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CELL DIAPHRAGM POSITION INDICATOR

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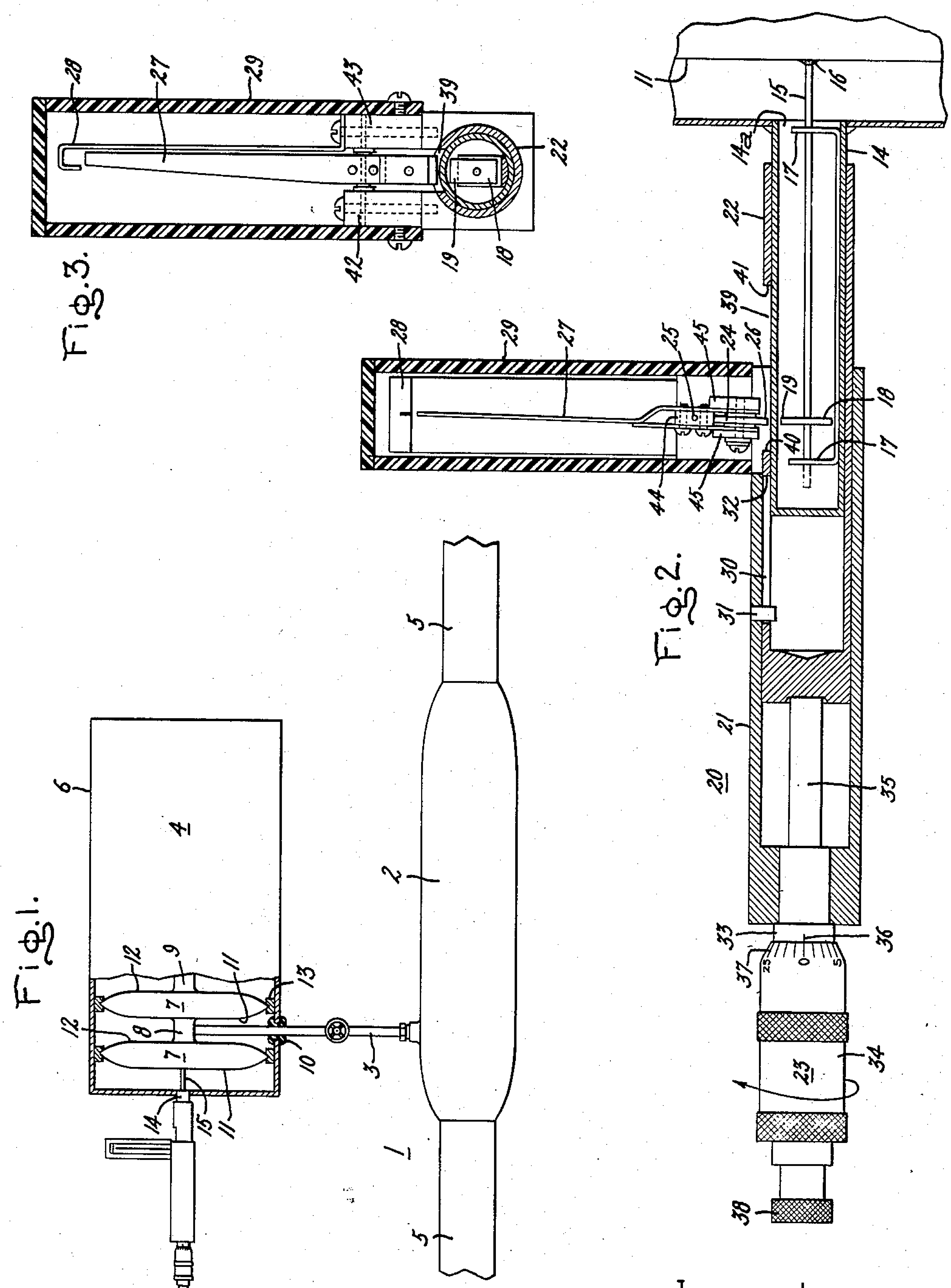

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CELL DIAPHRAGM POSITION INDICATOR

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4 Claims. (Cl. 33—125)

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This invention relates to measuring devices and in particular to a new and improved measuring device for measuring the deflection of a movable wall within a sealed container and more particularly for indicating the volume of oil within oil cells located within a sealed container.

