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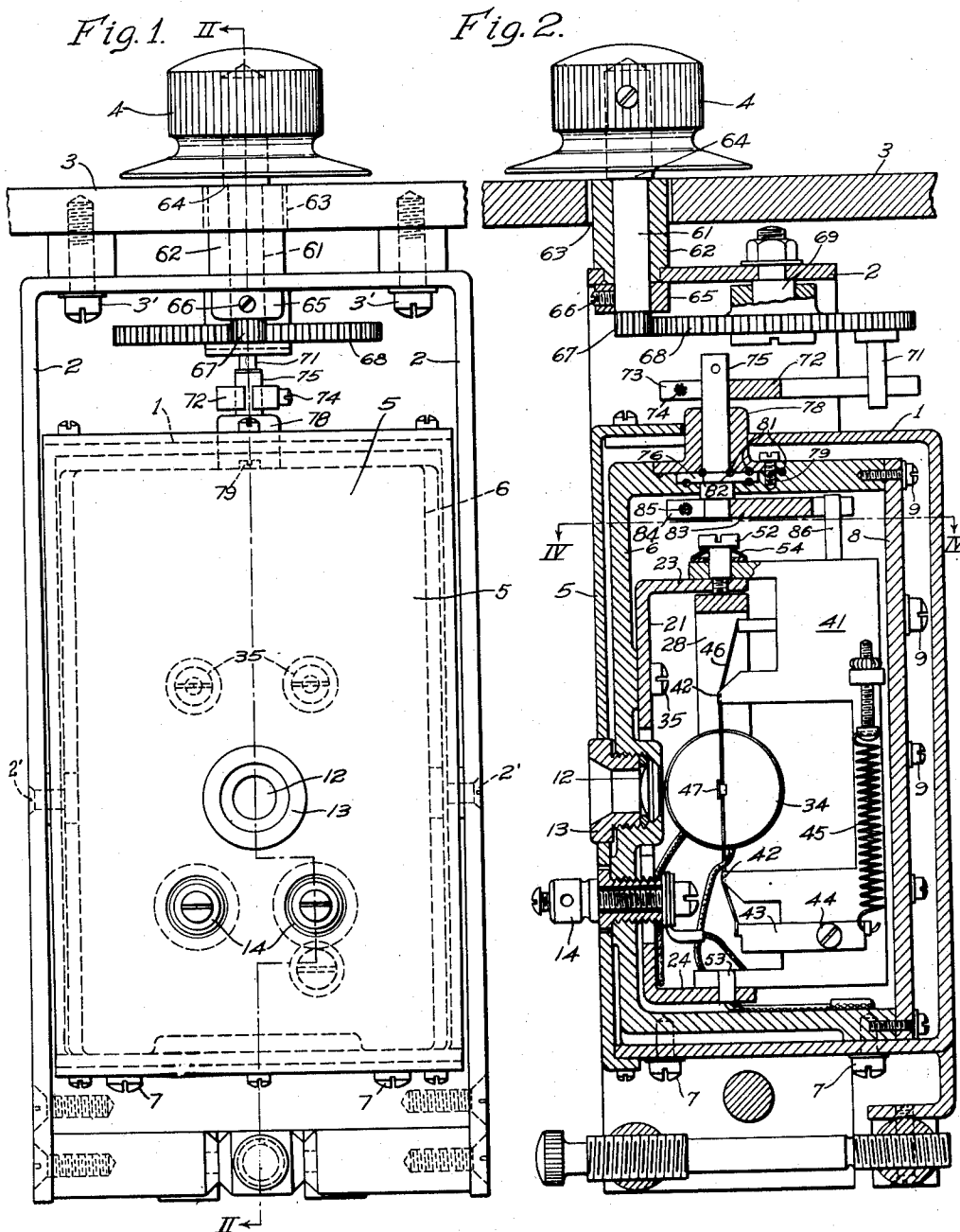
V. S. THOMANDER

1,982,333

ELECTRICAL INSTRUMENT

Filed Jan. 14, 1933.

