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TIMING APPARATUS

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Fig. 1.

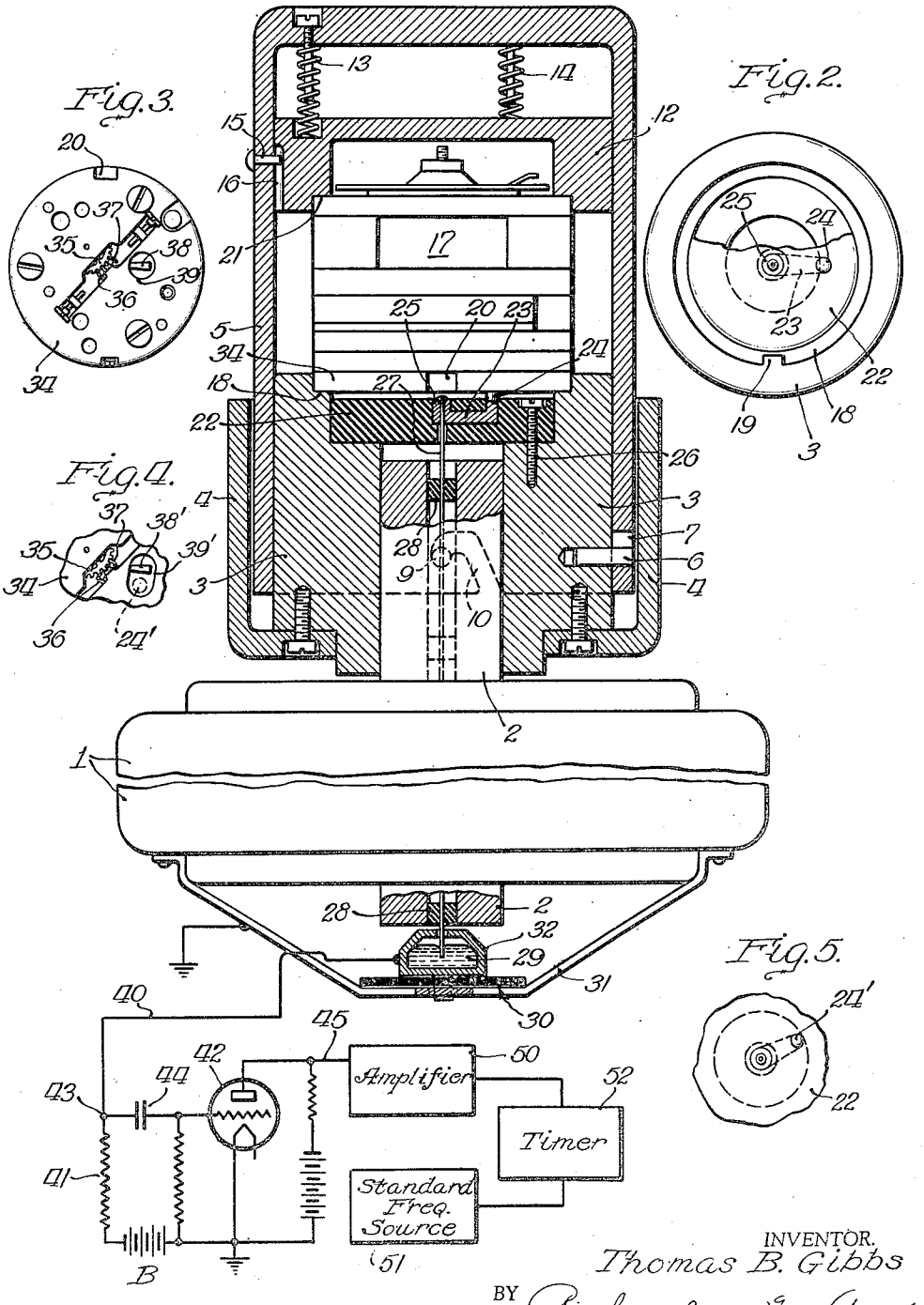

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

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TIMING APPARATUS

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15 Claims. (Cl. 73—51)

The present invention relates in general to timing apparatus, and more in particular to apparatus for timing or checking the rate of mechanical fuses such as are used in shells. The object of the invention is to produce a new and improved apparatus of this character.

