

March 10, 1931.

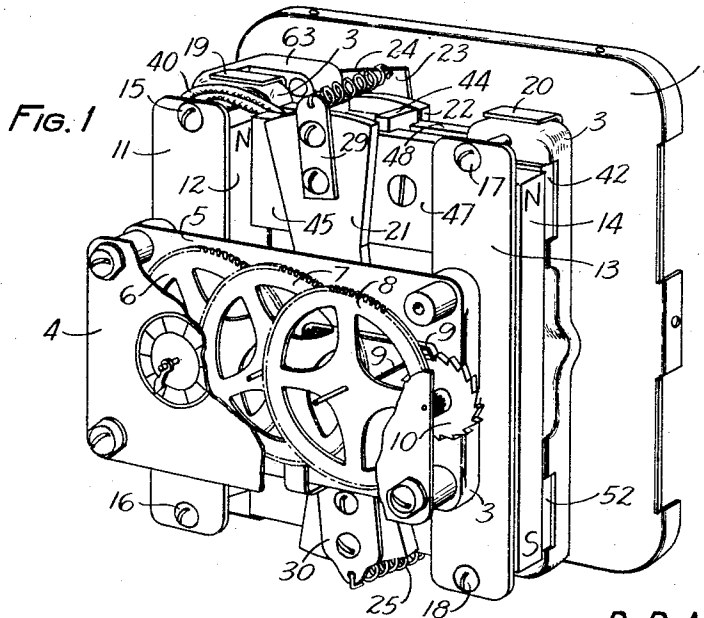
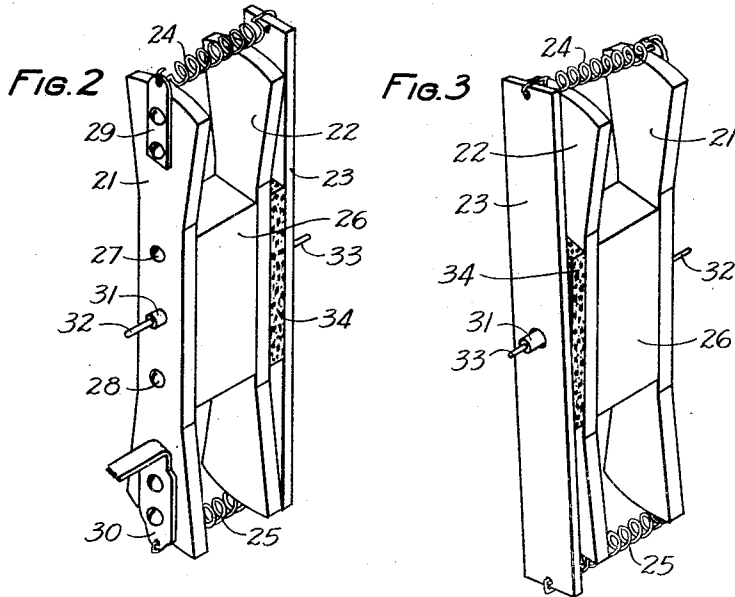
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MAGNETIC DEVICE

