Oct. 31, 1939. H. LIST 2,178,482

INSTRUMENT FOR STROBOSCOPIC OBSERVATIONS

Filed April 1, 1937 2 Sheets-Sheet 1

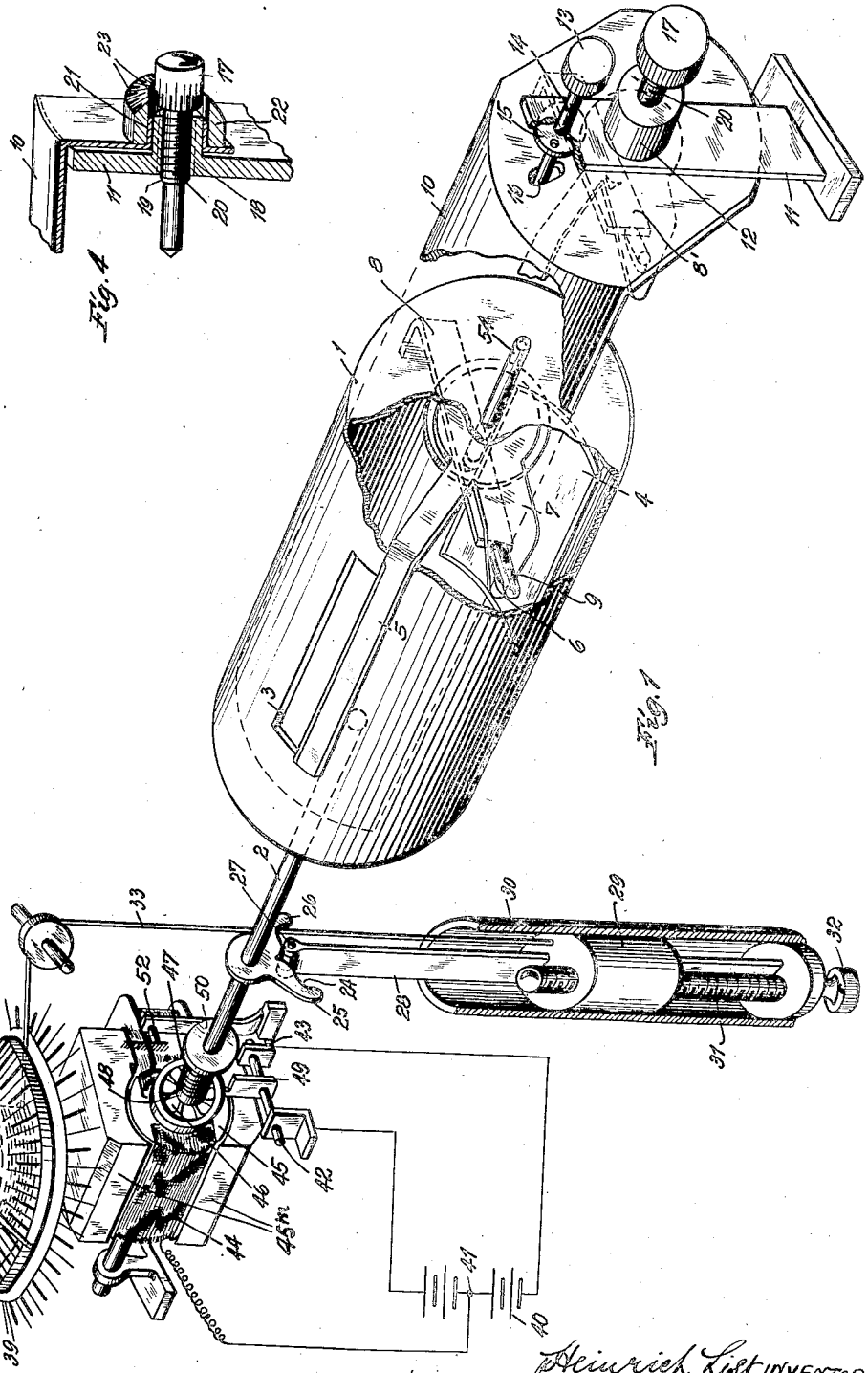


Fig. 4

Fig. 1

Heinrich List, INVENTOR.

per H. D. Fleischhauer ATTORNEY.

