July 14, 1953 H. F. FRANKE 2,645,729

PENDULUM CONSTRUCTION

Filed Feb. 27, 1952 3 Sheets-Sheet 1

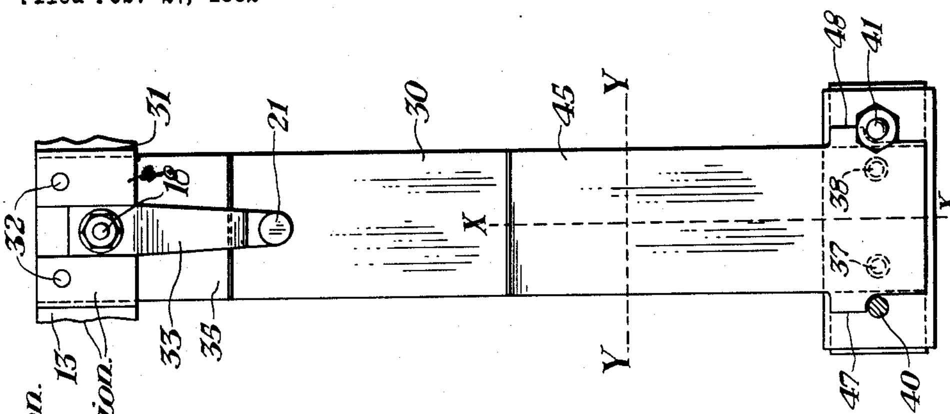

Fig. 5.

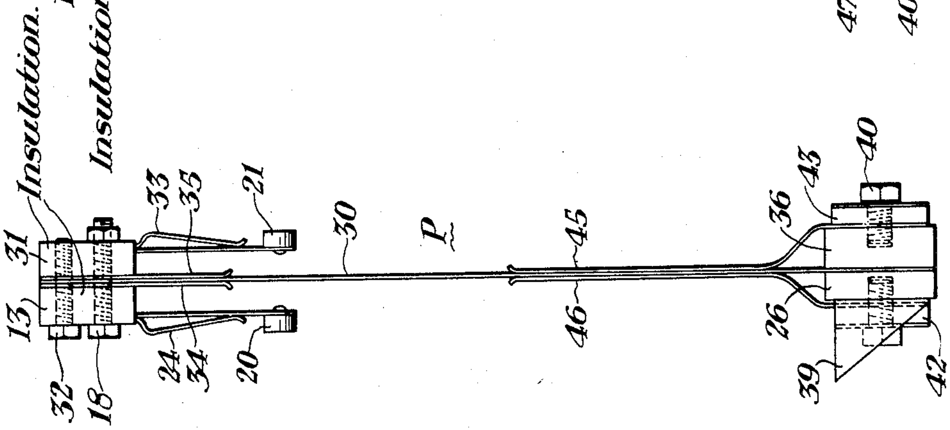

Fig. 4.

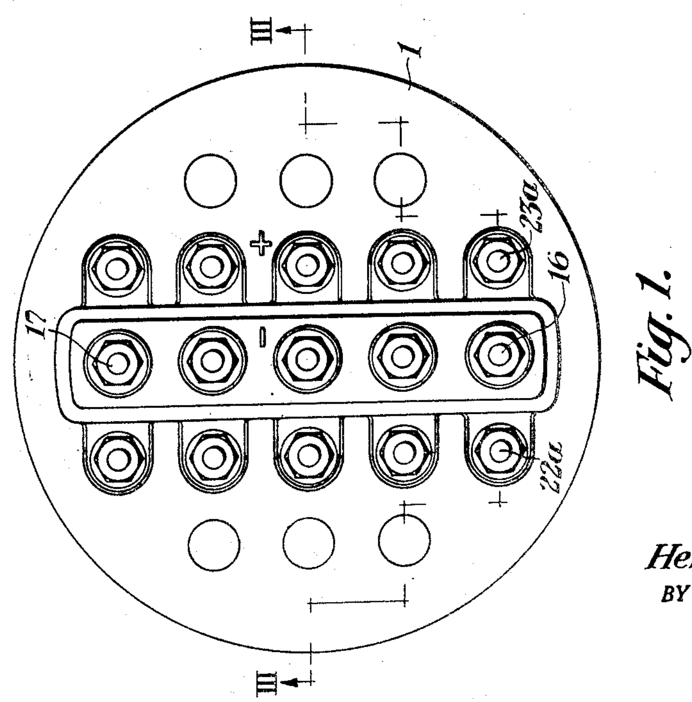

Fig. 1.