Filed May 31, 1929

2 Sheets-Sheet 1



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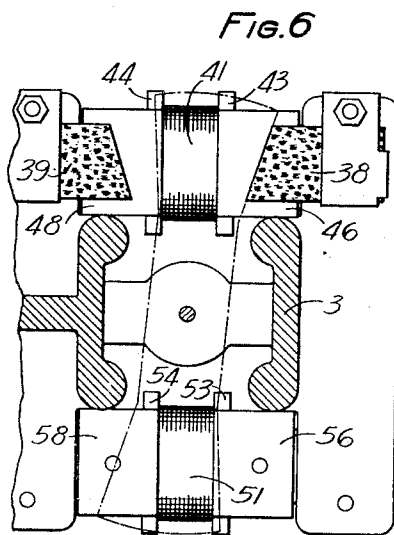
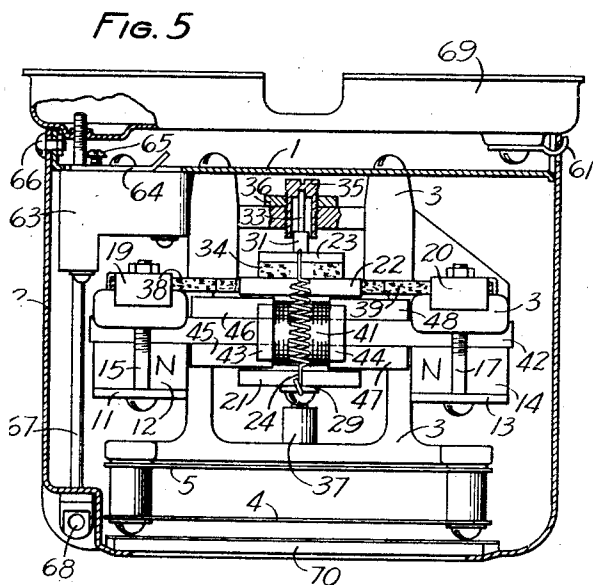
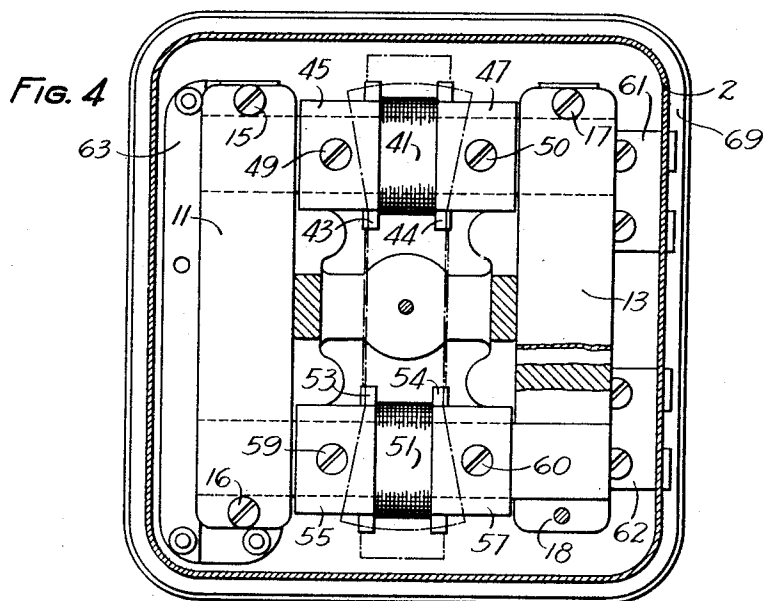
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MAGNETIC DEVICE

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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MAGNETIC DEVICE

Application filed May 31, 1929. Serial No. 367,490.

This invention relates to magnetic devices and particularly to such devices when used for measuring service in telephone systems.

The object of the invention is to increase the sensitivity, to improve the efficiency and to insure a greater reliability of operation of electromagnetic measuring devices.

Heretofore, various types of telephone substation meters have been proposed for measuring the amount of use a subscriber makes of his telephone. Many of these are open to the objection that they are not efficient enough to operate on the low operating currents. Others are not dependable in their operation. Still others are delicate in construction and subject to damage in handling and shipping.

According to the present invention these objections are overcome by means of an instrument comprising two permanent bar magnets having their respective ends interconnected by two electromagnets, said electromagnets having restrictions intermediate their ends in which energizing coils are wound, together with an armature comprising two parallel pieces, one above and the other below said coils, and arranged to oscillate in such a manner as to overlap the restricted portions of said bars and the unrestricted portions on either side of the restrictions.

A feature of the invention is a device of this character in which the armature shaft carries a member loosely mounted for movement relative to the armature and having a yielding connection between the armature and said member and a friction element between said parts to prevent rebound of the armature as it moves to its extreme position.

Another feature is a magnetic device in which the armature is so shaped as to produce a slight amount of magnetic bias when the armature is at either of its extreme positions. This prevents the armature from drifting due to vibration and causing a false operation of the device.