Oct. 31, 1939. H. LIST 2,178,482

INSTRUMENT FOR STROBOSCOPIC OBSERVATIONS

Filed April 1, 1937 2 Sheets-Sheet 2

Fig. 5

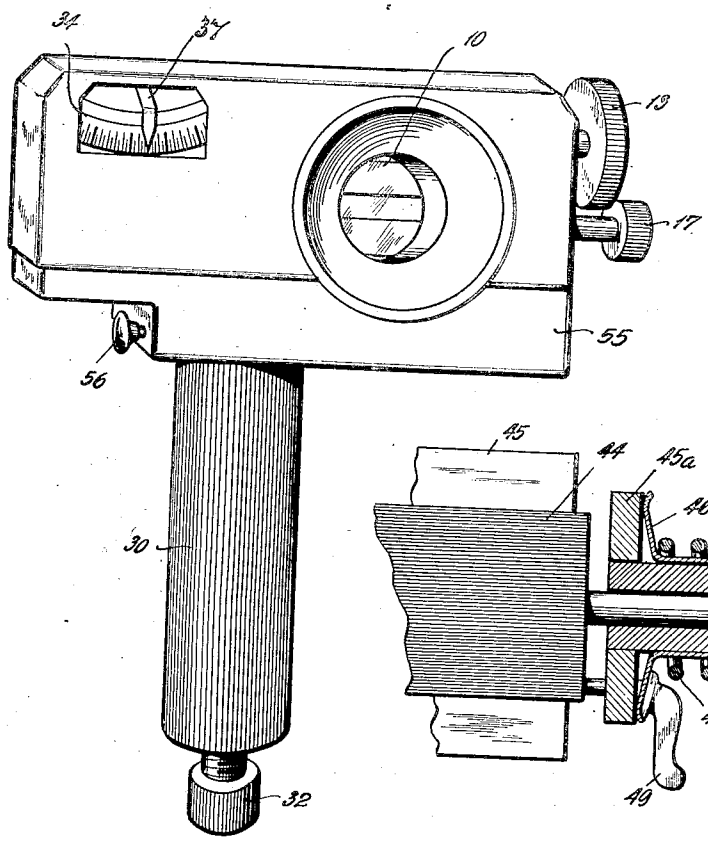


Fig. 3

Fig. 6

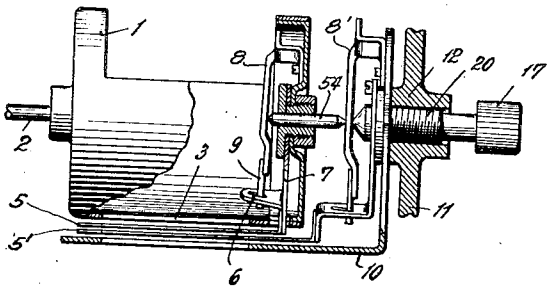
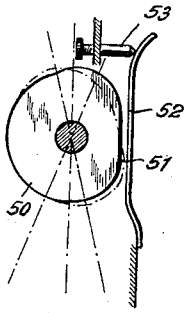


Fig. 2



Heinrich List INVENTOR.

per A. D. Stippelmann ATTORNEY.

Patented Oct. 31, 1939 2,178,482

UNITED STATES PATENT OFFICE

2,178,482

INSTRUMENT FOR STROBOSCOPIC OBSERVATIONS

Heinrich List, Berlin-Lichterfelde, Germany

Application April 1, 1937, Serial No. 134,449
In Germany April 14, 1936

5 Claims. (Cl. 88—14)

My invention relates to stroboscopes, that is instruments for performing stroboscopic observations.

An object of my invention is to provide a stroboscope which is of simple and improved construction yet permits the performance of all problems for stroboscopic observation, in particular revolution or oscillation counting of machine parts, and by which, in addition, exact observation of quickly rotating or oscillating parts, for the determination of overswing and non-uniformities in motion, can be carried out satisfactorily by direct observation.

Another object of the invention is to improve the construction and operation of a stroboscope which has in association with its inspection aperture a shutter that is oscillated by an electromagnet oscillator which alternately drives forward and in reverse by virtue of current reversing means embodying a mechanical slip coupling the improvements including the following: The elements of the mechanical coupling are so constituted that, despite their function as a slip coupling associated with parts lubricated by oil, they are capable of maintaining continuously satisfactory electrical contact even if oil is applied to or otherwise reaches the elements of the coupling. The instrument is remarkably compact and can be readily held to the eye and all adjustments and settings can be made while still holding the instrument to the eye.

