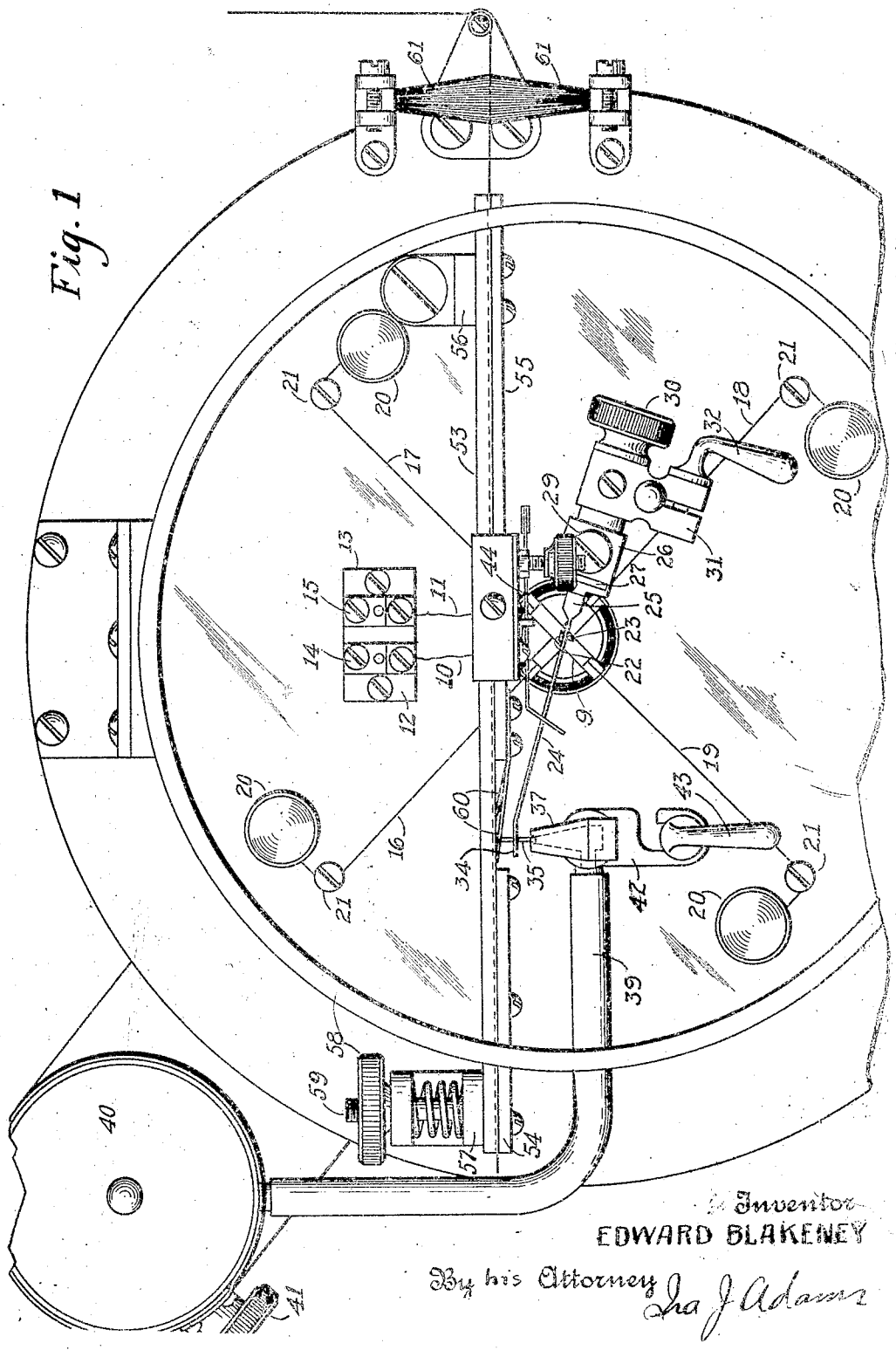
May 31, 1927. 1,630,324

E. BLAKENEY

SIPHON RECORDER

Filed Dec. 6, 1921 3 Sheets-Sheet 1

Fig. 1



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SIPHON RECORDER

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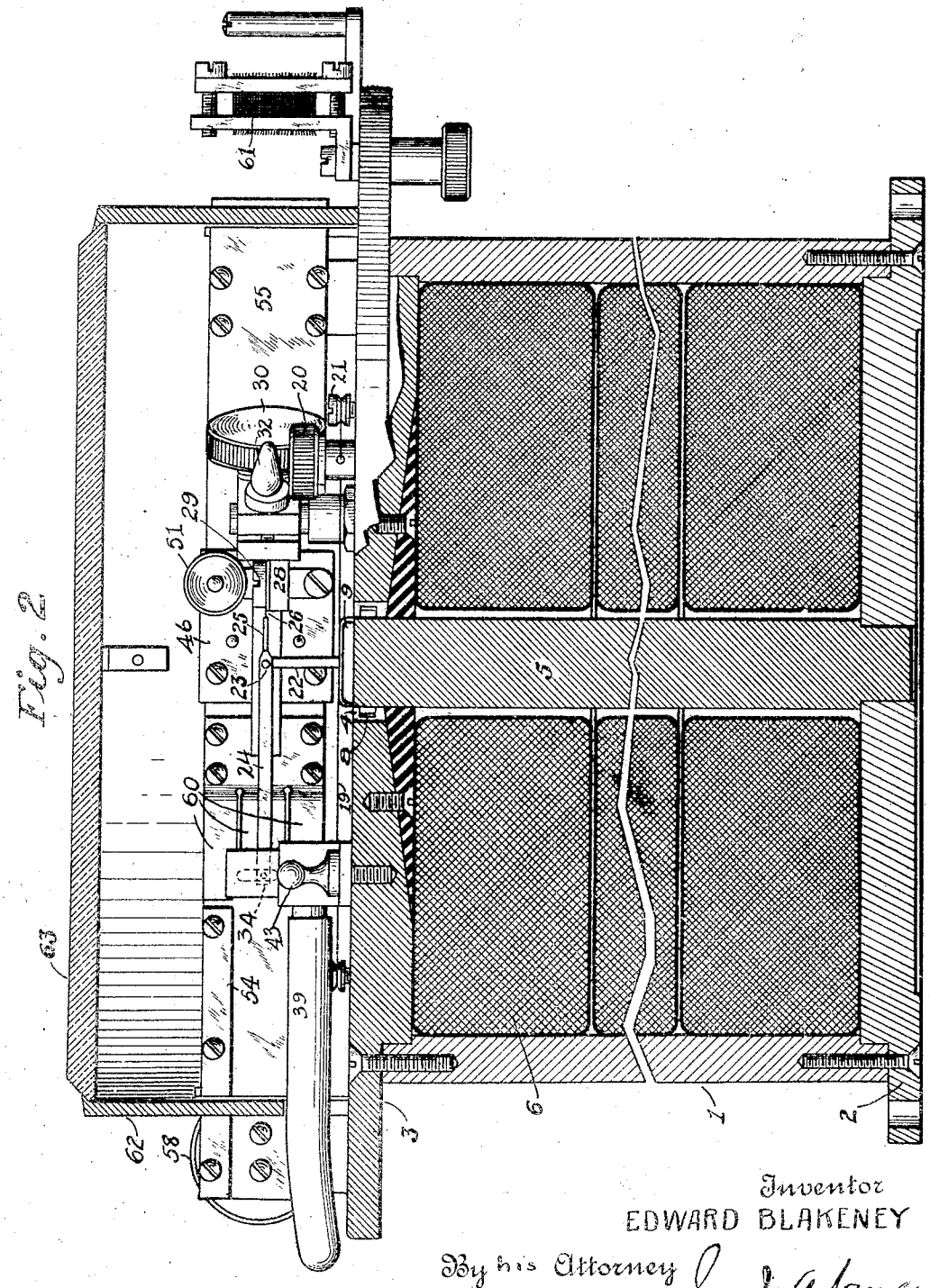


Fig. 2.

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Fig. 3

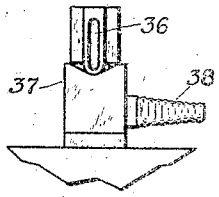


Fig. 4

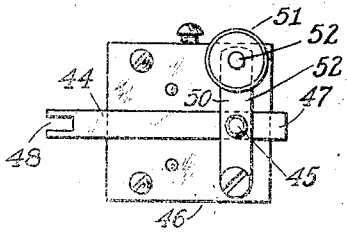


Fig. 5

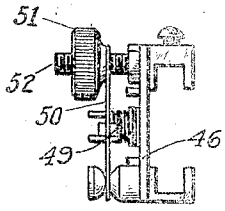
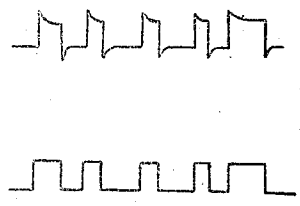


Fig. 6



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Patented May 31, 1927.