The accompanying drawings show an embodiment of the invention arranged for use at a telephone subscriber's station to record the amount of conversation for which the sub-

scriber is to be charged. Fig. 1 is a front view of the recording instrument, the outside casing having been removed; the face of the indicating mechanism has been cut away to show the driving ratchet and gears. Figs. 2 and 3 are views of the armature whose movement back and forth actuates the indicating mechanism. Fig. 4 is a front view with the indicating mechanism and armature removed; the mid-position of the armature is shown by the broken lines. Fig. 5 is a top view with the outside casing cut away, and Fig. 6 is a rear sectional view which shows the structure of the electromagnets and the cork stops which limit the movement of the armature. The embodiment of the invention as disclosed by Figs. 1 to 6, inclusive, will now be described in detail.

Referring to Figs. 4 and 5, the operating mechanism of the recording device is enclosed in a rectangular box-like casing which consists of the shell 2 and base plate 69. Being made of magnetic metal, the casing shields the mechanism from external magnetic interferences. The base 69 is arranged to be fastened by screws to a wall or other vertical support, and has a hole in its middle portion through which the telephone wires may be brought in for connection to wiring lugs such as 64 by terminal screws such as 65. The wiring lugs are mounted on the terminal block 63 which is fastened by screws to a mounting plate 1. Two hinge-like devices 61 and 62 are fastened to the right-hand edge of the base plate 69 and are engaged by slots in the shell 2. The head of the screw 67 which extends from the front of the casing to the base plate 69 is formed into an eye 68 which may be sealed to a similar eye permanently connected to the front of the casing so as to prevent tampering with the wiring after installation. The mounting plate 1 is rigidly held inside of the shell 2 by screws such as 66 which are spaced around the edge of the shell. The installer has no access to the operating mechanism without breaking the manufacturer's seal which is placed on one of the screws which hold the mounting plate 1 in the shell 2.

A non-magnetic, many-limbed, metallic

framework 3 is rigidly attached by screws to the mounting plate 1 and upon this framework the recording mechanism is assembled. Two permanent magnets 12 and 14 are fastened to the framework 3 by the clamping plates 11 and 13 and screws 15, 16, 17 and 18 as shown in Figs. 1, 4 and 5. The upper ends of these magnets are like magnetic poles and are designated N. A magnetic bar 42 of rectangular cross section extends between the upper ends, N poles, of the bar magnets 12 and 14 and a similar bar 52 extends between the lower ends, S poles, of these magnets. These bars are held by the screws 15, 16, 17 and 18 between the ends of the bar magnets and the framework 3. The bar 42 is the core of electromagnet 41 and the bar 52 is the core of electromagnet 51. The winding of the magnet 41 is limited at its ends by the copper collars 43 and 44 and the winding of the electromagnet 51 is limited at its ends by the copper collars 53 and 54, as shown in Figs. 4, 5 and 6. Pole pieces 45 and 46 are fastened by the screw 49 to the front and rear, respectively, of the core 42. The pole piece 45 occupies the space between the upper end of the bar magnet 12 and the copper collar 43 and the pole piece 46 occupies the space between copper collar 43 and the corresponding end of the supporting limb of the framework 3. In a similar manner pole pieces 47 and 48 are fastened by the screw 50 to the front and rear of the core 42. The pole piece 47 occupies the space between the copper collar 44 and the upper end of bar magnet 14 and the pole piece 48 occupies the space between the copper collar 44 and the corresponding end of the supporting limb of the framework 3. The pole pieces 55 and 56 and the pole pieces 57 and 58 are similarly fastened by screws 59 and 60 to the core 52 which extends between the S poles of the bar magnets 12 and 14, as shown in Fig. 4. The winding of the electromagnet 41 is connected by leads 40, shown in Fig. 1, to wiring lugs on the back of the terminal block 63. The winding of the electromagnet 51 is similarly connected to lugs on the terminal block 63.

The armature whose movement is controlled by the electromagnets 41 and 51 consists of the two magnetic pieces 21 and 22 and the non-magnetic spacing block 26, all of which are rigidly fastened together by the screws 27 and 28, as shown in Figs. 1, 2, 3 and 5. The armature is mounted on a shaft which consists of a middle section 31, which extends through the pieces 21 and 22 and the block 26, and the two end sections 32 and 33. These end sections which have a greatly reduced diameter, as compared with the middle section 31, extend into bearings 35 and 37 which are supported by the framework 3, as shown in Fig. 5. The bearings are so shaped that the normal bearing surface is limited to the extreme ends of the sections 32 and 33.