3 Sheets-Sheet 1



WITNESSES:

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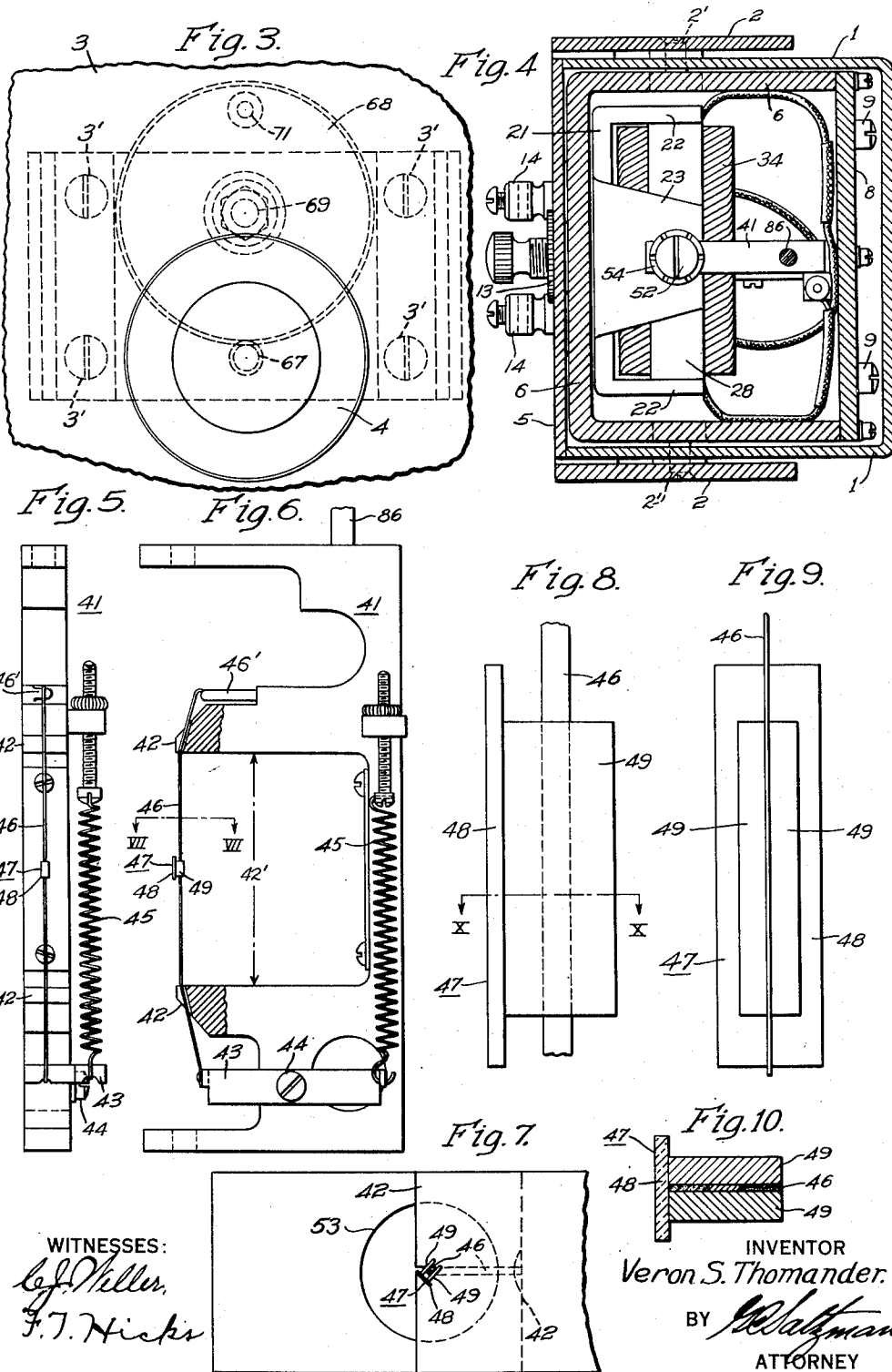
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3 Sheets-Sheet 2