Another object of the invention is to provide in the instrument, in a compact manner, a blade spring, the natural frequency of which can be varied within wide limits, but which is relatively long and demands much space.

Another object of the invention is to provide the instrument with indicating means by which it is possible to obtain directly a measure of the frequency at which the instrument oscillates, without requiring special preparatory information.

Other objects of the invention will be apparent from the following specification and claims.

One embodiment of the invention is shown diagrammatically by way of example on the drawings wherein:

Fig. 1 is a view of the assembled instrument with parts broken away for purposes of illustration.

Fig. 2 illustrates a detail view of the amplitude damping means, which is incorporated in the instrument shown in Fig. 1.

Fig. 3 is a detail sectional view of the mechanical slip coupling which is incorporated in the instrument shown in Fig. 1.

Fig. 4 is a detailed view of a modified feature.

Fig. 5 is a perspective view of the completely assembled apparatus.

Fig. 6 is a sectional elevation showing constructional details of means for effecting aperture adjustment.

Referring to the drawings:

Reference 1 denotes an oscillating shutter constituted by a drum 1 which is pivotally mounted upon a shaft 2 and has an aperture 3 which consists of a slit disposed lengthwise of the axis of the drum. This slit lies opposite a larger opening 4 (viewing opening). The effective breadth of the slit 3 of the drum 1 is variable by means of a mask constituted as a finger 5 which projects from a radial arm at a right angle thereto. The arm is freely pivoted on a spindle 54 and is formed with a radial extension 7 the end of which is bent at right angle and bears a cam track constituted as an inclined slot 6. The finger 5 is displaced angularly and so caused to mask more or less of the slit 3 by axial pressure applied by the spindle 54 to a spring tongue 8 one end of which is secured to the wall of the drum and the other end of which has a follower for the cam track constituted as a pin 9 engaging in the inclined slot 6, the pin and the slot together constituting a cam device.

An inspection aperture similar to the slit 3 is formed in a non-oscillating diaphragm or cover 10 (see Figs. 5 and 6) in front of the oscillating drum. A part of the cover has been omitted in Fig. 1 on the ground of clearness. Adjusting means similar to that provided for the oscillating aperture is provided for varying the effective width of this aperture also. The adjusting pressure for the two adjustment means is applied along a common axis, the spindle 54 pressing against the back of the spring part 8' for the non-oscillating inspection aperture so that the followers of the two adjusting cam devices are continuously under the controlling influence of a single knob 17.

The cover 10 is pivotally mounted on a frame member 11 at 12, being adjustable about its pivot by a second adjusting knob 13 mounted on a spindle 14 which carries a disc 15. This disc, in turn, carries eccentrically a pin 16 which engages in an elongated slot in the cover 10 and enables this to be adjusted through a small angle about the pivot 12. Adjustment of the cover is effected to enable the inspection aperture therein to be located accurately in the exact centre of

oscillation of the aperture in the oscillating shutter. When this is not the case it is found that the object under inspection is not sharply defined and indeed may be scarcely recognizable. Instead of having the adjusting device (13, 14) spaced from the mounting 12, obviously a further adjusting screw having a common axis with the adjusting knob 17 could be provided directly at 12, if it is desired to simplify the use of the instrument, as shown in Fig. 4. Here the frame member 11 is provided with a bearing 18 which is internally tapped to receive the threaded spindle 20 of the adjusting knob 17. The cover 10 has a bearing 21 on which is arranged a positioning knob 22 provided with a scale 23 on which the angular adjustment of the non-oscillating diaphragm may be read. This positioning knob is so constructed that the adjusting knob 17 is partly housed therein in order to produce a pleasing appearance.

On the shaft 2 a cam 24 is mounted with its effective surface in engagement with the free end of a blade spring 28, the cam being formed so as to give a linear relationship between the deflection of the free end of the spring 28 and the angular displacement of the cam and therefore of the device turning it. The cam form can be determined graphically, but the form used in practice differs somewhat from the theoretical form which would be designed in the same manner as that of a tooth of a gear wheel, being influenced as a result of practical test by considerations such as friction. The cam itself has abutments constituted as small horn-like extensions 25, 26 for preventing the spring edge 27 from leaving the cam. The free effective length of the spring 28 is adjustable, so as to vary the frequency of the oscillating system, by a cylindrically shaped slide 29 which slides in a tube 30 which serves as a handle for holding the instrument to the eye as seen especially in Fig. 5. The spring 28 is a neat sliding fit in a passage through the slide 29. The slide 29 is constituted as a nut, being traversed by means of a screwed rod 31 provided with a turning knob 32 so that the periodicity of the shutter 1 can be varied within wide limits. A scale 34, turnably mounted at 35 in the housing of the instrument (see Figs. 1 and 5) is connected with the slide 29 by a flexible inextensible cord 33. This scale cooperates with a stationary indicator 37. The scale has inside it a spring 36 which constrains the scale to return to its zero setting when the cord is slackened. The scale is calibrated so as to indicate the periodicity of the oscillating shutter, for example by markings 34'.