By reducing the diameter of the bearing surface of the shaft the force necessary to overcome the bearing friction in moving the armature is greatly reduced. Sleeve-like portions of the bearings, which overlap the ends of the unreduced section of the shaft 31 and have an inside diameter slightly larger than the section 31, limit the flexure of the end sections of the shaft, when subjected to shock such as might be experienced in shipping, to a safe limit. Thus the peculiar construction of the shaft and bearings results in a very sensitive but rugged instrument. The bearing 37 is fixed but the bearing 35 is adjustable and the lock nut 36 holds it in any given position.

The armature pieces 21 and 22 and the spacing block 26 are made heavy so that the armature will not respond to momentary impulses even though they greatly exceed the normal actuating force. The copper collars 43 and 44 encircling the core 42 and the copper collars 53 and 54 encircling the core 52 help to retard any movement of the armature in response to momentary impulses of current through the windings of the electromagnets or to mechanical shock.

The movement of the armature is limited by cork stop pieces 38 and 39 which are fastened to the framework 3 by clamps 19 and 20 and screws 15 and 17. See Figs. 1, 5 and 6. The non-magnetic damping bar 23 is attached by the spiral spring 24 and lug 29 to the upper end of the armature piece 21, and by the spiral spring 25 and arm 30 to the lower end of the armature piece 21. The damping bar 23 which is loosely pivoted on the shaft 31 is held by the two springs 24 and 25 against the flat surface of a piece of cork 34 which is affixed to the rear side of armature piece 22. When the armature strikes either one of the cork stop pieces 38 or 39, the damping bar, springs, and cork surface 34 are effective to prevent rebound and hold the armature in either of its extreme positions until moved to the other by current through the windings of the electromagnets. This arrangement prevents false operation of the indicating mechanism.

The ends of the armature pieces 21 and 22 are so shaped that with their upper ends in the extreme left-hand position, as viewed from the front of the instrument, their upper right-hand edges are substantially in line with the copper collar 44; and with their upper ends in the extreme right-hand position, their upper left-hand edges are substantially in line with the copper collar 43. The lower ends of the pieces 21 and 22 are similarly shaped. This construction secures the maximum amount of overlap between the armature and the pole pieces 45 and 46, when the upper ends of the armature pieces are in their extreme left-hand position, without any overlap between the armature and the pole

pieces 47 and 48; it also secures the maximum overlap between the armature and the pole pieces 47 and 48, when the upper ends of the armature pieces are in their extreme right-hand position, without any overlap between the armature and the pole pieces 45 and 46. Thus constructed there is a slight magnetic bias which tends to hold the armature in either of its extreme right or extreme left-hand positions if once moved to one of these positions.

The arm 30 which is attached by screws to the lower end of the armature piece 21 extends toward the indicating mechanism and the driving pawls 9 which engage the ratchet 10 are pivoted on the extension of this arm. See Fig. 1. The ratchet 10 and gears 6, 7 and 8 are supported between the plates 4 and 5. The plate 4 is the dial plate on which the dials, attached to the shafts of the gears 6, 7 and 8, indicate the amount of conversation, for which the subscriber, at whose station the device is installed, is to be charged. The three dials respectively indicate thousands, hundreds and tens. The dial plate 4 is visible from the front of the instrument through a glass window in a rectangular opening in the front of the shell 2, as shown in Fig. 5. The glass 70 cannot be removed from the outside without being broken.