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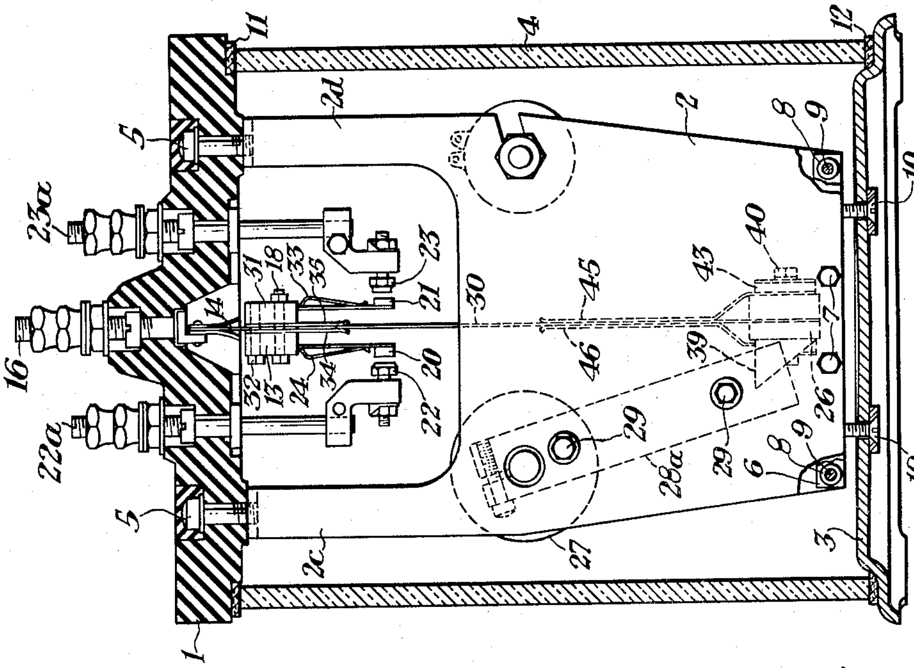

Fig. 3.