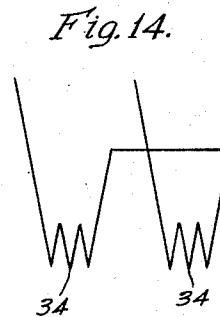
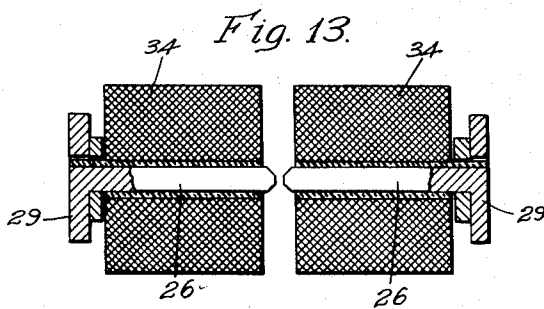
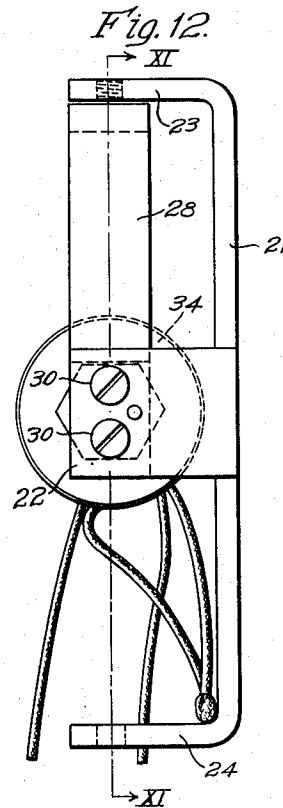
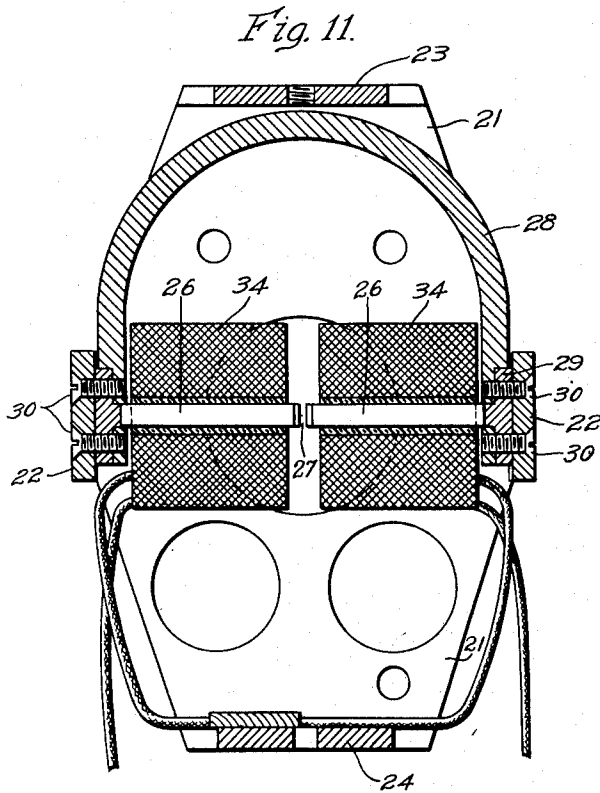
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

1,982,333

ELECTRICAL INSTRUMENT

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Application January 14, 1933, Serial No. 651,837

8 Claims. (Cl. 171-95)

My invention pertains to galvanometers and particularly to galvanometers suitable for use with amplifiers as in cardiographs.

It is an object of my invention to provide a galvanometer of improved sensitivity for cardiographs whereby one or more stages of amplification may be omitted or making possible a two stage amplifier for cardiograph application.

It is also an object of my invention to provide a rugged compact galvanometer of simple design.

Another object of my invention is to provide a galvanometer in which the mirror and magnet assembly may be conveniently adjusted to an angular position to allow for the normally large direct current output of an amplifier.

A further object of my invention is to provide a galvanometer support in which a galvanometer may be conveniently assembled comprising an oil tight casing in which the galvanometer may be readily adjusted during operation.

The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, in which

Figure 1 is a view in front elevation showing a galvanometer completely assembled in accordance with my invention;

Fig. 2 is a sectional view thereof taken on line II—II of Fig. 1;

Fig. 3 is a plan view thereof;

Fig. 4 is a cross-sectional view on line IV—IV of Fig. 2;

Fig. 5 is a detail view showing a front elevation of the vibrator assembly on an enlarged scale;

Fig. 6 is a side elevational view thereof partly in section;

Fig. 7 is an enlarged sectional view taken along the line VII—VII of Fig. 6, showing the angular relation of the indicating unit and its vibrator ribbon with reference to the yoke member;

Fig. 8 is an enlarged side elevational view showing the indicator unit in side elevation;

Fig. 9 is a front elevational view thereof.

