Oct. 24, 1944. T. B. GIBBS 2,361,281

TIMING APPARATUS

Filed Nov. 4, 1941

Fig. 1.

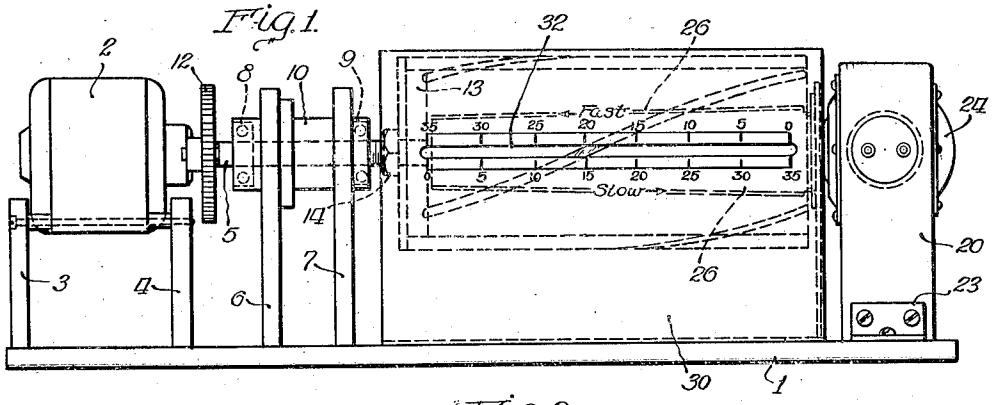


Fig. 2.

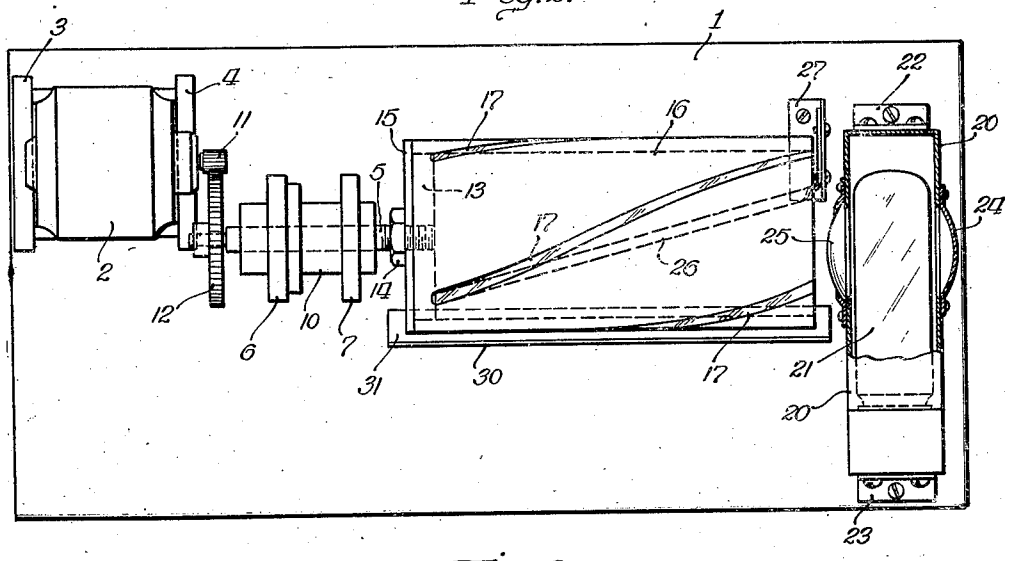
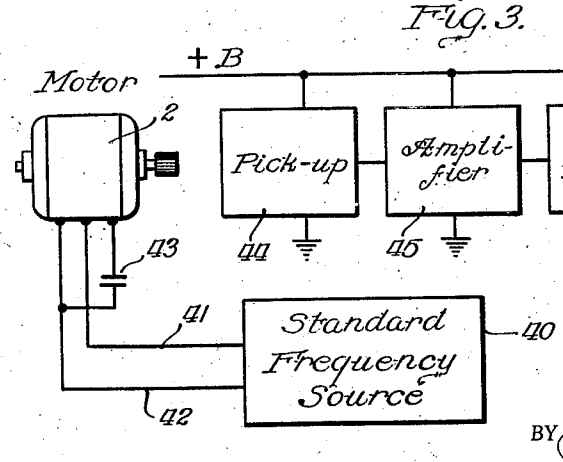


Fig. 3.