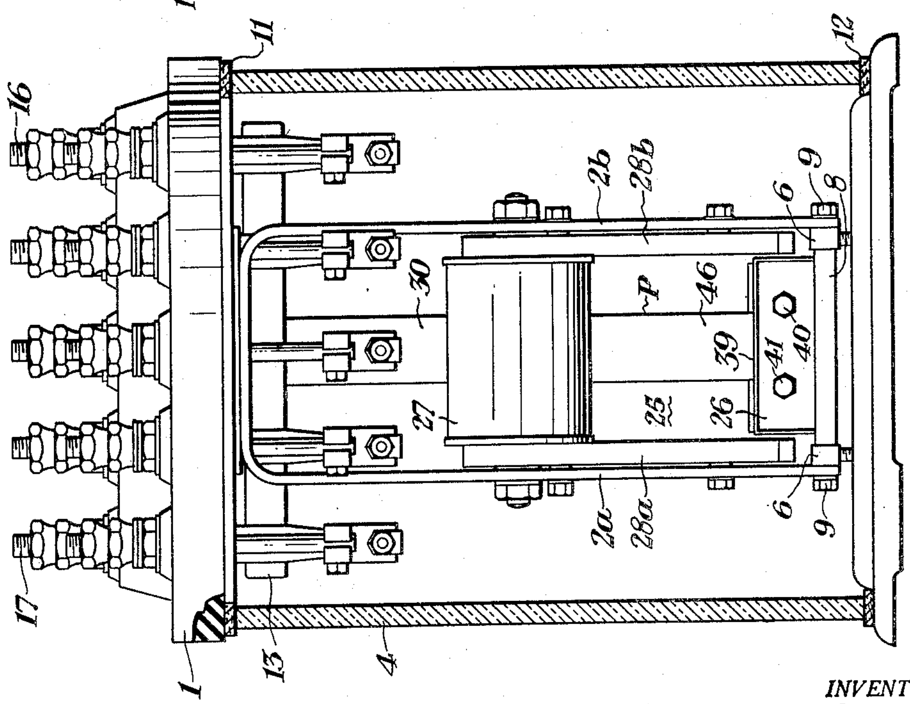

Fig. 2.

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PENDULUM CONSTRUCTION

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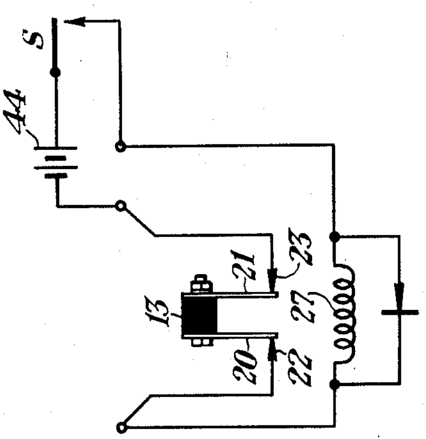

Fig. 8.

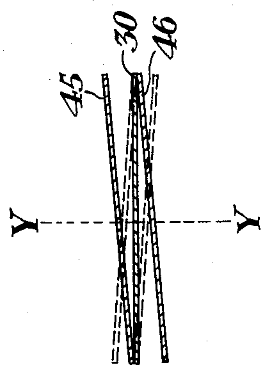

Fig. 9.

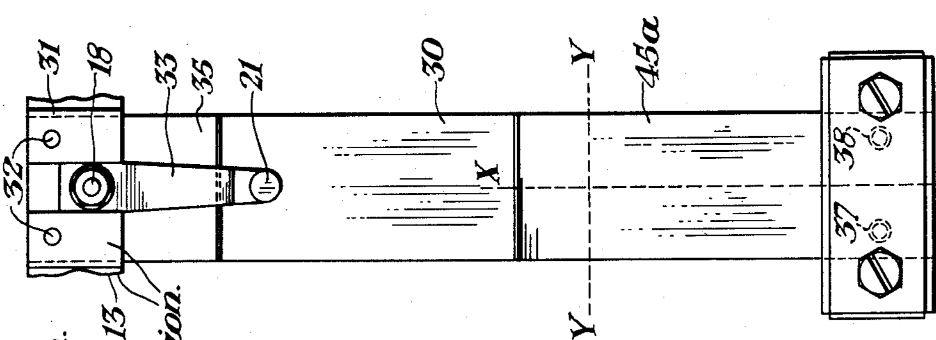

Fig. 7.

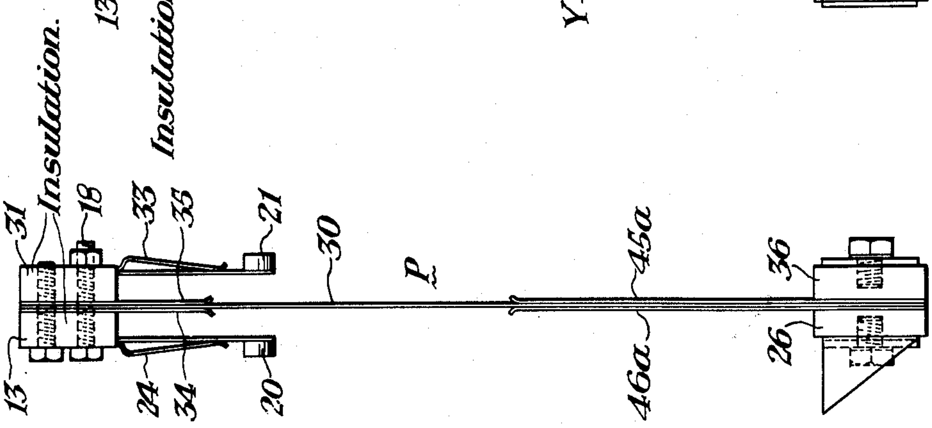

Fig. 6.