For the purpose of describing the actuation of the armature assume that the recording device has been installed at a telephone subscriber's station, the windings of both electromagnets 41 and 51 being connected in series with the line which connects the telephone instrument to the central office. With no current flowing over the line and through the windings of the electromagnets, the magnetic flux is so distributed, as hereinbefore explained, as to hold the armature pieces 21 and 22 in either one of their extreme positions if originally placed in one of these positions. As viewed from the front of the instrument one branch of the circuit for this flux may be traced from the N pole of the bar 12 through the left-hand end of core 42, through the pole piece 45, armature piece 21, pole piece 55 and through the left-hand end of core 52 to the S pole of bar 12; another branch may be traced from the N pole of bar 12, through core 42, pole piece 46, armature piece 22, pole piece 56 and core 52 to the S pole of bar 12; another branch may be traced from the N pole of bar 14, through the right-hand end of core 42, pole piece 47, armature piece 21, pole piece 57, right-hand end of core 52 to the S pole of bar 14; and a fourth branch may be traced from the N pole of bar 14, through core 42, pole piece 48, armature piece 22, pole piece 58 and core 52 to the S pole of magnet 14.

When a connection has been established between this station and some other sta-

tion, for which the subscriber at this station should be charged, the central office equipment causes equally spaced reversals of the talking current over the line through the windings of the electromagnets 41 and 51 and the subscriber's telephone instrument. With the talking current flowing in one direction the field of the electromagnet 41 is such as to strengthen the flux through the pole pieces 45, 46, 57 and 58 and weaken the flux through the pole pieces 47, 48, 55 and 56; if not already with their upper ends in the extreme left-hand position as viewed from the front of the instrument the armature pieces will be moved to that position. If the current is reversed over the line the flux through pole pieces 45, 46, 57 and 58 becomes weaker than the flux through the pole pieces 47, 48, 55 and 56 so as to cause the upper ends of the armature pieces 21 and 22 to be moved to their extreme right-hand position. Thus each reversal of the talking currents moves the armature pieces 21 and 22 to the other position from that in which they were resting and in so doing the driving pawls 9 advance the ratchet one step to record one conversation unit of time for which a charge is to be made.

The copper collars 43 and 44 which surround the core 42 at the ends of the winding of the electromagnet 41 and the copper collars 53 and 54 which surround the core 52 at the ends of the winding of the electromagnet 51, act as short-circuited secondary windings of a transformer to reduce the effective impedance of the windings of the electromagnets so that the quality of the transmission over the subscriber's line will not be seriously affected by the installation of the register.

What is claimed is:

1. The combination in an electromagnetic device of two permanently magnetized bars, two electromagnetic bars interconnecting the respective ends of said first mentioned bars, said electromagnetic bars having restrictions intermediate their ends, energizing coils in said restrictions, an armature comprising two parallel pieces, one on one side and one on the other side of said coils, and arranged to oscillate in such manner as to overlap the restricted portions of said bars and the unrestricted portions, and means driven by said armature.

2. The combination in an electromagnetic device of a permanent magnet, an electromagnet having an energizing winding thereon, a shaft, an oscillating armature mounted on said shaft and cooperating with said magnets, a member loosely mounted on said shaft for movement relative to said armature, a yielding connection between the armature and said member, and a friction element between said armature and member to prevent said armature from rebounding.

3. The combination in an electromagnetic device of a core, a coil wound around said core, and a copper collar surrounding said core at the end of said coil for reducing the impedance of said coil to voice frequency currents.

4. The combination in an electromagnetic device of permanently magnetized and electromagnetic members, a core for each of said electromagnetic members extending between the poles of said permanently magnetized members, a coil for each of said electromagnetic members wound around said core, and a collar of non-magnetic metal surrounding said core at the end of said coil for reducing the impedance of said coil to voice frequency currents.

5. The combination in an electromagnetic device of permanently magnetized members, electromagnetic members, the core of each of said electromagnetic members extending between like poles of the permanently magnetized members, the coil of each of said electromagnetic members being wound around the middle portion of the associated core, an armature included in the magnetic circuits of said permanent magnets and arranged to move back and forth about an axis normal to the plane of said permanent magnets, and means actuated by said armature.

6. The combination in an electromagnetic device of two permanent bar magnets, two electromagnets whose cores extend respectively between like poles of said bar magnets, the coil of each of said electromagnets being wound around the middle portion of the associated core, an armature comprising two parallel pieces extending respectively from the sides of one of said coils to the corresponding sides of the the other of said coils, said armature being arranged to move back and forth about an axis extending through the middle of said pieces normal to the plane of said bar magnets, and means actuated by said armature.