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TIMING APPARATUS

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12 Claims. (Cl. 73—6)

The present invention relates in general to timing apparatus, but more in particular to timing apparatus operating on the stroboscopic principle and including a constant speed element and a lamp which is flashed under control of the device being timed or tested. The object of the invention is to produce a new and improved timing apparatus of this character.

A special object of the invention is to produce a stroboscopic timing apparatus in which a light spot is used as an indicator and in which such indicator travels along a straight line in a direction and at a speed which is dependent upon the rate of the device being timed.

The invention and various features thereof will be described in detail hereinafter, reference being had to the accompanying drawing, in which:

Fig. 1 is a front view of a timing apparatus constructed in accordance with the invention;

Fig. 2 is a top or plan view of the same; and

Fig. 3 is a diagrammatic circuit drawing showing the essential items of electrical equipment required and their connections.

Referring to the drawing, the reference numeral 1 indicates a rectangular metal plate which serves as a base on which the various parts of the timing apparatus are mounted. The construction and arrangement of these parts will be explained briefly.

The reference numeral 2 indicates a small synchronous motor of any suitable and known type. This motor is supported on two upright plates 3 and 4 which are secured to the base plate 1. The construction will be clear from Figs. 1 and 2.

The motor 2 is geared to a shaft 5 by means of a pinion 11 and gear wheel 12. The shaft 5 is supported in ball bearings 8 and 9, which are mounted in a tube or cylinder 10 supported on the two upright plates 6 and 7. These upright plates are attached to the base 1 in any suitable manner, like the upright plates 3 and 4. They may, for example, be welded to the base plate.

At the end opposite the gear wheel 12 the shaft 5 carries a flanged disk 13, which is rigidly secured to the shaft. The shaft may be, for example, threaded into the disk and secured by a lock nut 14. The disk 13 supports a drum or cylinder 16, as shown. The disk 13 is of the same diameter as the inside diameter of the drum 16, which fits tightly on the disk with its end against the flange 15. A small amount of suitable cement may be used, if desired, to aid in holding the drum in place.

The drum 16 is opaque to light except for a plurality of narrow spiral light-transmitting windows 17 therein. The drum may be constructed in different ways. For example, the drum may be made of opaque material and may have light-transmitting portions in the form of spiral slots which are cut in the wall of the drum. In this case the slots should terminate short of the right hand end of the drum, leaving sufficient material to support the several sections into which the drum is divided by the slots. However, a preferred form of construction is to employ a drum made of some transparent plastic material such as Lucite and to paint the drum black except for the spiral light-transmitting portions 17.

Adjacent the end of the drum 16 there is an upright casing 20 constructed of sheet metal and secured to the base 1 by means of L-shaped brackets 22 and 23. In this casing there is mounted a light source 21, which is preferably a type 631P1 gas-filled tube known as a "Strobotron." The tube 21 is so located in the casing 20 that the light-emitting portion of the tube is centrally disposed with reference to the open end of the drum 16. A reflector 24 and a lens 25 are provided to project the light into the interior of the drum.

The reference character 26 indicates a concave cylindrical mirror which is located inside the drum 16 and is supported on the base 1 by means of an L-shaped bracket 27. The mirror 26 made be made of sheet metal, with a polished light-reflecting surface which is adapted to reflect the light received from lens 25 toward the window 32.

In front of the drum 16 there is a mask comprising a rectangular sheet metal plate 30 having a foot portion 31 by means of which it is attached to the base 1. This mask is of sufficient size so as to entirely cover the drum 16 when the latter is viewed from in front, as in Fig 1. The mask 30 is, however, provided with a horizontal slot or window 32 which is parallel to the axis of the drum and has the same elevation above the base. Through the window 32 the intersecting portion of one of the spiral windows 17 of the drum may be observed.

If desired, two calibrated scales may be provided above and below the window 32, one reading from right to left and the other from left to right.