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2,645,729

PENDULUM CONSTRUCTION

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Application February 27, 1952, Serial No. 273,733

7 Claims. (Cl. 310—32)

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My invention relates to pendulum constructions and particularly to the construction of pendulums suitable for electrical relays employed in code signaling systems using current which is coded by being periodically interrupted.

In signaling systems of the type here contemplated, electrical relays are used as code transmitters or coders for periodically interrupting a current at a desired frequency or code rate. For example, in many railway signaling systems different code rates selected from the range of 75 to 240 interruptions per minute are used to reflect different traffic conditions, a code transmitter being provided for interrupting the current at each of the different code rates used.

The operating requirements for the code transmitters of railway signaling systems are exacting. In the first place continuous operation is generally required with little inspection and maintenance. For example, these code transmitters are located at outlying points along a railway where they are inspected only as a maintainer makes trips over a given territory. Also, these code transmitters are energized from a local source which is usually a battery and the transmitter is required to maintain a selected code rate of operation within a very close range over a relatively wide voltage variation of the supply battery. Furthermore, each code cycle is divided into an on code period during which the contact is closed and current flows, and an off code period during which the contact is open and no current flows, and only a small variation in the predetermined off and on code periods can be tolerated because otherwise the code distortion causes unsatisfactory operation of the code following relays responsive to the code.

Code transmitters of the pendulum type are used extensively because of their reliable operating characteristics. However, it has been found that with the pendulum construction heretofore provided for code transmitters, a torsional vibration or so-called "wobble" may develop in addition to the regular swinging movement of the pendulum. This torsional vibration or "wobble" occurs about the longitudinal axis of the pendulum and tends to vary the on and off code periods, and in severe conditions it may cause the pendulum to stall. These torsional vibrations have been found to be most severe when the natural frequency of vibration of the pendulum about its longitudinal axis happens to be a multiple of the normal swinging frequency of the pendulum. For example, in code transmitters of a construction having an extensive use in railway signaling, and set for a code of 120 interruptions per minute, this wobble was found to be most pronounced when the natural frequency of vibration of the pendulum about its longitudinal axis is 600 oscillations per minute.

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The problem of avoiding this wobble in code transmitters of a pendulum electrical relay type has been given much study but as far as I am aware no satisfactory solution of the problem had been found prior to my invention.

In view of the foregoing problem, an object of my invention is the provision of an improved pendulum construction for electrical relays and whereby torsional vibration or wobble is avoided.

Another object of my invention is the provision of a pendulum construction free from torsional vibration and which construction is relatively simple and economical to manufacture.

Again, a feature of my invention is the provision of an improved torsional vibration damping means for pendulums of the type here involved and which damping means can be readily applied to the pendulums of code transmitters already in service.

Other features, objects and advantages of my invention will appear as the specification progresses.

Specifically, my invention relates to an improved pendulum construction for a code transmitter relay similar to that described in Letters Patent of the United States No. 2,285,890, granted to Herman G. Blosser June 9, 1942, for Stationary Contact.

I shall describe certain forms of a pendulum construction embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a top plan view showing an electrical relay having the pendulum construction embodying my invention. Fig. 2 is a side elevational view of the relay of Fig. 1, certain of the parts being shown in section. Fig. 3 is an elevational view of the relay of Fig. 1 taken substantially on the line III—III of Fig. 1 and showing certain of the parts in section. Figs. 4 and 5 are front and side views, respectively, showing a pendulum construction used in the relay of Figs. 1, 2 and 3, and which construction embodies my invention. Figs. 6 and 7 are front and side views, respectively, showing another form of pendulum construction that may be used for the relay of Figs. 1, 2 and 3, and which construction also embodies my invention. Fig. 8 is a schematic view showing means that may be used for energizing the relay of Figs. 1, 2 and 3.