7. The combination in an electromagnetic device of two permanently magnetized members, magnetic bars extending between like poles of said permanent magnets, a coil wound around the middle portion of each of said magnetic bars to form an electromagnet, pole pieces common to said permanent and electromagnetic members, an armature arranged to move back and forth on an axis which passes through its middle normal to the plane of said permanent magnets, means for limiting the movement of said armature in both directions so that in either of its extreme positions one end of said armature overlaps one of said coils and the pole pieces associated with the N pole of one of said permanent magnets and the other end of said armature overlaps the other of said coils and the pole pieces associated with the S pole of the

other of said permanent magnets, and means actuated by said armature.

8. The combination in an electromagnetic device of permanently magnetized and electromagnetic members, a core for each of said electromagnetic members extending between like poles of said permanently magnetized members, a coil for each of said electromagnetic members wound around the middle portion of the associated core, an armature, a shaft extending through the middle of said armature normal to the plane of said permanently magnetized members, bearings supporting the ends of said shaft, a member loosely mounted on said shaft, retractile springs linking the ends of said member to the ends of said armature, a friction element affixed to said armature for retarding the angular motion of said member relative to said armature, and armature stop pieces for limiting the movement of said armature.

9. The combination in an electromagnetic device of permanently magnetized and electromagnetic members, a core for each of said electromagnetic members extending between like poles of said permanently magnetized members, a coil for each of said electromagnetic members wound around the middle portion of the associated core, copper collars surrounding each of said cores to reduce the impedance of said coils and to retard a change in the position of said armature, pole pieces common to said permanently magnetized and electromagnetic members affixed to the sides of said cores between the ends of said coils and the poles of said permanently magnetized members, an armature comprising two pieces arranged to move back and forth about an axis through its middle, non-metallic stop pieces limiting the movement of said armature, and means actuated by said armature.

10. The combination in an electromagnetic device, of a permanent magnet, an electromagnet having an energizing winding thereon, a copper collar surrounding said core at the end of said winding for reducing the impedance of said winding to voice frequency currents, a shaft, an oscillating armature mounted on said shaft and cooperating with said magnets, a member loosely mounted on said shaft for movement relative to said armature, a yielding connection between the armature and said member, and a friction element between said armature and member to prevent said armature from rebounding.

11. The combination in an electromagnetic device of permanent and electromagnetic members, said electromagnetic members having restrictions therein, energizing coils in said restrictions, a copper collar surrounding the core of each of said electromagnetic members for reducing the impedance of said energizing coil to voice frequency currents, and

an armature mounted to oscillate in such a manner as to overlap the restricted and unrestricted parts of said electromagnetic members on either side of said restrictions, the sides of said armature being so shaped that when said armature is in its extreme position one side of the armature is substantially parallel to the edge of the coil restriction.

12. The combination in an electromagnetic device of permanently magnetized members, electromagnetic members, the core of each of said electromagnetic members extending between like poles of the permanently magnetized members, the coil of each of said electromagnetic members being wound around the middle portion of the associated core, a collar of non-magnetic metal surrounding the core of each of said electromagnetic members for reducing the impedance of said coils to voice frequency currents, an armature included in the magnetic circuits of said permanent magnets and arranged to move back and forth about an axis normal to the plane of said permanent magnets, and means actuated by said armature.

13. The combination in an electromagnetic device of two permanent bar magnets, two electromagnets whose cores extend respectively between like poles of said bar magnets, the coil of each of said electromagnets being wound around the middle portion of the associated core, an armature comprising two parallel pieces extending respectively from the sides of one of said coils to the corresponding sides of the other of said coils, said armature being arranged to move back and forth about an axis extending through the middle of said pieces normal to the plane of said bar magnets, a collar of non-magnetic metal surrounding the core of each of said electromagnets for reducing the impedance of said coils and to retard a change in the position of said armature, and means actuated by said armature.

In witness whereof, we hereunto subscribe our names this 28th day of May, 1929.

DANIEL D. MILLER.

EDWARD J. PRATT.