1,630,324

UNITED STATES PATENT OFFICE.

EDWARD BLAKENEY, OF KITCHAWAN, NEW YORK, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE.

SIPHON RECORDER

Application filed December 6, 1921. Serial No. 520,247.

This invention relates to apparatus for recording electric currents and particularly to recording telegraphic or radio signals. The apparatus is especially suited and meets the exacting requirements of high speed radio signalling and the objects and operation will therefore be described particularly with reference thereto, as it will be obvious from such discussion that the arrangement can be used under other conditions where the conditions are less severe.

The cost of equipment, especially transmitting stations for radio signalling, has been continually increasing, due to the desire to communicate over greater distances and the use of an excess of power to secure reliable communication under adverse weather conditions. To overcome this and secure profitable operation it is desirable to greatly increase the speed beyond that ordinarily obtainable with manual operation and aural reception which is about 20 to 25 words per minute. It is readily possible for high power transmitters to transmit automatically at speeds of 100 or more words per minute and in fact most such stations are now equipped with relays adapted to handle this speed. If the receivers were equipped for higher speeds the transmitters could, if necessary, be built for working at even greater speeds.

The limitation of the receiving speed is due to the fact that prompt and efficient service requires almost immediate transcription, so that the duplex receivers and transmitters may immediately cooperate when any difficulty in reading or adjustment is encountered. In practice it has been found that this condition is only realized by aural reception and manual transcription (which is limited to about 50 words per minute) with the best operators or by recording the signals directly in the form of a permanent record which is at once transcribed by a suitable number of operators. These requirements are especially pressing in radio signalling because of difficulties encountered in reading through atmospheric disturbances, which makes it necessary to occasionally repeat portions of a message or adjust the receiver or transmitter.

It is also desirable to secure a device which responds to very small currents so that excessive amplification with its attendant expense and difficulty is avoided.

Some of the general objects of the invention will be apparent from the previous discussion. More particularly the objects of the invention are to decrease the inertia of the moving parts by the construction hereinafter described and particularly by shortening the pen.

Another object of the invention is to provide an improved ink feeding device which is adapted to cooperate with the shortened inking pen.

A further object of my invention is to provide means for damping the movements of the pen arm at the ends of the pen stroke.

A still further object of the invention is to provide a coil and magnet arrangement capable of giving a considerable movement for small signal current variations.

In accordance with one embodiment of my invention, I utilize a short tube of small diameter which moves in a slot connected to a source of ink supply. The slot and ink supply are arranged so that the ink is retained in the slot by its surface tension and the movements of vibratory parts are imparted to the tube which oscillates with one end projecting in the slot and the other end against the recording strip. As the strip moves past the pen it draws ink from the slot through the tube. The tube moves between the prongs of a yielding fork which limits the vibratory motion due to the inertia of the pen arm.

The invention, both as to its construction, mode of operation and features of novelty, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a plan view of the top of the instrument with portions broken away for convenience of illustration.

Fig. 2 is a side view with certain parts in cross section.

Fig. 3 is a detail view showing the slotted ink feed.

Figs. 4 and 5 are detail views of the damping device.

Fig. 6 is a diagram showing the effect of the damping device.

Referring to the drawings, as shown in Fig. 2, I utilize a magnetic circuit comprising a cylindrical casing 1, a base 2, top 3, having a central circular opening 4 and a

central core 5 projecting from the base through the circular opening. In the space around the core is placed an exciting winding 6 in the form of a number of flat coils which will be connected to a source of direct current and a controlling rheostat which are not shown. The plate 3 may be bevelled as shown so that in the air space around the upper end of core there exists a uniform radial magnetic field. In view of the large dimensions of the iron, the small air gap (e. g. ⅛ inch) and the space for the windings obtainable with this arrangement I have it possible to secure a powerful magnetic field in the air gap and by placing a coil which is supplied with the varying currents in this field a considerable pull may be obtained with very small variations of the current in the coil. The arrangement is therefore applicable to directly recording currents of a value as low as .0005 amperes, so that the degree of amplification necessary for recording radio signals is readily obtained without high expenditures.