Referring to Fig. 3, the reference character 40 represents a standard frequency source which is provided for generating alternating current of constant frequency for running the motor 2 at a predetermined constant speed. The standard frequency generator may be of any known and suit-

able type, although preferably a generator using a crystal oscillator as the constant frequency element is employed. The generator is connected to the motor 2 by means of conductors 41 and 42. As shown herein, the motor 2 is a two-phase motor, a condenser 43 being provided to produce the necessary phase displacement of the current in one of the motor windings.

The output frequency of the standard frequency generator depends on the motor speed desired, which in turn depends on a number of other factors, including the rate or frequency of the device to be timed. As disclosed herein, the timing apparatus has been designed especially for the static timing of fuses of the clockwork type, which have a beat frequency of 330 beats per second. As will appear presently, a suitable standard frequency for use in this situation is 55 cycles per second, which causes the motor 2 to run at a speed of 1650 R. P. M., assuming that the motor has four poles.

The circuit arrangement by means of which the fuse being timed controls the Strobotron tube 21 may be similar to known circuit arrangements used in watch timing, since the fuse is timed in a stationary condition. However, a circuit arrangement such as is used in the dynamic timing of fuses may also be employed, an example of such circuit arrangement being disclosed in the pending application of Gibbs et al., Ser. No. 350,932, filed August 3, 1940. The circuit may be simplified somewhat due to the fact that the elaborate filtering means required in dynamic timing is not necessary.

Fig. 3 shows the essential features of a circuit arrangement which may be employed following the teaching of the Gibbs et al. application.

The rectangle 44, labeled "Pick-up," represents a photo-electric pick-up apparatus by means of which a fuse being timed is caused to generate periodic voltages having the same frequency as the beat frequency of the fuse, that is, a frequency of 330 cycles per second or approximately that frequency, depending on how accurately the rate of the fuse is adjusted.

The rectangle 45 represents a suitable amplifier for amplifying the periodic voltages generated by the pick-up apparatus.

The rectangle 46 represents a frequency divider, comprising preferably a plurality of multivibrators arranged in tandem, for reducing the fuse frequency to a sub-multiple frequency which is more suitable for use in controlling the timing apparatus. The frequency divider may, for example, divide by 18; and in this case, since the frequency of the voltages generated by the fuse is 330 cycles per second, the output frequency of the frequency divider is 18⅓ cycles per second.

The output of the frequency divider is applied to the control grid 50 of the Strobotron tube 21. The grid 50 is normally at ground potential, while the grid 51 is maintained at a selected potential somewhere between ground potential and the positive B potential by a potentiometer comprising resistances 52 and 53. The output of the frequency divider has a wave shape characteristic of multivibrators; that is, the negative half-waves are of considerable amplitude and have a steep wave front. Each negative half-wave therefore drives the grid 50 to a potential which is considerably below ground potential and the potential on grid 51 has such a value that the difference in grid potentials thus established is sufficient to start the discharge of the tube 21. Each time the tube becomes conductive, the condenser 55 discharges very rapidly over a path which includes the cathode and plate of the tube, which emits a flash of light of very short duration. Each time the condenser 55 discharges the voltage at the plate of the tube 21 is reduced to such a low value that the space discharge through the tube cannot be maintained and it becomes non-conductive. Each time the tube 21 is extinguished in this manner, the condenser 55 charges through the resistor 54, and thus prepares for another discharge through the tube, when the next half-wave of control voltage is received at grid 50. The condenser 55 has sufficient capacity to light the tube 21 properly and the resistance 54 has such a value that the condenser becomes nearly fully charged each time.

The operation of the complete timing apparatus when set up for the static timing of fuses may now be explained briefly, it being assumed that the apparatus is connected as indicated in Fig. 3.

As previously stated, the output frequency of the standard frequency generator is 55 cycles per second, and accordingly the motor 2, being a four-pole motor, runs at a speed of 1650 R. P. M. The gear ratio between the motor 2 and the drum 16 is 1 to 6, and accordingly the speed of the drum is 275 R. P. M., or 4⅞ R. P. S. There are four of the light-transmitting spirals 17 on the drum so that these spirals 17 pass the viewing window 32 at the rate of 18⅓ spirals per second. In other words, if the motion of the spirals relative to the window 32 is regarded as a scanning operation, the scanning frequency is 18⅓ times per second.