The rate of a mechanical or clockwork type fuse is affected by the rotation of the shell in flight and consequently it is necessary to time such fuses while they are subjected to rotation simulating the rotation they acquire when the shells in which they are used are fired. This condition renders the timing of fuses a considerably more difficult problem than it would be otherwise. A special object of the invention, therefore, is to provide a new and improved arrangement for obtaining an indication of the rate or beat frequency of a fuse while the same is being rotated at high speed. More in detail, the invention provides a variable condenser, one of the elements of which is an oscillating member forming part of the clockwork mechanism of the fuse. The capacity of the condenser is varied periodically by operation of the fuse and the variations in capacity are employed to produce periodic voltages the frequency of which may be compared with a standard frequency in order to determine if the rate of the fuse is correct or not.

The invention and various features thereof will be described fully hereinafter with reference to the accompanying drawing, in which—

Fig. 1 is a sectional view of a chuck for holding a fuse while it is being rotated, together with a motor for rotating the chuck and fuse, and a diagrammatic circuit drawing;

Fig. 2 is a top view of the chuck, with the cap removed;

Fig. 3 shows a mechanical fuse; and

Figs. 4 and 5 show details of a slightly modified form of the invention.

Referring to the drawing, the reference character 1 indicates a motor for rotating the fuses while they are being timed. This motor may be a three-phase synchronous motor. Although not shown in the drawing, suitable means is provided for supporting the motor with its shaft in a vertical position.

The chuck for holding the fuse is mounted on the end of the motor shaft and comprises two main parts, a receptacle for receiving the fuse and a cap for locking the fuse in position in the receptacle. The receptacle part of the chuck includes a base portion 3 which is suitably fitted to the shaft 2 so as to be rotated thereby when the motor is running. There is also an internally flanged cylindrical part 4, which is secured to the base 3 by means of screws, as shown. The interior wall of the cylindrical part 4 is spaced away from the exterior wall of the base 3 to form an annular space for receiving the open end of the cap 5.

The cap 5 is a cylindrical shell open at the lower end and closed at the top. The cap is removable from the chuck. When assembled in place, the open end of the cap enters the annular space between the base 3 and the part 4, where it is held by a plurality of bayonet joints. One of these joints is shown on the section line in Fig. 1, and comprises the pin 6, rigidly fixed in the base 3, and the cooperating slot 7 which is cut in the skirt of cap 5. The shape of the slots can be seen from the dotted line showing of the next adjacent joint comprising the pin 9 and the slot 10. It will be understood that in practice there will be three or four of these joints, equally spaced around the lower end of the cap 5.

Inside the cap there is a short cylindrical member 12, which is slidable up and down in the cap. The member 12 is urged in a downward direction by three springs such as 13 and 14. A pin 15, the end of which enters a groove 16 in member 12, limits the extent of the downward movement of said member.

A fuse of the type previously referred to is indicated at 17. With the cap 5 removed, the fuse may be placed in the annular seat 18 which is formed at the upper end of the base 3. The seat 18 is provided with a projection 19 (see Fig. 2), which fits in a recess 20 in the fuse, and accordingly the fuse must be turned until the recess and the projection are in alignment before it can be properly seated. The arrangement described prevents rotation of the fuse in the chuck and also insures that the fuse will be placed in the chuck in the correct angular position to bring the elements of the variable condenser into operative relation, as will be explained shortly.

When the fuse 17 has been properly positioned in its seat, the cap 5 may be put on and is rotated until the pins such as 9 enter the slots such as 10. The upper seat 21 thereupon engages the top of the fuse. The cap is now pressed down as far as it will go, the cylindrical member 12 moving upward against the tension of springs 13 and 14, and is then rotated in the proper direction to engage the bayonet joints. The cap is thus locked in position and the fuse is securely

held between the lower seat 18 and the upper seat 21.