For oscillating the shutter an electro-magnet oscillator is provided comprising an armature component 45 and a magnet component 45^m which components interact electro-magnetically. The oscillator is associated with current-controlling means, the essential part of which is a pair of complementary contacts which also constitute a mechanical slip coupling. One of the contacts consists of a disc 46 (Figs. 1 and 3) cut so that it has a plurality of sectoral blades, the disc being turnably mounted on an insulating bushing 47 to which the second contact member 45^a is secured. The bushing 47 is fixed on the shaft 2, which is the shaft of the armature and constitutes an operative connection functioning to transmit oscillatory motion from the armature to the shutter. The circuit of a battery 40 is completed from a centre tapping 41 through the winding 44 of the armature 45, and, by means of a reversing finger contact 49, through one or other of two reversing branches in which are incorporated, respectively, abutment contacts 42, 43, the battery circuit being therefore constituted as a reversing circuit. The finger-contact 49 is on the contact disc 46 and pendulates between the contacts 42, 43 which are fixed but adjustable and are located for engagement alternately by the contact 49. The contacts 45^a and 46 are resiliently pressed together by a spring 48 acting upon the disc 46, the blades of the disc tending to distend themselves against the face of the contact 45^a serving to ensure at all times satisfactory electrical contact between these members, and preventing lubricant, say, from breaking the contact and giving rise to high resistance between said co-operating parts. It will be evident from Fig. 3 that the contacts 45^a and 46 are both insulated from the armature shaft 2, the contact 45^a being electrically connected with the armature winding. The spring 48 is also carried by the bush, one of its ends bearing against a flange 47^a on the corresponding end of the bush. If the circuit of the armature 45 is completed by suitable switch means 56 (Fig. 5) a current flows, for example, through the contact 42 (with which the finger contact happens to be in engagement) and armature winding 44, which current causes the armature to turn in a magnetic field and in such a direction that it presses the finger-contact against the abutment contact 42, the mechanical slip coupling however permitting the armature to move relatively to the finger-contact. This turning of the armature is converted to an opposite turning by means of the spring 28 when this has been sufficiently stressed by the cam 24, and at the moment of the reversal contact is broken at 42 by the frictionally coupled contact disc 46 which, being momentarily unrestrained in the direction of the armature motion, moves together with the armature. The armature is unexcited and turns now by virtue of the stressed spring 28 until the finger-contact engages the other abutment contact 43, and thereby reverses the electro-magnetic interaction of the oscillator's armature and magnet components. The turning in the opposite direction, started and aided at first by the spring is continued by the electro-magnet whose armature is again turning relative to the finger contact, but this movement is later opposed and ultimately overcome and reversed at the extreme position by the spring stress and thereby a regular to-and-fro motion of the armature and with it, of the shutter, is obtained. The contact disc 46 by virtue of its being frictionally coupled produces the advantage that even with unequal deflections of the armature consequent upon current variations always the result is accurately timed current stoppages and damping forces on the oscillating shutter are eliminated.

If an observation is being carried out at low frequency the amplitude of oscillation may be greater than is desirable and for this reason damping means adapted to reduce the amplitude at such frequencies is provided, consisting of a cam 50 which is mounted in front of an extended spring 52 which constitutes a brake, the cam being separated therefrom by a small adjustable air-gap, to this end the spring 52 being adjustable by an abutment screw 53. Should the shutter be deflected more than is desirable past the extreme positions indicated by dotted lines (Fig. 2) for example, so that the end of the spring 28 would leave the cam sur-

face 24, a damping is produced by virtue of a suitable choice of cam form 50. The gap is created, in the example shown, by a flattening of the cam at one part as it is preferable not to alter the shape of the spring itself. The action of the damping means does not appreciably affect the frequency if the frequency is low.