Fig. 10 is a sectional view taken along the line X—X of Fig. 8;

Fig. 11 is a rear sectional view of the magnetic structure taken on line XI—XI of Fig. 12;

Fig. 12 is a side elevational view thereof;

Fig. 13 is a sectional view through the electromagnets in a plane at 90 degrees to the section of Fig. 11; and

Fig. 14 is a diagrammatic view representing the circuit connections for energizing the electromagnets.

Referring more specifically to Fig. 1 of the drawings, my galvanometer comprises a supporting housing 1 which is pivotally suspended on pivot pins 2' in an inverted U-bracket 2. The bracket is fastened to any suitable instrument board 3 in any suitable manner as by screws 3'. A knob 4 is disposed in front of the instrument board 3 for conveniently adjusting the angular position of the galvanometer mirror during operation in a manner to be subsequently set forth.

Referring to Fig. 2, it will be seen that the housing is closed on one side by a magnetic shield cover 5 and encloses a galvanometer casing 6 which is secured to the bottom of the magnetic shield or housing 5 by suitable screws 7. The galvanometer casing 6, in turn, completely encloses and supports the element of the galvanometer and is closed at the back by a closure plate 8 secured in oil tight engagement with the casing by suitable screws 9.

The front wall of the galvanometer 6 is provided with an orifice to receive a glass lens 12 which is held firmly seated by a threaded ring 13. By placing suitable cement on the lens and its retaining ring, prior to seating them, an oil tight joint is assured. Binding posts 14 are mounted in insulated relation in the front wall of the galvanometer casing 6 in any well known manner to afford connection with the interior thereof. The cover 5 of the supporting housing 1 is provided with open portions through which the window and the binding posts are exposed.

The structure of the galvanometer, which is mounted within the casing 6, comprises a front plate 21 having a laterally projecting arm extending from each edge and bent perpendicular thereto. The various perpendicular arms extending back from the front plate comprise a pair of side arms 22, an upper arm 23 and a lower arm 24, as shown in Figs. 2, 4, 11 and 12.

The magnetic circuit comprises a pair of pole pieces 26, and a U-shaped piece 28 as a return circuit of extremely low-inductive magnetic material, which are secured between the two intermediate arms 22 in such relation that the pole tips are disposed in adjacent spaced relation to form an air gap 27. The curved U-shaped magnetic member 28, which carries magnetic flux around the air gap 27 and back to the outer ends of the pole pieces 26, is securely fastened to the pole pieces 26 as clearly shown in Fig. 11. The outer end of each pole piece 26 is provided with

a head 29 which is clamped between one end of the U-shaped member 28 and one of the side arms 22 by screws 30. The elements are thereby secured into a rigid compact assembly and the reluctance of the magnetic circuit is diminished.

The tips of the pole pieces 26 are preferably tapered, as clearly shown in Fig. 13, to provide a concentrated field in the air gap 27. In order to still further concentrate the flux in the air gap, the magnetomotive force for energizing the magnetic circuit is provided by two windings 34, one of which is disposed on each pole piece 26 adjacent to the pole tip.

By placing the coils 34 on the pole tips, the magnetomotive force is applied to a point in the magnetic circuit where the reluctance of the magnetic path is concentrated, and consequently, the magnetic flux density in the air gap is greatly increased. This contributes to increase the current sensitivity of the instrument. Another advantage of having the coils so close together on opposite sides of the air gap is that all the flux must pass between them and will not go out into surrounding space and interfere with other galvanometer elements. The magnetic circuit return to the coils is of low reluctance; therefore, little leakage will result.

The cross section of the pole pieces 26 is made small thereby reducing the size and mean turn of the coil and its reactance and resistance for a given number of coil turns. The voltage-sensitivity of the instrument is thus greatly increased. Conversely the small core makes it possible to provide a coil of a greater number of turns, having the same resistance and reactance and thus further increases the current sensitivity of the galvanometer.

In assembling the instrument, the flat portion of the front plate 21 is secured to the front wall of the galvanometer casing 6 by suitable screws 35. The plate 21 is provided with openings arranged to admit the terminal connectors 14 and the window 12.

The vibrator assembly, as clearly shown in Figs. 5 and 6, comprises a yoke 41 having bridges 42 thereon. A tensioning means is provided comprising a lever 43 which is pivotally mounted on a screw 44. One end of the lever 43 is biased by an adjustable tensioning spring 45 and the other end is secured to a vibrator ribbon 46 which passes over the bridges to an anchor 46' above the upper bridge. The spring is preferably stretched to about forty grams tension.