Before proceeding to further describe the construction of the arrangement it may be stated that any of the usual devices for amplifying radio or tone frequencies may be used together with any present or future improvements for eliminating, limiting, reducing or otherwise avoiding the effects of undesired, natural or artificial disturbances. It is also usually necessary to rectify the current supplied to the recorder in a suitable manner. An ordinary telephone may also be used in conjunction therewith for listening to quality of the signals.

The ring shaped moving coil 8 is fitted in the space around the core and consists of a large number of turns (e. g. 500 to 1000) of very fine silk or enamel covered wire which is held in shape by impregnation, the entire arrangement being adapted to give a maximum of turns for a given weight. The coil is attached to a four-prong aluminum spider 9 of light weight by means of adhesive material. Electrical connection with the moving coil is made by extending the leads 10, 11 back to damping blocks 12, 13, to which the input leads 14, 15 are also fastened. To support the coil without appreciably adding to its inertia, four waxed silk threads 16, 17, 18, 19 are attached by adhesive to the four prongs of the aluminum spider. The threads are each attached at the other end to adjusting screws 20 by means of which the coil is properly centered and the tension of the threads adjusted. Near the adjusting screws 20 the threads pass into grooves in the adjustable screws 21 by means of which the height of the coil may be regulated.

Connection for the marking member is provided by a vertical aluminum arm 22 having a pin 23 at the upper end which serves as a connection for the arm 24 which moves the marking member. The arm 24 is also a light strip of aluminum which is bent to form a pocket at one side 25 of the pin so as to be at right angles to the portion on the other side. A flat spring 26 is fitted in the pocket and is provided with a slot 27 and the spring is clamped to a support 28 by means of a screw 29. The adjustment of the lever and spring is facilitated by the thumb screw 30 attached to the spring support. The thumb screw permits the pen to be angularly adjusted so that it bears on the paper uniformly during its movement. The entire assembly is mounted for lateral adjustment on a bracket 31 which is fitted on a stud 32 to which the bracket is clamped by a hand lever 33. This method of support permits the pen arm 24 to be readily removed when repairs or adjustments are required to it or the moving coil suspension. The portion 34 of the arm 24 on the left of the pivot is longer than the portion attached to the spring so that the distance from the support 28, which acts as a fulcrum, to the pen is several times the distance from the fulcrum to the point 23 where the moving coil is connected. The weight of the various members, location of the pivot point, spring fulcrum, tension of the coil supports, etc. are all adjusted and proportioned so that the pen arm is in a suitable position and the movement of the end of the lever 24 is sufficient to give a record having convenient variations. A suitable movement is about ⅛ inch.

While the structure described is especially suitable for reducing the inertia and securing a low natural period or high natural frequency thus enabling small current variations to be recorded, another important feature of the construction which gives it simplicity, reliability and sensitiveness is the pen and the ink feeding arrangement. In known types of siphon recorders a glass tube of small diameter is used but as far as I am aware the mechanical construction of the recorders necessitates bent tubes at least several inches in length dipping into an ink reservoir. This adds considerably to the inertia and the tubes are delicate and difficult to keep in working order. The present construction utilizes a very fine tube 35 of glass, silver or brass which is held in a hole in the lever 24 by wax, adhesive or solder. The tube is straight and need only be about ½ inch in length, due to the arrangement for feeding the ink and the features of the mechanical construction described. The lever 24 is adjusted on the stud so that one end of the pen presses lightly against the paper or tube and the other end moves in a vertical slot 36 in an ink nozzle 37. The vertical slot in the ink nozzle is proportioned so as to hold the ink therein due to the surface ten-

sion of the ink. The dimensions of this may vary considerably and are readily found by trial. In the present case a slot about $\frac{5}{16}$ inch long and $\frac{1}{16}$ inch wide was found satisfactory. The nozzle which is hollowed out for receiving the ink has a spout 38 for attaching a hose 39 which leads to a reservoir 40. The reservoir is raised and lowered by means of the knob 41 which cooperates with any suitable mechanical movement such as a rack and gear. By trial it is easy to find the maximum height to which the reservoir may be raised without causing the pressure to overcome the surface tension and cause the ink to flow from the slot. The adjustment is not particularly sensitive and it is not essential to keep the level of the ink exactly constant. To facilitate the adjustment of the ink feed the nozzle is provided with a slotted portion 42 and clamp 43. The nozzle and pen are arranged so that the pen enters the slot about $\frac{1}{64}$ to $\frac{1}{32}$ inch and moves freely in the middle of it. It is found that the rapid movement of the tube in the slot at the rate necessary for high speed recording does not cause the ink to shake out of the slot.