By the arrangement according to the invention adjustment is possible by means of three knobs 32, 17 and 13 when the instrument is assembled so that the use of the instrument does not require a particular knowledge of the apparatus. The knobs can be adjusted without removing the apparatus from the eye, and the results can be read directly by means of the indicating means. The instrument is thus available to the normal practical man.

The battery elements are, suitably, dry cells which are replaceably mounted within a housing 55 (Fig. 5) on the under-side of the instrument housing after the fashion of the cell arrangement in a pocket lamp. This renders the instrument a self-complete portable instrument.

I claim as my invention:

1. A stroboscope comprising a portable apertured housing, a tubular handle on said housing whereby the stroboscope can be held, an apertured diaphragm attached to said housing with the diaphragm aperture in registry with the housing aperture, and an apertured shutter oscillatably mounted in the housing with the shutter aperture movable to and from registry with the housing and diaphragm apertures to give a stroboscopic effect, in combination with means mounted in said housing for oscillating said shutter, said means comprising a magnet component, an armature component and an electric-current-reversing contact, said components inter-acting electro-magnetically and one of said components being oscillatory in relation to the other under the electro-magnetic interaction, an operative connection between the oscillatory component and said shutter, said operative connection functioning to transmit oscillatory motion from said oscillatory component to said shutter, a slip coupling between said oscillatory component and said contact, a reversible electric circuit in which one of said components and said contact are incorporated, said circuit including reversing branches, elements incorporated respectively in said branches and located for engagement alternately by said contact, a blade spring supported at one end in said tubular handle, means on said operative connection acting on the other end of said spring to constrain the spring to follow movements of said shutter and to deflect the spring when the shutter is displaced from a central position, said spring functioning at first to aid, then to oppose and eventually to overcome and reverse the movement of said shutter, and said slip coupling functioning on reversal of the shutter to displace said contact from one of said elements to the other so as to reverse said electro-magnetic inter-action, and a slide manually traversible lengthwise of the blade spring to vary the effective length thereof, said slide being guided in said tubular handle.

2. A stroboscope comprising the combination claimed in claim 1 in which the slide is constituted as a nut with a screw-threaded bore, a screw engaging with said nut by passing through said bore, said screw being turnably supported by the tubular handle and located therein, and a passage through said nut in which passage said blade spring is a sliding fit so that the effective length of the blade spring is variable by turning the screw.

3. A stroboscope comprising the combination claimed in claim 1 comprising also frequency-indicating elements, namely a scale and an indicator, said elements being mounted on the housing and one of said elements being movable relatively to the other, a flexible inextensible cordlike member connecting the movable one of the indicating elements to said slide; and a resilient member acting on the movable element to oppose the pull of the cordlike member, said cordlike member serving to displace the movable element proportionally to any displacement imparted to the slide and said resilient member serving to return the movable element.

4. A stroboscope comprising the combination claimed in claim 1, in which the means acting on the free end of the blade spring consists of a cam, and in which the operative connection between the oscillatory component and the shutter includes a shaftlike member on which said cam is mounted, said cam having the effective part thereof which is engageable with the blade spring formed with a profile designed to give an approximately linear relationship between the angular displacement of the cam and the deflection of the free end of the blade spring, and the cam having abutments which limit the effective part thereof and serve to prevent deflection of the blade-spring end beyond the cam.

5. In a stroboscope comprising a portable apertured housing, an apertured diaphragm attached to said housing with the diaphragm aperture in register with the housing aperture, an apertured shutter mounted in the housing for oscillation about the shutter's axis so that the shutter aperture is movable to and from registry with the housing and diaphragm apertures to give a stroboscopic effect, and adjustable means supported by the housing for varying the breadth of the shutter aperture: means for simultaneously varying the breadth of the diaphragm aperture comprising a mask in near relationship with the diaphragm and pivotally supported by the housing for displacement across the diaphragm aperture co-axially with the shutter, cam members for effecting the displacement of said mask and consisting of a track member formed with an oblique track and a follower member engaging said track, one of said cam members being mounted on the mask and the other being mounted on the diaphragm, said cam member on the diaphragm being in engagement with so as to be displaced in response to movement of said adjustable means supported by the housing so that adjustment of said adjustable means will effect displacement of said mask through said cam members, and resilient means on the diaphragm acting upon said cam member on the diaphragm to keep said cam member continuously under the controlling influence of said adjustable means.

HEINRICH LIST.