The direction of rotation of the drum 16 may be counterclockwise, as seen from the right hand or open end of the drum. During each scanning operation, therefore, the intersection of the spiral which is performing the operation with the window 32 moves along the window from left to right at a uniform velocity. The spirals are ninety degrees apart, so that as one spiral completes a scanning operation the next spiral becomes effective to repeat the operation, and so on continuously so long as the rotation of the drum continues.

The pick-up apparatus 44 generates periodic voltages in response to the operation of the fuse, as previously explained, said voltages having a frequency of 330 cycles per second. These voltages are amplified by the amplifier 45, the output of which is transmitted to the frequency divider 46. This equipment divides the frequency by 18 and consequently the output of the frequency divider has a frequency of 18⅓ cycles per second or thereabouts, depending on the accuracy of the fuse being timed.

The frequency divider output is used to control the Strobotron tube 21, which accordingly flashes at the same frequency. At each discharge of the tube a momentary flash of light is projected to the interior of the drum by the reflector 24 and lens 25, and is reflected toward the window 32 by the mirror 26. These flashes are seen through the window at the point or points where the window is intersected by one of the spirals 17 at the instant the flashes are produced.

The first flash will be seen at some random point along the window, depending on the instant position of the spiral which is scanning the window. The drum may be in the position in which it is shown in Fig. 1, for example, in which case the first flash will be seen slightly to the left of the center of the window. Now the scanning

frequency is 18⅓ times per second, and since the Strobotron flashes at the rate of 18⅓ times per second (if the rate of the fuse being tested is correct), when the second flash occurs the drum will have rotated ninety degrees and the next spiral 17 will be in the same position relative to the window 32 as the preceding spiral was at the instant of the first flash. The second flash is accordingly seen at the same position in the window as the first flash, and the same is true of the succeeding flashes. These flashes are visible to the operator as a diamond-shaped light spot, which functions as an indicator. If the light spot remains stationary in one position while a fuse is being timed, it indicates that the rate of the fuse is correct, as will be understood from the foregoing.

If the rate of the fuse being tested is fast, then the interval between the first and second flashes will be shorter, the drum will not rotate a full ninety degrees during such interval, and when the second flash occurs the second spiral will intersect the window 32 at a point slightly to the left of the point where it was intersected by the first spiral at the time the first flash occurred. The succeeding flashes gain on the scanning drum in the same way and are seen at points located progressively farther to the left along the window 32. The light spot observed by the operator therefore drifts to the left, which indicates that the rate of the fuse is fast.

If the rate of the fuse is slow, the light spot will move to the right along the window 32, for reasons which will be readily understood. In this case the scanning drum gains on the flashes of the Strobotron, and as the spirals 17 scan the window 32 the intersections thereof advance progressively farther to the right as the corresponding flashes occur. This causes the light spot to drift to the right, which indicates that the rate of the fuse is slow, as stated.

The rate at which the light spot drifts along the window 32 is an indication of how much the fuse is fast or slow, as the case may be. The operator observes the rate of the drift, therefore, as well as its direction, for the purpose of making the necessary adjustment to correct the rate of the fuse. The direction of the drift indicates whether the rate should be increased or decreased, and the rate of the drift is a measure of the extent of the adjustment which has to be made in either case.

It will be understood from the foregoing that an experienced operator does not need to know the exact amount of the errors that are met with in order to time fuses satisfactorily, and the scales shown in Fig. 1 may not always be provided; or if provided, need not be used. Under certain circumstances, however, it may be desirable to ascertain the value of the gain or loss and to meet such a requirement the scales may be calibrated on the basis of a predetermined timing interval such as one minute so that the drift which takes place during such timing interval may be read as error in seconds per day.

The timing speed, or the rapidity with which readable rate indications can be obtained, depends on the scanning speed, which is a function of the scanning frequency and the linear distance traversed in each scanning operation. The scanning frequency is 18⅓ scanning operations per second, as previously explained. The effective length of the window 32, that is, the distance along the window which is scanned by each of the spirals 17, may be six inches. The scanning speed is therefore 110 inches per second, which is a relatively high speed. It may be compared, for instance, with the scanning speed in a well known watch timing apparatus of the recording type, which has a scanning speed of 90 inches per second.