Attached to the vibrator ribbon 46 is an indicator unit 47 comprising a mirror 48 and a pair of small permanent magnets 49 of cobalt steel. To secure this unit to the ribbon, the permanent magnets 49 are cemented together with the ribbon 46 clamped between, and the mirror 48 is cemented to the edges of the magnets, as shown in Figs. 8, 9 and 10.

The surfaces of the bridges 42 are cut at an angle of about 45 degrees to the plane of the yoke 41, and when the vibrator ribbon 46 is tensioned between the bridges, it supports the indicator unit 47 in an angular position, as shown in Fig. 7. This allows a large deflection in one direction for the normally large direct current output of the amplifier also the bridges are cut at a 15 degree angle the other way, as shown at the top of bridge 42, to make a knife edge on the inside edge of each bridge, to insure that the vibrator ribbon will always ride on these two edges, and give a definite bridge spacing 42' of about one inch.

The ends of the yoke 41 are pivotally supported by pivot pins 52 and 53 which extend through the extremities of the respective upper and lower arms 23 and 24, respectively, projecting from the front plate 21. The orifices for receiving the pivot pins are provided in the yoke extremities in exact axial alignment with the vibrator ribbon 46 and the latter is so positioned that it extends through the air gap 27 and supports the indicating unit 47 directly between the pole tips where the density of the flux is greatest. A spring washer 54 under the head of pivot pin 52 applies sufficient tension to hold the yoke 41 firmly in any adjusted position.

Since the rotation of the yoke 41 on its pivots is about an axis which extends lengthwise through the ribbon, the angular position of the cross section of the ribbon 46 and of the indicating unit 47 thereon will be varied as the yoke is turned, but the axial alignment of the ribbon in the air gap 27 will not be disturbed. This renders possible the use of a small air gap, the dimensions of which are comparable with the magnets of the indicating unit itself which are thereby exposed to the maximum flux density available.

After the galvanometer is assembled and its casing has been filled with oil, the angular position of the vibrator yoke 41 may be conveniently adjusted from the front of the instrument board by manipulating the knob 4. The knob 4 rotates the yoke 41 through a suitable interconnecting mechanism comprising a dial shaft 61 which is journaled in a bearing 62 supported by the U-bracket 2. The shaft and its bearing are elongated and extend through an opening 63 in the instrument board 3 to support the knob 4 adjacent the front of the board. The outer end of the shaft 61 is provided with a shoulder 64 which predetermines its position in the bearing and the inner portion of the shaft carries a collar 65 which abuts the inner end of the bearing and is rigidly secured to the shaft 61 by a screw 66. A small pinion 67 is rigidly secured on the end of the shaft in any suitable manner, and operatively engages a gear wheel 68 which is journaled on a stud shaft 69 depending from the bracket 2.

The gear wheel 68 carries a pin 71 which projects into a slot in one end of a bifurcated lever 72. The opposite end of the lever 72 is provided with a split bearing 73 and a screw 74 which clamps it onto the end of a galvanometer shaft 75 which extends into the galvanometer casing. The galvanometer shaft 75 is provided with a flanged shoulder 76 which is seated in a bearing in the upper end of the galvanometer casing. The flanged shoulder 76 is secured in position by an end bearing plate 78 and a screw 79 which is threadably received by the end wall of the casing 6.

The bearing has a long oil creepage surface and is provided with numerous glands 81 for the reception of a strong lye soap 82 which is thereby held in compressed engagement with the shaft and its flanged shoulder. Such a bearing is completely oil proof and positively prevents the creepage of oil out of the galvanometer casing along the shaft. When oil comes in contact with the lye in the soap, more soap is made and the opening between the bearing and the shaft is closed. This bearing has completely eliminated difficulties caused by oil creepage.

The lower end of the galvanometer shaft 75 carries a lever arm 83 clamped thereto in any suitable manner as by a split end 84 and screw 85.

The free end of the lever 83 is bifurcated. A pin 86 projects upwardly from the yoke 41 and is received by the slot of the bifurcated lever 83.

In adjusting the instrument, the knob 4 and its shaft 61 are turned and the small pinion 67 drives the large gear wheel 68 through a relatively small angle. The pin 71 on the large wheel turns the adjacent lever 72 which turns the galvanometer shaft 75 and the lever 83 within the galvanometer casing. The movements of the lever 83 are then transmitted to the vibrator yoke 41 through the pin and slot connection.