At the upper end of the base 3 of the chuck there is a circular recess in which there is mounted a disk 22 by means of screws such as 26. The disk 22 may be of suitable molded plastic material which is a good insulator and has embedded therein a U-shaped metallic member 23. One leg of the member 23 is in the form of a pin 24 which projects upward a short distance above the top of the disk 22. The other leg 25 has its end flush with the top of the disk and has a hole drilled through it axially to receive a stiff wire 27 which may be a piece of piano wire. The end of wire 27 is secured to the leg 25 in some suitable manner, as by soldering.

The wire 27 extends downward through the hollow shaft 2 of the motor 1 and is supported at intervals by insulators such as 28. The lower end of the wire projects into a quantity of mercury 29 which is contained in a metal cup 32. The cup is supported at the lower end of the motor by a bracket 31, there being a piece of insulating material 30 interposed between the cup and bracket. It will be seen that the described arrangement provides a conductive connection between the pin 24 in the chuck, which is adapted to be rotated by the motor, and the fixed cup 32.

The fuse shown in Fig. 3 includes a plate 34 having openings therein through which parts of the clockwork mechanism may be seen. These parts include the oscillatable balance or pallet arm 38, the two pallets 36 and 37, and the escape wheel 35. When the fuse is running the pallet arm 38 oscillates back and forth across the opening 39 in the plate 34. The pallet arm is shown in its mid-position in Fig. 3, where it appears at the center of the opening 39. The pin 24 is so located with reference to the projection 19 (see Fig. 2), that when the fuse is seated properly in the chuck the pin enters the opening 39 in plate 34 of the fuse. The pin 24 does not contact any part of the fuse, being centrally disposed in opening 39, but it is long enough so that its flat end surface comes close adjacent to the pallet arm 38. The pallet arm 38 and the pin 24 thus form the elements or "plates" of an air condenser, the capacity of which is variable responsive to oscillation of the pallet arm. The capacity is a maximum when the pallet arm is in its mid-position and is a minimum when the pallet arm reaches the end of its beat in either direction.

The reference character 42 indicates a space discharge device, which may be any known tube suitable for use as an amplifier. The circuits of the tube are conventional and need not be described in detail.

The rectangle 50 represents a suitable amplifier which will usually be required in addition to the amplifying tube 42. The amplifier may include a suitable filter. The rectangle 51 represents a standard frequency source, which may be of any known and suitable type, such, for example, as a standard frequency generator using a crystal oscillator. The rectangle 52 represents any known type of device, referred to as a timer, which is used to compare the frequency of the current produced by the fuse with the frequency of the standard frequency source. The invention is not concerned with these parts of the equipment and accordingly they are not shown in detail.

The operation of the invention will now be described. The fuse is placed in the chuck in the manner described and is locked in placed by the cap 5. A protective guard or housing for the chuck may be provided and is lowered into position around the chuck after the fuse has been inserted. This guard is not a part of the invention and has accordingly been omitted. The motor 1 has circuit connections, also not shown, to a suitable source of alternating current.

When the power is turned on the motor starts to run and comes rapidly up to speed, rotating the chuck and the fuse which is held therein. The fuse is provided with a pair of pivoted weights which are acted on by centrifugal force while the fuse is rotating and supply power for operating the clockwork mechanism. Accordingly the pallet arm 38 in the fuse starts to oscillate in the manner previously described.

The variable condenser formed by the pallet arm and the pin 24 is included in a circuit which extends from ground by way of the frame of the motor, the chuck, the body of the fuse, the oscillating pallet arm, the pin 24 (separated from the pallet arm by a varying air gap), member 23, wire 27, mercury 29, cup 32, conductor 40, and resistance 41 to the grounded battery B. The condenser charges and discharges over this circuit as its capacity varies responsive to the oscillation of the pallet arm 38, and accordingly variations in potential are produced at the junction point 43, which are applied to the control grid of tube 42 through the condenser 44. These potential changes produce plate current fluctuations at the tube 42 and amplified potential changes at the plate of the tube, which are transmitted to the amplifier 50 by way of conductor 45.

