that is to say, operation to determine the difference between the two tick intervals and operation for timing the running of the watch. By further adjustment the time of charge may be even further extended to provide longer intervals between responses if desired. The bias resistance 38 of the first amplifier tube 26 should be high to cause the tube to act as a rectifier. The neon lamp or spark gap serves to prevent a discharge of the condenser 30 before it reaches the break-down voltage of this tube or gap.

The power for the amplifying circuit may conveniently be supplied from an A. C. current which also operates the motor of the reference dial. In the arrangement illustrated the A. C. line current passes through the primary 45 of a transformer 46 which transformer through a secondary winding supplies current to the filaments of the tubes. A rectifier tube 48 provides direct current to the +B circuit. The arrangements giving the +B, -B and -C voltages are

conventional and are sufficiently illustrated in the drawings.

Operation

In operation the watches to be tested are placed in the supports 2 and each watch is compared with the master chronometer. After a definite interval, as for example, two minutes, each watch is again compared to determine whether it is gaining or losing and how much. This procedure is repeated with the watches held in each position for which tests are desired. The method of comparison involves, preferably, first framing the dial by turning the switch 20 to connect the master watch to the circuit and adjusting the index 4 to indicate the zero position as the lamp 5 flashes and then successively connecting the watches being tested and reading the dial as illuminated thereby. The expression "framing the dial" is used to indicate the operation of bringing together the zero reading and the indicator 4 when the master watch is connected in the circuit. By this means when the watch to be tested is connected in the circuit the deviation from zero can be read directly. The dial should be shaded from any bright light for easy readings. For accuracy the dial should be again framed when taking the second set of readings after a time interval. Furthermore if the impulses from alternate ticks are eliminated in effect, accuracy will be better insured if repeated readings are taken to use either the responses from what may be termed the fast ticks or those from the slow ticks in each case. It will be remembered that the time intervals between ticks is not uniform and if the dial is first framed for the fast tick and for second reading is framed for the slow tick or if a tested watch is similarly timed an error amounting to the difference of the tick intervals will be introduced. Obviously this is of minor importance until close adjustment of the watch is approached.

The electrical responses may be explained as follows: When the voltage of the control grid of the tube 28 swings in a positive direction the plate impedance of the tube decreases and the neon tube 28a, "breaks down" and passes current. The condenser 30 discharges through the primary of the transformer 29. The impulse is passed by the secondary winding of the transformer 29 to the control grid of the output tube 32. This tube will pass plate current and so flash the neon lamp 5. On account of the high resistance of resistor 31 the condenser 30 will not be charged sufficiently to "break through" the neon lamp 28a or spark gap the first time thereafter that the grid of the tube 28 swings positive and no output impulse will be obtained. But the next time the grid of tube 28 swings positive the condenser 30 will have had time enough to charge to full voltage, and the neon tube will "break through" and an output impulse will be obtained. This cycle will repeat itself.

Fig. 3 shows an alternative arrangement for obtaining a limited number of output impulses from a given number of input impulses.

The commutator 40 is composed of one conducting segment 41 and one non-conducting segment 42. It is attached to the dial shaft in such a way that the conducting segment is concentric with one section of the dial, and the non-conducting segment is concentric with the other section of the dial. The output circuit of the amplifier tube 32 is modified to include two brushes 43 engaging the commutator 40. When

these brushes engage the conducting segment 40 the plate current passes through the tube 32 and lights the neon lamp 5. By this arrangement the number of output impulses will be reduced to half the number of input impulses. By designing the dial and the commutator differently other combinations may be obtained.

The dial 3' of this arrangement rotates once during each two-fifths of a second if the watches to be tested tick five times per second, but must rotate at a correspondingly different speed or must be differently graduated if the watches or other chronometers to be tested tick at a different rate. The brushes 43 preferably engage the center of the contact segment when the zero point of the dial is opposite the index at its mid-position in order that the same tick of the watch may be selected and they may be adjustable around the commutator.

Fig. 4 shows an alternative form of reference dial 50 designed to rotate once during each four tick intervals whether the watch ticks four times per second as usual or at a different rate and of which only alternate sections are graduated whereby only alternate ticks will be readable. This provides for avoiding the apparent hunting.

The foregoing particular description is illustrative merely and is not intended as defining the limits of the invention. Numerous variations may be made, for example if the reference member is driven with sufficient accuracy the master watch becomes unnecessary.

I claim—

1. An apparatus for timing watches comprising, in combination, a constantly driven reference member, an index member, said reference member and index member being relatively adjustable to frame the reference member, a flash lamp for illuminating the reference member adjacent the index member, a pair of tick responsive devices arranged to receive a master watch and a watch to be tested respectively, a circuit for momentarily energizing said flash lamp, and an amplifier circuit arranged to be connected alternatively to the tick responsive devices and arranged to trigger the flash lamp energizing circuit in response to ticks of the master watch or the watch to be tested respectively.

2. An apparatus for timing watches comprising, in combination, a motor and a reference dial constantly driven thereby, an index member adjacent said dial, means for mounting the motor and index member for relative adjustment to frame the dial, tick responsive microphone devices adapted to receive respectively a master watch and a watch to be tested, a flash lamp for illuminating the reference dial adjacent the index member, a circuit for energizing the flash lamp including a condenser of a capacity to be discharged to energize the flash lamp for a period of the order of 1/1000 of a second and a circuit connected to the microphone devices and arranged to trigger the flash lamp energizing circuit in response alternatively to the ticks of the master watch or the watch to be tested.

3. An apparatus for timing watches comprising a constantly driven graduated dial, an index member adjacent said dial, a flash lamp positioned to illuminate said graduated dial, means for energizing said flash lamp alternatively from a master watch or from a watch to be tested comprising tick responsive devices, an amplifier arranged to be connected alternatively to said tick responsive devices, and a flash lamp energizing circuit comprising a condenser, a resist-

ance through which the condenser is slowly charged and a tube the grid of which is connected to the amplifier to be energized by the tick impulse to trigger the discharge through the flash lamp.

4. An apparatus for timing watches comprising a constantly driven graduated dial, an index member adjacent said dial, a flash lamp positioned to illuminate said graduated dial, means

for energizing said flash lamp alternatively from a master watch or from a watch to be tested comprising tick responsive devices, an amplifier arranged to be connected alternatively to said tick responsive devices, and a flash lamp energizing circuit connected to the amplifier to be energized by the tick impulse to trigger the current through the flash lamp.

ERNST NORRMAN.