Fig. 9 is a view illustrating operating characteristics of the pendulum construction embodying my invention.

In each of the several views, like reference characters are used to designate similar parts.

Referring first to Figs. 1, 2 and 3, a pendulum relay of the type here involved includes a top plate 1 of insulating material, a nonmagnetic frame 2, a metal base plate 3, and a transparent glass cylinder 4.

The top plate 1 is preferably of a molded insulating material formed with openings suitable for the mounting of terminal posts therein, as will be apparent from an inspection of the drawings.

Frame 2 is an inverted U-shaped nonmagnetic member comprising two vertically disposed plates 2*a* and 2*b* spaced apart and terminating at their upper ends in spaced parallel arms 2*c* and 2*d* which form an opening through which certain parts of the relay can be viewed for inspection. Horizontal bars 6 are secured to the lower ends of the plates 2*a* and 2*b* by screws 7, and extending between the bars 6 at their opposite ends are spacing rods 8, held in place by screws 9, the screws 9 extending through clearance holes in the plates 2*a* and 2*b* and the bars 6 and screwed into tapped holes formed in the ends of the spacing rods 8.

The frame 2 is suspended from the top plate 1 by screws 5 extending through holes molded in the top plate and screwed into tapped holes in the upper ends of the frame 2.

The base plate 3 is of suitable material and is adapted to be secured to the frame 2 by means of screws 10 screwed into tapped holes formed in the bars 6. The top plate 1 and base plate 3 are fitted to the opposite ends of the glass cylinder 4 when the frame 2 is secured to the top plate and the base plate 3 is secured to the bars 6 on the frame 2 in the manner explained above, gaskets 11 and 12 being interposed between the top and base plates and the ends of the cylinder and thereby sealing the interior of the cylinder against the entry of dirt and moisture.

The code transmitter or relay includes a contact spring support 13 of insulating material and which is suspended from the top plate 1 for swinging movement between two extreme positions by means of two flexible strips 14 and 15 one at each end of the support and only strip 14 being shown in Fig. 3. The upper ends of the strips 14 and 15 are secured to the lower ends of terminal posts 16 and 17, respectively, as by rivets. The lower ends of the strips 14 and 15 are secured to the support 13 by means of bolts 18 and 32, and spacer 31. Hence the support 13 can swing between two extreme positions due to the flexibility of the strips 14 and 15 by which it is suspended.

A plurality of flexible contact fingers are mounted on the support 13. For example, a pair of contact fingers 20 and 21 each with a spring stop 24, are mounted one on each side of the support by a bolt 18 and a spacer 31. These contact fingers 20 and 21 are mounted in vertical grooves in the support 13 and spacer 31 to maintain a vertical position of the contact fingers. The contact fingers 20 and 21 are electrically connected by the bolt 18 for reasons to appear hereinafter. The two contact fingers 20 and 21 cooperate with a pair of fixed contact members 22 and 23, respectively, and thereby form two sets of contacts 20—22 and 21—23. The fixed contact members 22 and 23 are adjustably secured to the extensions of corresponding terminal posts 22*a* and 23*a* mounted in the top plate 1. It follows that these contacts 20—22 and 21—23 can be adjusted to be alternately opened and closed as desired when the support 13 is swung between its two extreme positions.

Additional contact fingers similar to contact fingers 20 and 21 are mounted on the support 13 and made to cooperate with fixed contact members similar to the contact members 22 and 23. These additional contact fingers and contact members are connected to individual terminal posts mounted in the top plate 1 and thus provide contacts that are opened and closed by the swinging movement of the support 13.

The relay or code transmitter includes a motor means for swinging the support 13 between its extreme positions and thereby alternately opening and closing the associated contacts. The motor means comprises an electromagnet 25 having an armature 26 which is operatively connected to the support 13 by a pendulum P. The electromagnet 25 includes a winding 27 mounted on a magnetic core having pole pieces 28*a* and 28*b* which are secured by screws 29 to the plates 2*a* and 2*b* of the frame 2. The free ends of the pole pieces cooperate with the armature which is attached to the lower end of the pendulum P, the construction of which pendulum embodies my invention. This pendulum construction can be according to that disclosed in Figs. 4 and 5 or that disclosed in Figs. 6 and 7.