Even with the arrangement as described there is, of course, some inertia to the moving parts and in consequence the recorder will give some sharp points on the record as shown in Fig. 6. To eliminate these sharp points due to the inertia of the moving parts, a damping device is arranged to cooperate with the pen. This consists of a substantially balanced damping arm 44. At one end 47 the lever is counterweighted and is forked at the other end 48. The forked end is bent into a position such that the pen arm 24 moves therein. The width of the slot in the fork is sufficient to permit the pen arm to move freely therein for a distance slightly less than the desired movement of the pen arm. When the pen arm strikes the damping arm the inertia is overcome and the movement retarded sufficiently to give a flat top record as shown in Fig. 6. The damping produced by the arm is controlled by a spring 49 arranged between the arm and a pressure member 50. The pressure member may be an elastic strip fastened at one end to the support 46 and movable at the other end by means of an adjustable nut 51 cooperating with a threaded stud 52 so that the pressure on the spring 49 and the freedom of movement of the damping arm may be varied.

A permanent record is made directly on a strip of paper or tape. A guide is provided for the tape and consists of a brass strip 53 suitably slotted to provide a narrow passage for the tape which moves in a vertical plane past the pen which is preferably in the horizontal plane. The passage is open for a short distance near the pen to expose the surface of the tape but is covered throughout the balance of its length by strips 54, 55. One end of the guide is attached to a fixed standard 56 and the other end is attached to an adjustable standard 57 cooperating with an adjusting knob and screw 58, 59. This adjustment permits the tape to be moved against the paper without disturbing the pen. A spring 60 is attached to the guide and presses against the paper in the neighborhood of the pen so as to keep it tight against the guide.

The tape before passing through the guide is preferably passed through a pair of brushes 61 which serve to brush off dust and lint and thus aids in preventing the pen from clogging.

To protect the instrument it is preferably inclosed in a casing 62 having a glass top 63 so that the operation is visible.

In view of the preceding description of the construction detailed discussion of the operation is believed unnecessary. Briefly, however, the operation is as follows: The coil is adjusted to the proper position and the current in the exciting winding and coil is regulated to give the proper movement of the pen arm. The ink well and nozzle are adjusted so that the surface tension retains the ink in the slot and the nozzle is moved so that the pen dips in the slot a short distance. The usual tape feed pulling motor such as is used in the "tikker" may be utilized for drawing the tape through the instrument. By careful adjustment and trial the pen and paper are regulated to get the proper pressure so that the ink is drawn from the tube to secure a uniform line. With the extremely fine tubes used it is difficult to do this except by trial as it is difficult to break or grind off the end of the tube so as to give a perfect inking end, and the elements are adjustable in various ways to facilitate this as well as the assembling and disassembling of the structure for replacement or repairs.

As the paper is moved past the pen the ink is drawn therefrom and the flow of ink as well as the movement of the pen has been found satisfactory for recording signals at speeds of 200 words per minute and apparently can be used for considerably higher speeds.

The damping device will square off the signals but it will be understood that any interfering currents which reach the recorder will also be recorded and will give the record a ragged appearance. If these interfering currents are of sufficient amplitude the damping device will decrease their effect on the record. In view of the fact that a perfect signal will give a substantially square top record, any irregularities in the record are the result of intereference, particularly static. It will therefore be possible for an

experienced operator to decipher the signals even when considerable static interference exists, although it will be understood that it is highly desirable for recording radio signals to associate the recorder with the best arrangements for reducing static interference. A well defined permanent record is obtained at the moment the signal is received which may be at once transcribed by the required number of operators, each of which will read certain lengths of the tape. The record is then preserved for checking purposes. This type of recorder gives the receiving station immediate and permanent record at a very low cost and also allows the receiving operator an opportunity to immediately secure a repeat of any portions of the message which are missed by having the duplex transmitter request repetition. This is very conveniently accomplished in modern duplex installations in which the receiving operator and transmitting operator are located at the same table in a central station connected by telegraph lines with the receiving and transmitting station.