The output frequency of tube 42 corresponds to the beat frequency of the fuse, as will be appreciated from the fact that the capacity of the condenser formed by the pallet arm 38 and the pin 24 rises from a minimum to a maximum and decreases to a minimum again during each beat of the pallet arm. If the beat frequency of the fuse is 344 beats per second, therefore, the output of tube 42 will have a frequency of 344 cycles per second, and for any departure of the beat frequency of the fuse from its correct value there will be a corresponding departure in the output frequency.

The output of tube 42 may be further amplified at the amplifier 50, if necessary, and the output of the amplifier is transmitted to the timer 52, where its frequency is compared with the standard frequency. The timer may be of any suitable type, as previously mentioned, and if a mechanical timer is employed the amplifier equipment 50 will include suitable means for converting the amplifier output into impulses of the proper character to operate the timer. However, a very simple arrangement is to use a cathode ray oscilloscope as a timer. In this case the amplifier 50 supplies the fuse signal frequency to one pair of deflecting plates in the cathode ray tube and the standard frequency generator supplies sweep frequency to the other pair of deflecting plates. The use of a cathode ray oscilloscope for comparing frequencies is well known and hence need not be described in detail.

From the foregoing it will be seen that the invention provides a simple and efficient apparatus for use in regulating fuses, whereby signal currents or voltages having a frequency corresponding to the beat frequency of a fuse may be obtained while the fuse is rotating, thus enabling the rate of the fuse to be determined by

comparison of the signal frequency with a standard frequency.

The modification which is shown in Figs. 4 and 5 involves a change in the location of the pin which cooperates with the oscillating pallet of the fuse to form a variable condenser. In Fig. 5, the pin is indicated at 24'. As can be seen from this figure, the pin 24' is angularly displaced in a counter-clockwise direction from the position occupied by pin 24 in Fig. 2. The fuse is partly shown in Fig. 4, from which it can be seen that the opening 39' is elongated on one side instead of being round. When the fuse is inserted in the chuck, the pin 24' enters the opening 39' where it occupies a position near one end of the opening, as indicated by the dotted circle 24'. In this position the pin is overlapped by the oscillating pallet 38' at the extremity of its beat in a clockwise direction, as seen in Fig. 4. At the end of this clockwise beat, therefore, the capacity of the variable condenser is a maximum. On the counter-clockwise beat the capacity decreases and reaches a minimum at the end of the beat, when the pallet is at the greatest distance from the pin. Two beats are required, therefore, to produce a complete cycle of capacity change in the condenser, and the output frequency is equal to one-half the beat frequency. Otherwise the operation is the same as previously described.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

I claim:

1. Apparatus for timing a device having a part which is subjected to oscillatory motion, comprising means for rotating said device, means for forming a variable condenser including said part as an element and having a capacity which is varied by oscillatory motion of the part while said device is rotating, and means responsive to variations in the capacity of said condenser for generating periodic voltages.

2. Apparatus for timing a fuse of the clockwork type having a part subject to oscillatory motion, comprising means for rotating said fuse, a condenser including said part the capacity of which is variable by oscillatory motion of said part while the fuse is rotating, and means responsive to variations in said capacity for generating periodic voltages.

3. Apparatus for timing a fuse of the clockwork type having a part subject to oscillatory motion, comprising a chuck for holding said fuse, means for rotating said chuck and fuse, an insulated part mounted on said chuck and located adjacent the said oscillatory part of the fuse when the fuse is held in the chuck, said parts forming a variable condenser, and means responsive to variations in the capacity of said condenser produced by the oscillatory motion of the said fuse part for generating periodic voltages.