Referring first to Figs. 4 and 5, the pendulum P includes an operating arm consisting of a flat strip 30, the upper end of which is secured to the support 13 by a bolt 18 and two screws 32 and a spacer 31. Preferably, two reinforcement springs 34 and 35, one on each side of the arm 30 are included in the mounting of the arm to the support to provide stiffness for the arm 30, but these reinforcement springs 34 and 35 may not be required. The armature 26 and a weight 36 are secured to the lower end of the arm 30 by rivets 37 and 38. Also, an armature extension piece 39 of magnetic material is secured to the armature 26 by bolts 40 and 41, small additional weights 42 and 43 being also attached to the armature 26 by the bolts 40 and 41, as required for tuning to the correct code frequency.

Normally, that is, when the electromagnet 25 of the code transmitter is deenergized, the pendulum P is suspended in a vertical position and is free to be swung at right angles to the width of the arm 30 and when thus swung it causes the spring support 13 to be swung between its two extreme positions. Looking at Fig. 8, there is shown a circuit which may be used for operating the code transmitter. Normally, that is, when the pendulum P occupies its vertical position, the two contacts 20—22 and 21—23 are adjusted to be closed and hence when the control switch S is closed, current is supplied from a battery 44 to the winding 27 of the electromagnet and the armature 26 is attracted by the magnetic field set up at the pole pieces of the electromagnet. When the armature is first attracted it is pulled in between the pole pieces 28*a* and 28*b* and thereby causes the pendulum P and in turn the support 13 to be swung in a corresponding direction which is clockwise as viewed in Fig. 3. This movement of the contact support 13 causes the contact 21—23 to open and interrupt the supply of current to the winding 27. The pendulum will continue its movement due to its kinetic energy until the force is overcome by the tension on the contact finger mounted on the support 13 and by gravity. This causes the pendulum to reverse and swing counterclockwise. During this movement the contact 21—23 is reclosed but due to the inductance of the winding 27 the magnetic field builds up relatively slow and the pendulum swings to a reverse position where the contact 20—22 is open to again interrupt the circuit for the winding 27. Then, the pendulum again swings toward the vertical position and the two contacts 20—22 and 21—23 are closed, so that the electromagnet is again energized to attract the armature and repeat the above operating cycle. The parts are proportioned as to the length, width, and thickness of the pendulum arm 30 and the weight of the armature 26 and size of the additional weights 36, 42 and 43, so that the pendulum swings at a predetermined code rate.

The pendulum P as thus far constructed is susceptible to torsional vibration or wobble about the axis X—X, illustrated by a dotted line in Fig. 5 and which wobble as explained hereinbefore is undesirable and may cause unsatisfactory operation of the code transmitter, particularly when the amplitude of torsional vibration becomes so great as to cause mechanical interference between extension 39 and pole pieces 28.

As shown in Figs. 4 and 5, I include a right-hand and a left-hand damping spring or members 45 and 46, respectively, in the construction of the pendulum P. These damping springs 45 and 46 are of a relatively thin flexible material having a width which preferably is substantially the same as the width of the arm 30. The springs are of a suitable length and preferably the length is selected so as not to exceed one-half the length of the arm 30. The length of the damping springs 45 and 46 is not critical. The springs are laid one along one side of the arm 30 and the other along the other side of the arm 30 adjacent the lower end of the arm. The spring 45 is formed with an offset at its lower end and is inserted betwen the weight 36 and the weight 43, the spring 45 having formed thereon two ears 47 and 48 which fit over the bolts 40 and 41 and thus center the spring to make sure that it aligns with the arm 30. Similarly, the spring 46 is formed with an offset which is inserted in between the armature 26 and the weight 42 and is centered by the ears fitting over the bolts 40 and 41. It follows that the lower ends of the two damping springs are secured to the lower end of the arm 30 of the pendulum but that the upper ends are free. The springs 45 and 46 are formed so that they lie along the side of the arm 30 with little or no pressure except a slight pressure at the upper end of the spring against the arm 30 may be helpful. As thus constructed and applied to the pendulum P these damping springs exert little or no pressure on the arm 30 and do not appreciably affect the code rate of the swinging movement of the pendulum. I have found, however, that these damping springs do exert a damping effect tending to minimize or eliminate the torsional vibration of the arm about its longitudinal axis, that is, about the axis indicated by the dotted line X—X of Fig. 5.