Having described my invention, what I claim is:

1. In an indicator for electric currents, the combination of a fluid reservoir having a slot adapted to retain fluid by surface tension and a recording pen movable in said slot adapted to withdraw said fluid from the slot.

2. In an indicator for electric currents, the combination of a fluid reservoir having a slot adapted to retain marking fluid by surface tension, and a siphon pen movable in said slot adapted to withdraw said fluid from the slot.

3. In an indicator for electric currents, the combination of a fluid reservoir having a vertical slot adapted to retain marking fluid by surface tension and a horizontal siphon pen movable in said slot adapted to withdraw said fluid from the slot.

4. In an indicator for electric currents, the combination of a fluid reservoir having a slot adapted to retain marking fluid by surface tension, a strip of recording tape opposite and spaced a relatively short distance from said slot and a siphon pen movable in said slot bridging the space between it and the strip.

5. In an indicator for electric currents, the combination of a fluid reservoir having a vertical slot adapted to retain marking fluid by surface tension, a vertical strip of recording tape opposite and spaced a relatively short distance from said slot and a horizontal siphon pen having one end movable in said slot bridging the space between it and the strip.

6. In an indicator for electric currents, the combination of a fluid reservoir having a slot adapted to retain marking fluid by surface tension, a strip of recording tape opposite and spaced a relatively short distance from said slot and a substantially straight siphon pen having an end movable in said slot bridging the space between it and the strip.

7. In an indicator for electric currents, the combination of a movable arm carrying a marking member, a pivoted forked arm between which the first arm is freely movable during a portion of its movement and means for varying the freedom of movement of said forked arm.

8. In an indicator for electric currents, the combination of an electro-magnet having a ring shaped air gap, a ring shaped movable coil suspended in the air gap, a siphon pen connected to the coil and an ink reservoir having a slot adapted to retain fluid by surface tension, said pen being movable in said slot for withdrawing fluid therefrom.

9. In an indicator for electric currents, the combination of an electro-magnet having a ring shaped air gap, a ring shaped movable coil suspended in the air gap, a siphon pen connected to the coil and an ink reservoir having a slot adapted to retain fluid by surface tension, said pen being movable in said slot for withdrawing fluid therefrom.

10. In an indicator for electric currents, the combination of an electro-magnet having a horizontally disposed ring shaped air gap, a ring shaped movable coil suspended in the air gap, a horizontally disposed siphon pen connected to said coil and an ink reservoir having a vertical slot in which an end of the pen is movable, said slot being adapted to retain marking fluid by surface tension and to supply the pen therewith.

11. In an indicator for electric currents, the combination of an electro-magnet having a ring shaped air gap, a ring shaped movable coil suspended in the air gap, an arm connected to said coil, a siphon pen attached to said arm, and a fluid reservoir having a slot for supplying said pen, said slot being adapted to retain fluid due to the surface tension of the fluid.

12. In an indicator for electric currents, the combination of an electro-magnet having a ring shaped air gap, a ring shaped movable coil suspended in the air gap, a pivoted arm connected to said coil, a recording strip and an ink reservoir having a vertical slot facing and in close proximity to said strip, said slot being adapted to retain fluid by surface tension and a tube of small diameter attached to said arm and having one end movable in said slot and the other end in contact with said strip.

13. In an indicator for electric currents, the combination of a primary reservoir for marking fluid, said reservoir having an opening in a fluid retaining wall, a secondary reservoir connected with said primary

reservoir to supply marking fluid thereto and means for adjusting the height of said supplementary reservoir with respect to said first mentioned reservoir to adjust the fluid pressure in a manner to feed fluid to said first mentioned reservoir at a pressure insufficient to overcome the surface tension of the fluid across said opening.

14. In an indicator for electric currents, the combination of a fluid reservoir having an opening in a fluid retaining wall thereof, a reserve reservoir connected to said first named reservoir to supply marking fluid thereto, the fluid pressure in said reserve reservoir being adjusted in a manner to supply fluid to said first named reservoir at a pressure insufficient to overcome the surface tension of said fluid across said opening.

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