It will be understood that the timing apparatus shown and described herein is well adapted for timing other devices, such as watches, for example. For timing five beat watches, which includes the great majority of all watches in use today, the timing apparatus may be used without change except that the scanning frequency must be changed so that it is equal to or an exact multiple of the beat frequency. This may readily be accomplished by using a standard frequency generator having an output frequency of 60 cycles per second. On 60-cycle current the motor 2 runs at 1800 R. P. M., or 30 R. P. S. The gear ratio being 1 to 6, the drum will rotate at a speed of 5 R. P. S., and since there are four spirals the resulting scanning frequency is 20 times per second, a frequency which is an exact multiple of the beat frequency.

It will be understood also that the speed of the drum or the number of spirals thereon, or both may be changed when necessary or desirable. For example, a gear ratio of 1 to 3 may be used, resulting in a drum speed of 10 R. P. S., assuming a 60-cycle standard frequency source as used in the preceding example. If the drum is now provided with three spirals spaced 120 degrees apart, the scanning frequency will be 30 times per second. With this scanning frequency the timing apparatus is adapted for timing both five and six beat watches.

It will be clear that various other combinations may be devised, whereby practically any desired scanning frequency may be obtained, adapting the timing apparatus for operation in timing any frequency that will ordinarily be met with in practice.

Various other modifications may be made within the principles of the invention. I do not therefore wish to restrict myself to the exact forms of the invention illustrated and described herein, but desire to include and have protected by letters patent all forms and modifications thereof that come within the scope of the appended claims.

I claim:

1. In a timer of the stroboscopic type, viewing means including a straight narrow window, a rotatable drum having one or more spiral windows so arranged that one window is at all times in intersecting relation with said first window, means controlled by a device being timed for producing light flashes inside said drum which are visible at the point where a spiral window on the drum intersects said first window, and means operative before any such light flashes are produced for rotating said drum at a predetermined constant speed such that if the rate of the device being timed is correct a spiral window will intersect said first window at the same point each time a light flash occurs and the light spot produced by successive flashes will appear to stand still.

2. In a timer of the stroboscopic type, viewing means including a straight narrow window, a drum open at one end supported for rotation behind said window, said drum having a light transmitting portion arranged to intersect said window at a point which travels lengthwise of the window as the drum is rotated, a light source lo-

cated outside said drum adjacent the open end thereof, an optical system for projecting light from said source into the interior of said drum, and a stationary mirror inside said drum for reflecting the light toward said window.

3. In a stroboscopic timer, means for forming a momentary beam of light, viewing means including a long narrow window extending parallel to said beam, means for reflecting said beam toward said window, and an element rotating between said reflecting means and window having means for blocking off from said window all of said beam except a small section thereof the position of which along the window depends on the instant position of the rotating element when the beam is formed.

4. In a timer of the stroboscopic type, viewing means including a straight narrow window, a rotatable drum behind said viewing means and having one or more spiral windows for scanning said first mentioned window, a light source for illuminating the interior of said drum to project light through said first mentioned window at any point where the same is intersected by a spiral window on the drum, means controlled by a device being timed for flashing said light source, and means effective whether the rate of said device is correct or not for rotating said drum at a predetermined constant speed such that the scanning frequency is an exact multiple of the flashing frequency produced by said device when its rate is correct.

5. In an apparatus for comparing the frequency of a train of periodic impulses with a standard impulse frequency, a rotatable drum having a plurality of narrow spiral light transmitting scanning windows equally spaced around the periphery of the drum, a mask in front of said drum having a straight narrow viewing window which is parallel to the axis of said drum, means including a light source for projecting light from the interior of said drum outwardly through said viewing window at any point where the same is intersected by one of said scanning windows, means controlled by said train of impulses for periodically flashing said lamp, and means comprising a synchronous motor and a constant frequency source of alternating current for rotating said drum at a predetermined constant speed such that the product of the drum speed in revolutions per second and the number of scanning windows is a number which is an exact multiple of the said standard impulse frequency in impulses per second.