In Fig. 9, this damping effect produced by the damping springs 45 and 46 is illustrated, Fig. 9 being a view taken on a line Y—Y of Figs. 5 and 7. The arm 30 and the damping springs 45 and 46 are shown in section and the movement of the springs 45 and 46 with respect to the surfaces of the arm 30 is somewhat enlarged as an aid in

the understanding of the action. A torsional vibration of the arm 30 about the axis X—X, counterclockwise as viewed in Fig. 9, tends to tilt the damping springs 45 and 46 to the position illustrated by the solid lines in Fig. 9 and form air pockets between the inner surfaces of the springs and the surfaces of the arm 30 as the arm vibrates. Similarly, the torsional vibration of the arm clockwise as viewed in Fig. 9 tends to tilt the damping springs to the position illustrated by the dotted lines in Fig. 9 and in which position air pockets between the surfaces of the springs and the adjacent surfaces of the arm 30 are formed. These air pockets tend to damp this torsional vibration or wobble of the armature because of friction between members 30, 45 and 46, and the air which is continually filling and emptying from these pockets. I have found that with the pendulum thus constructed to include these damping springs, torsional vibration or wobble of the pendulum is substantially eliminated without affecting in any way the swinging movement of the pendulum.

It is clear that with the damping springs 45 ande 46 formed in the manner shown in Figs. 4 and 5, they can be applied to a pendulum of a code transmitter in service by loosening the bolts 40 and 41 of the pendulum, slipping the lower ends of the damping springs in place and then tightening the bolt.

In Figs. 6 and 7, the pendulum construction is the same as that shown in Figs. 4 and 5 except for the damping springs. In Figs. 6 and 7, the damping springs 45*a* and 46*a* are the same as the damping springs of Figs. 4 and 5 except that they are not provided with an offset at the lower end. The damping springs 45*a* and 46*a* are secured to the lower end of the pendulum arm 30 by the rivets 37 and 38 which secure the armature 26 and weight 36 to the arm 30, the damping spring 45*a* being inserted between the weight 36 and the arm 30 and the spring 46*a* being inserted between the armature 26 and the arm 30. It is clear that the damping springs 45*a* and 46*a* will eliminate the wobble of the pendulum about its longitudinal axis X—X in the same manner as the damping springs provided for the pendulum of Figs. 4 and 5.

The damping springs shown in Figs. 6 and 7 are preferred when the damping springs are applied during the manufacture of a code transmitter and before it has been put into service and the damping springs as provided in the pendulum construction of Figs. 4 and 5 are preferred when they are to be applied to a code transmitter already in use.

While I prefer to use a pair of damping springs in each pendulum construction, a single damping spring may be sufficient to eliminate the torsional vibration or wobble of the pendulum and in that case one of the damping springs can be omitted.

Although I have herein shown and described only certain forms of pendulum constructions embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a code transmitter of the pendulum electrical relay type, a pendulum comprising, a flat arm of a selected length and width, means attached to one end of said arm to suspend the arm

in a vertical position free to swing in a plane at right angles to the width of the arm, an armature of magnetic material attached to the lower end of said arm, said armature being susceptible to recurrent magnetic attraction for swinging said arm, a pair of damping springs, each said damping spring having a width substantially equal to the width of said arm and of a length selected of the order of one half the length of said arm, each said damping spring having an end secured to the lower end of said arm, and said springs extending one up along one side of the arm and the other extending up along the other side of said arm.