Paper insulated power cable generally comprises copper, paper, impregnating oil and lead sheath. Of these materials the oil has the highest coefficient of thermal expansion, while the lead has a much lower expansion coefficient, and is relatively inelastic. Under load, the total effect of thermal expansion of the materials in the solid type cable is to stretch the lead sheath. A reduction in temperature causes all the material to contract to their original dimensions, except the lead sheath, which remains expanded. Voids thus tend to form under the sheath or between layers of the insulation wall. These voids ionize at relatively low voltage stress, and ionization may lead to deterioration of the cable insulation and eventually to cable failure.

In oil filled cable, a low viscosity impregnating oil is used, and continuous longitudinal oil passages are provided so that the oil may easily penetrate all parts of the cable. Oil reservoirs are installed at suitable intervals. These serve automatically the dual function of maintaining a positive internal pressure at all temperatures and of permitting thermal expansion of the oil without straining the lead sheath. The reservoirs are designed to provide complete separation of the oil from any moisture, gas or air. Reservoirs are of proper size to satisfy completely the varying oil requirements in the cable from possible no-load on the cable in the winter up to full load in the summer.

The reservoirs which maintain the pressure of the oil comprise a plurality of diaphragms arranged in series within a container. The diaphragms conventionally are circular in shape and substantially comprise a pair of cylindrical flexible disks sealed at their peripheral edges so that the disks will expand and contract in response to the differential pressure exerted between the oil and the atmosphere within the cylinder. The cylinder, in one type reservoir is sealed and filled with a gas under pressure which constantly plays against the diahpragm walls to exert a pressure on the oil tending to force it into the cable to which the reservoir is connected.

The problem, then, is to measure, every few months, the quantity of oil in one of the series diaphragms located within a sealed container to determine the amount of oil in it. Accordingly,

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it is an object of this invention to provide a new device for measuring oil within an oil reservoir of the type described.

It is a further object of this invention to provide a very simple device for measuring oil within an oil reservoir.

It is a still further object of this invention to provide a simple yet unique device for determining the postion of a flexible diaphragm or movable wall positioned within a sealed container.

Briefly, this invention comprises the positioning of a magnet and supporting rod to one wall of a flexible diaphragm or movable wall so that the rod extends perpendicularly from the diaphragm through the wall of the diaphragm enclosing container to lie within a hollow extension affixed to the container wall. A measuring device is positioned telescopically to engage the hollow extension and to measure the position of the enclosed magnet thereby recording the expansion and contraction of the flexible diaphragm.

In the drawing, Fig. 1 is a schematic view of an oil-filled cable and an oil reservoir positioned to supply oil under pressure to the cable; Fig. 2 is a side elevation, partly in section, of the improved measuring device for determining the quantity of oil within the diaphragm shown in Fig. 1; while Fig. 3 is an end elevation partly in section of the indicating device shown in Fig. 2.

In the drawing, an oil-filled cable 1 is shown having a joint 2 where oil under pressure is admitted through pipe 3 from a reservoir 4.

An oil-filled cable generally is supplied with perforated walled tubes which extend the length of the cable and through which oil may pass to permeate through the insulation within the cable and within a lead sheath 5 which encases the elements of the cable. The oil receiving joint 2 surrounds two adjacent ends of the cable sheath 5 and it is designed to conduct oil to perforated wall passageways within the cable 1. The oil pipe 3 is schematically indicated as merely connecting the oil reservoir 4 with the joint 2.

Oil reservoir 4 comprises a sealed container 6, usually of cylindrical form. The sealed container, which in one embodiment, is maintained full of a gas under pressure, has positioned therein a plurality of diaphragms 7 interconnected by tubes 8 and 9, for a series connection. Tubes 8, 9 in turn are connected to the oil pipe 3. Oil pipe 3 extends through a pressure-tight seal 10 in one wall of container 6. It is to be understood, of course, that the sealed container has been selected merely as an example to explain the operation of this invention, and it is not intended as a limitation on the scope of this invention.