In operation the attendant adjusts the angular position of the vibrator assembly until the surface of the vibrator mirror is parallel to the surface of the lens in the window. This allows a large beam deflection for use with an amplifier as in cardiographology or for other purposes where a direct current component is present. As the mirror and magnet unit deflects to overcome the 45 degrees, angular displacement allowed, the vibrator assembly has a full swing in one direction to keep the mirror always parallel with the lens surface, or to keep the reflected spot from the mirror on the photographic surface.

It will be apparent that I have provided a very compact and rugged galvanometer which may be immersed in oil without danger of the oil creeping, which is provided with an adjustable vibrator assembly whereby the direct current component in the output of an amplifier may be compensated, and which is of improved sensitivity thereby rendering possible the elimination of one or more stages of amplification and making possible a two stage amplifier for cardiograph application.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except as necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. In a galvanometer the combination of a vibrator assembly, an oil tight casing, means for pivotally mounting said assembly within the casing, externally adjustable means extending into the casing for regulating the position of said assembly and a soap packed oil seal bearing for preventing seepage of oil from said casing along said adjustable means.

2. In combination in a galvanometer, a rectangular plate of non-magnetic material having a laterally projecting arm extending from each edge thereof and bent perpendicular to the plane of the plate, magnetizable pole pieces supported by and projecting inwardly to form an air gap between an oppositely disposed pair of said arms, a curved U-shaped magnetic member arching over and serving as a magnetic return path to said air gap and having its ends secured to the outer ends of said pole pieces, a vibrator assembly comprising a yoke, and means for pivotally supporting said yoke between the other pair of projecting arms.

3. In combination in a galvanometer, a rectangular plate having a laterally projecting arm extending from each edge thereof and bent perpendicular to the plane of the plate, magnetizable pole pieces supported by and projecting inward-

ly to form an air gap between an oppositely disposed pair of said arms, a yoke having bridges thereon, a vibrator ribbon, means for tensioning said ribbon between said bridges on said yoke, an indicating unit comprising a mirror and a permanent magnet secured to said ribbon, and means for pivotally supporting said yoke between the other pair of projecting arms whereby the permanent magnet on the ribbon is suspended in said air gap.

4. In combination in a galvanometer, a rectangular plate having a lateral arm extending from each edge and bent perpendicular to the plane of the plate, a magnetizable structure supported between an oppositely disposed pair of said arms, indicator means supported between the other pair of projecting arms in cooperative relation with said magnetizable structure, an enclosing casing having a window in the front wall thereof, an aperture in said plate, and means for securing said plate to the inner surface of said front wall with the aperture in alignment with said window.

5. In a galvanometer the combination of an oil tight casing, a vibrator assembly, means for pivotally mounting said assembly within said casing, a split bearing in the upper wall of said casing, a shaft extending through said bearing, a flanged shoulder on said shaft, glands in said bearing, a strong lye soap in said glands, and means for interconnecting the inner end of said shaft with said vibrator assembly whereby it may be adjusted by rotating the shaft.

6. In combination in a cardiograph galvanometer a vibrator assembly comprising a supporting yoke, a vibrator ribbon, bridges on said yoke inclined at an angle to the plane of the yoke, means for tensioning said ribbon over said bridges, indicating means comprising a mirror and permanent magnet carried by said ribbon, an enclosing casing having a window, a magnetizable structure, and means for adjustably supporting said yoke whereby the position of the mirror relative to the window may be axially adjusted to compensate for a direct current component in the variable current.

7. A galvanometer vibrator assembly comprising a supporting yoke, a vibrator ribbon, bridges on said yoke having vertical surfaces inclined at an angle to the plane of the yoke, means for tensioning said ribbon over said surfaces, a pair of magnets secured together on opposite sides of said ribbon, and a mirror secured to the edges of said pairs of magnets.

8. In a galvanometer, a yoke member having a pair of bridges thereon, a vibrator ribbon extending between said bridges and means for tensioning it, ribbon-engaging faces on said bridges so formed that the vertical plane defined by said ribbon is angularly related to the vertical plane of the yoke member, means for establishing a variable magnetic field across said ribbon in accordance with a quantity to be measured, a permanent magnet secured to said ribbon within said field, means carried by said ribbon to indicate the deflection thereof under the influence of variations in said field, and means for adjustably supporting said yoke.

VERON S. THOMANDER.