6. Apparatus for checking the rate of timekeeping devices of the type which includes an element having periodic oscillatory motion, said apparatus comprising a light valve including a rotatable element and a fixed element cooperating therewith to define a light transmitting area which travels repeatedly along a straight line responsive to rotation of said rotatable element, said fixed element having a straight narrow window and said rotatable element having an intersecting window adjacent portions of which successively cooperate with said first window in defining said area, a source of alternating current having a predetermined constant frequency in cycles per second of standard time, a motor supplied with current from said source to drive said rotating element, said motor having a speed bearing a fixed relation to the frequency of said source, and means responsive to the beats of the oscillatory element of a device the rate of which is being checked for producing light flashes which are visible through said light valve.

7. In a watch timer, viewing means including a straight narrow viewing window, a rotatable drum behind said viewing means and having one or more spiral windows for scanning said viewing window, means including a light source for projecting light outwardly from the interior of said drum through said viewing window at any point where the same is intersected by a spiral window on said drum, means responsive to the beats of a watch being timed for flashing said light source, and means effective whether the watch is fast or slow for rotating said drum at a constant speed such that the scanning frequency is an exact multiple of the beat frequency of said watch when the same is keeping correct time.

8. In an apparatus for timing fuses, viewing means including a straight narrow viewing window, a rotatable drum having one or more spiral windows for scanning said viewing window, means including a light source for projecting light through said viewing window at any point where the same is intersected by a spiral window on said drum, means responsive to the operation of a fuse being timed for generating periodic voltages having a frequency corresponding to the beat frequency of the fuse, means including a frequency divider responsive to said voltages for flashing said light source at a frequency which is a submultiple of the frequency of said voltages, a time standard comprising a source of alternating current of predetermined constant frequency, and means including a motor driven from said source of alternating current for rotating said drum at a constant speed such that the scanning frequency is an exact multiple of the flashing frequency if the rate of the fuse being timed is correct.

9. In a stroboscopic timer, viewing means including a straight narrow window, a drum supported for rotation adjacent said window, said drum having a light transmitting portion arranged to intersect said window at a point which travels lengthwise of the window as the drum is rotated, means including a light source for projecting light through said window at any point where the same is intersected by the light transmitting portion of said drum, means controlled by a device being timed for flashing said light source at a frequency bearing a predetermined relation to the rate of the said device, and means for rotating said drum at a predetermined constant speed such that if the rate of said device is not correct the light spot produced by successive light flashes will travel in one direction or the other along said window depending on whether the rate of said device is fast or slow.

10. In a stroboscopic timer for timing watches or other timekeepers, means including a rotatable element and a fixed element cooperating therewith for producing a light transmitting area which moves repeatedly along a straight line during rotation of the rotatable element, said fixed element having a straight narrow window and said rotatable element having an intersecting window adjacent portions of which successively cooperate with said first window in defining said area, means responsive to the beats of a timekeeper being timed for projecting flashes of light through said area to produce a visible light spot, means for rotating said rotatable element at a predetermined constant speed such that the said light spot appears to move in one direction or the other along said line depending on whether

the timekeeper being timed is fast or slow, and indicating means with which the moving light spot cooperates during a definite time interval to show the amount of the error in the rate of the timekeeper being timed in seconds per day.

11. In a stroboscopic timer, means controlled by a device being timed for producing momentary flashes of light, a fixed element having a long narrow window therein, a rotatable element having a long narrow window therein, said windows being so disposed relative to each other that in response to rotation of said element continuously changing portions of the said second window cooperate with the said first window to form a light transmitting area which moves repeatedly along said first window, said area constituting means whereby said flashes may be observed as a spot of light, and means independent of said light flashes for rotating said rotatable element at a predetermined constant speed such that the spot will stand still if the rate of the device is correct and will move in one direction or the other along the said first window if the device is fast or slow.

12. In a stroboscopic timer, means controlled by a device being timed for producing momentary flashes of light, a fixed element having a long narrow window therein, an element rotatable past said window and so related thereto that when any point thereon passes said window it moves in a direction perpendicular to the major axis of the window, said rotatable element having a window therein which forms a movable intersection with the first window to provide a light transmitting area through which said light flashes may be observed as a spot of light, and means comprising a source of alternating current of constant frequency and a synchronous motor for rotating said rotatable element at a predetermined constant speed such that the spot will stand still if the rate of said device is correct and will move in one direction or the other along the said first window if the device is fast or slow.

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