Each of the diaphragms 7 comprises a pair of flexible walls 11, 12 joined at their peripheral edges to form an expansible sealed oil containing unit. The peripheral edges of the diaphragms are positioned in blocks 13 or other devices to provide for their alignment within the container 6.

The walls 11 and 12 of diaphragm 7 flex outwardly and inwardly in response to the quantity of oil contained or restored to them and accordingly the tubes 8, 9 which interconnect the diaphragm walls should be flexible to expand and contract with the walls.

When the oil reservoir is first built and filled with oil, the walls 11 and 12 are furthest apart. Then, when gas pressure is built up in container 6, the walls 11 and 12 come together under the influence of the gas pressure within the container 6 to squeeze the oil into the cable. Then, when the cable heats up under load the oil is forced back through pipe 3 into the diaphragm 7 causing the walls 11 and 12 to separate again as the oil contents within diaphragm 7 is increased.

The problem is to measure the deflection of the walls 11 and 12 while they remain within the sealed container 6 so that the quantity of oil within one diaphragm may be checked.

The objectives of this invention are achieved in one illustrated embodiment by attaching a hollow tube or protrusion 14 to one end of the container 6 to be interconnected with the container proper through an aperture 14*a*. The tube 14 is of non-magnetic material, is closed at its outer end and is brazed or otherwise sealed to the container wall so that the pressure within the container and tube 14 is uniform.

Before the tube 14 is secured in place, a rod 15 is brazed or otherwise secured to wall 11 of one of the diaphragms 7 at a point 16. The rod may be positioned and guided within the tube 14 by bushing-like guides 17. Rod 15 is then free to move axially within the guides 17 and within tube 14 in response to the expansion and contraction of the wall 11 of diaphragm 7.

To provide a reference point for measuring the expansion and contraction of the wall 11, a permanent magnet 18, having a narrow pole face 19, is attached rigidly to the rod 15 so that the movement of the magnet 18 will simulate the expansion and contraction of the wall 11. Accordingly, if the position of the magnet 18 is determined when the oil reservoir is filled and again when the reservoir is in use, the difference between the two positions can serve to indicate the qauntity of oil missing from the diaphragm.

A simple method of determining the position of magnet 18 is to align a second magnet outside tube 14 with the magnet 18 within the tube. This is possible since tube 14 is made of non-magnetic material whereby the magnetic lines emanating from magnet 18 pass through tube 14 for alignment with a second magnet.

For the accurate positioning of a second magnet, a measuring device 20 is provided. It comprises a tubular body member 21 which telescopes over a sleeve 22 and is adjustable axially relatively to sleeve 22. Sleeve 22 is of a size to fit over tube 14 and to be located on tube 14 in a definite position. Carried by body member 21 is a magnet 24 which is pivotally mounted on body member 21 by a pivot pin 25. Magnet 24 has a pole face 26 adapted to be aligned with

pole face 19 of magnet 18 and connected to the magnet is a needle-like element 27 which moves over a stationary scale 28 carried by a tubular body member 21 and positioned within an indicating chamber 29.

Scale 28 has a reference mark so that all readings of the micrometer 23 may be made at the same relative position of alignment between pole faces 26 and 19 as indicated by needle 27.

The construction of the indicating instrument is such that body member 21, having any desired contour, is drilled or otherwise provided with a bore for housing tube 22 so that tube 22 may telescope into body member 21. The upper surface of tube 22 is slotted as at 30 and a pin 31 is passed through body member 21 into the slot 30 and thus limits the telescoping movement of the body member and tube 22 relatively to each other. In the position shown in Fig. 2, tube 22 is in its longitudinally furthest outward position with pin 31 against one end of slot 30. At its longitudinally innermost position, shoulder 32 of slot 30 is against the opposite side of pin 31.