2. In a code transmitter of the pendulum electrical relay type, a pendulum comprising, a flat arm of a selected length and width, means attached to one end of said arm to suspend the arm in a vertical position for a swinging movement at right angles to the width of the arm, an armature of magnetic material attached to the lower end of said arm, said armature being susceptible to magnetic attraction to swing said arm in a given direction from its vertical position, said arm swinging at a selected code rate when the armature is intermittently attracted at a rate corresponding to said code rate, a pair of damping springs of flexible material, each said spring of a width substantially equal to the width of said arm, each said spring having one end secured to the lower end of the arm and the two springs extending one up along one side of the arm and the other spring up along the other side of the arm, and said springs having a length of the order of one half the length of said arm.

3. In a code transmitter of the pendulum electrical relay type, a pendulum comprising an arm of a selected gauge, width and length; means attached to one end of said arm to suspend the arm in a vertical position for swinging movement at right angles to the width of the arm, an armature attached to the arm, said armature being susceptible to magnetic attraction to swing the arm in a given direction from its vertical position, said arm swinging at a given code rate when said armature is recurrently attracted at said code rate, said arm being susceptible to torsional vibration about its longitudinal axis, a pair of damping springs of a flexible material, each spring of a width substantially equal to the width of said arm and of a length selected of the order of one half the length of said arm, said springs laid one along one side of said arm and the other along the other side of the arm with their lower ends secured to the lower end of said arm, whereby air pockets are formed beween the adjacent surfaces of the springs and arm and torsional vibration of said arm avoided.

4. In combination with a pendulum having a flat arm which is suspended at one end for swinging movement at right angles to its width and which pendulum is susceptible to torsional vibration about the longitudinal axis of its arm, of means to eliminate torsional vibration, said means comprising a pair of damping springs mounted one on each flat side of the arm with their lower ends secured to the lower end of the arm, each said damping spring being relatively thin and of substantially the same width as said arm and of a length of the order of one half the length of the arm.

5. In combination with a pendulum having a flexible flat arm of a given width and length and

which are is suspended at one end for swinging movement in a plane at right angles to the width of the arm, and having an armature secured to the lower end of said arm for swinging the pendulum at a selected code rate in response to magnetic attraction recurrently applied to the armature and which pendulum has an inherent tendency to torsionally vibrate about the longitudinal axis of said arm, of means to avoid such torsional vibration, said means comprising a pair of damping springs mounted one on each flat side of the arm with their lower ends secured to the lower end of the arm, each said damping spring being relatively thin and of a width substantially equal to the width of said arm and of a length which is approximately one half the length of said arm, said springs laid along the sides of the arm with substantially no pressure exerted against the arm and tending to form air pockets between the surface of each spring and the adjacent surface of said arm when said arm vibrates abouts its longitudinal axis.

6. In combination with a pendulum having a flexible flat arm of a given width and length and which arm is suspended at one end for swinging movement in a plane at right angles to the width of the arm, and having an armature secured to the lower end of said arm for swinging the pendulum at a selected code rate in response to magnetic attraction recurrently applied to the armature and which pendulum has an inherent tendency to torsionally vibrate about the longitudinal axis of said arm, of means to avoid such torsional vibration, said means including a flexible damping member which has a width selected not to exceed the width of said arm and a length selected not to exceed one half the length of the arm, and said member mounted on one side of the arm with its lower end secured to the lower end of the arm and adjusted to exert substantially no pressure against the arm.

7. In combination with a pendulum having a flexible flat arm of a given width and length and which arm is suspended at one end for swinging movement in a plane at right angles to the width of the arm, and having an armature secured to the lower end of said arm for swinging the pendulum at a selected code rate in response to magnetic attraction recurrently applied to the armature and which pendulum has an inherent tendency to torsionally vibrate about the longitudinal axis of said arm, of means to avoid such torsional vibration, said means comprising a pair of flexible damping strips mounted one on each flat side of the arm adjacent the lower end of the arm, said strips having a width selected not to exceed the width of the arm and a length selected for the upper end of the strips to be approximately at the mid point of the arm, said strips having their lower ends secured to the lower end of the arm and formed to lie along the arm with little or no pressure between the arm and the strips.

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