4. The combination, with means for operating a fuse of the clockwork type by subjecting to rotation, of a conductive member, means for supporting said member in spaced relation to an oscillating part of said fuse while the fuse is in operation to form a variable condenser, and a control circuit including said condenser.

5. The combination, with means for operating a fuse of the clockwork type by subjecting it to rotation, of a conductive member, means for supporting said member in juxtaposition to an oscillating part of said fuse while the fuse is in operation, thereby forming a condenser the capacity of which varies responsive to operation of the fuse, means responsive to the capacity variations of said condenser for generating periodic voltages, and means for comparing the frequency of said voltages with a standard frequency.

6. In a fuse timing apparatus, a rotatable chuck comprising means for holding a fuse, a part mounted on said chuck and forming a variable condenser with an oscillatory part of a fuse which is held in the chuck, a space discharge device, and a circuit over which said condenser controls said device while the chuck and fuse are rotating.

7. In a fuse timing apparatus, a rotatable chuck comprising means for holding a fuse, means for forming a variable condenser with an oscillatory part of a fuse held in the said chuck, the variation in the capacity of said condenser being responsive to the oscillatory motion of said part, a source of current for charging said condenser, and a circuit including said condenser, said current source and the frame of the fuse and chuck.

8. In a fuse timing apparatus, a rotatable chuck comprising means for holding a fuse, an insulated part supported on said chuck and forming a variable condenser with a part of the fuse which is subjected to oscillatory motion when the chuck and fuse are rotating, and means for connecting said condenser in an external circuit.

9. In a fuse timing apparatus, a rotatable chuck comprising means for holding a fuse, an insulated part supported on said chuck and cooperating with an oscillatory part of the fuse to form a variable condenser, a source of current for charging said condenser, a circuit including said condenser and current source, and means for maintaining said circuit closed while said chuck is rotating.

10. Apparatus for timing a fuse having a part subject to oscillatory motion, comprising a chuck for holding said fuse, a motor for rotating said chuck, said motor having a hollow shaft, an insulated part supported on said chuck and located adjacent said oscillatory part of the fuse when the fuse is held in the chuck, said parts constituting a condenser the capacity of which is variable responsive to oscillatory motion of said fuse part, an insulated conductor connected to the said part supported on the chuck and extending through the motor shaft, and a circuit including said condenser and conductor.

11. In a fuse timing apparatus, a rotatable chuck comprising means for holding a fuse, and an insulated conducting part mounted on said chuck in such a position that when a fuse is held in the chuck the said part cooperates with an oscillatory part of said fuse to form a variable condenser.

12. Apparatus for timing a device having an oscillatory pallet, comprising a conductive member, means for supporting said member in such a position relative to the device that the member is juxtaposed to the pallet when the latter is in mid-position, thereby forming a condenser the capacity of which is varied at each beat of the pallet, and means controlled by said condenser for generating periodic voltages having a frequency equal to the beat frequency of the pallet.

13. Apparatus for timing a device having an oscillatory pallet, comprising a conductive member, means for supporting said member in such a position relative to the device that the mem-

ber is juxtaposed to the pallet when the latter is at one end of its path of oscillatory motion, thereby forming a condenser the capacity of which is varied at each complete oscillation of the pallet, and means controlled by said condenser for generating periodic voltages having a frequency equal to one-half the beat frequency of the pallet.

14. In a fuse timing apparatus, a chuck for holding a fuse, means for rotating said chuck, a circuit including an insulated conductor rotating with the chuck and a fixed conductor in electrical contact therewith, and means including an oscillating part of a fuse held in said chuck while the same is rotating for periodically varying a characteristic of said circuit.

15. Apparatus for timing a device having a part subject to periodic motion while the device is being rotated, comprising means for rotating said device, means for forming a variable condenser with said part, the variation in the capacity of said condenser being responsive to the periodic motion of said part, a source of current, and a circuit connecting said condenser and current source, said circuit including a slip connection comprising a rotating part in conductive connection with said condenser and a fixed part in conductive connection with said current source.

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