The movement of body member 21 on tube 22 is measured by a micrometer 23 which may be of known construction and is shown only in outline. The sleeve or barrel 33 of the micrometer is fixedly supported in the end wall of body member 21. The thimble of the micrometer is indicated at 34, the rod or screw at 35, the scale on sleeve 33 at 36, the vernier at 37, and the ratchet handle at 38. As is well understood the thimble 34 and the rod or screw 35 are connected together and have threaded engagement with sleeve or barrel 33 whereby when the thimble is turned, it and the rod or screw 35 are moved axially with respect to barrel 33. When micrometer 23 is retracted or turned in a counterclockwise direction as shown by the arrow in Fig. 2, rod 35 backs off from the end of tube 22 and body member 21 can then be slid along tube 22 until the end of rod 35 again contacts the end of tube 22.

The upper surface of tube 22 is provided with a second slot 39 defined by the shoulders 40 and 41 which are located to allow the pole face of magnet 26 to extend through the slot to be close to the outer surface of tube 14. With this structure, the magnetic face 26 of magnet 24 is separated from the face 19 of magnet 18 only by the thickness of the tube 14.

The relative positioning of the slots 30 and 39 is such that irrespective of the movement of tube 22 with relation to the body member 21, the stop 31 limits the motion of the tube so that the shoulders 40 and 41 will not touch the magnet 24 to damage it in any way.

To provide for the reading of the micrometer at proper positions, bearing pin 25 is located in a pair of mounting blocks 42, 43 (Fig. 3) which are rigidly secured to body member 21. Bearing pin 25 rotatably mounts a needle support 44 to which is fastened the indicating needle 27. The magnet 24 with its polarized face 26 is also suspended from the bearing pin 25 by means of the mounting blocks 45 and the weight of the blocks 45 and magnet 24 in comparison to the weight of needle 27 and its length is such as to effectively balance the parts distributed on either side of the bearing pin 25, thereby assuring a smooth, uniform operation of the needle 27.

The needle 27 and the component parts of the indicating device including the scale 28 are enclosed within the plastic chamber 29 preferably of clear material to prevent dust from accumulating on the bearing pin **25** and to allow for the reading of the needle **27** against the scale **28**.

In operation, tube **22** is placed over and held fixed in a predetermined position on tube **14** and micrometer **23** is rotated clockwise or counterclockwise while the body member **21** of instrument **20** is pushed slightly toward diaphragm **7**, body member **21** sliding on tube **22**, to keep the end of micrometer rod **35** against the end of tube **22**. At one particular point, the pole faces **26** and **19** will be in alignment and needle **27** will be rotated about the pivot pin **25** so that it registers against scale **28**. When needle **27** reads at the midpoint mark on scale **28**, the magnets are in exact alignment. A reading of the micrometer is then taken. By comparing readings of the micrometer taken when the diaphragms **7** are full, with later readings, a determination of the oil remaining in the diaphragms can be made.

In making measurements it will be seen that the measurement actually taken by the micrometer is the position of tubular body member **21** with respect to sleeve **22** when magnet member **24** is in alignment with magnet member **18**; and since the position of magnet member **18** represents the position of movable wall **11**, differences in successive micrometer readings taken when the magnet members are in alignment measures wall deflections.

The mechanism comprising body member **21**, the magnet member and scale carried by it, and the sleeve **22** constitutes a portable instrument which can be transferred from one reservoir to another for measuring the position of the diaphragms therein, it being only necessary that the reservoirs be each provided with a tube **14** having therein a magnet member connected by a rod to the movable diaphragm of the reservoir.

Modifications of this invention will occur to those skilled in the art and it is desired to be understood, therefore, that this invention is not intended to be limited to the particular embodiment disclosed but rather is it intended to cover all modifications which are within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for measuring the position of a movable member in a sealed casing comprising a tube attached at one end to the outer surface of the casing, a rod connected at one end to the movable member and projecting out through the casing into said tube, a magnet member fixed on the rod within the tube, a tubular body member, a magnet member pivotally mounted on the body member, a reference scale carried by the body member, an indicating needle carried by the second named magnet member which moves over said scale, a tubular sleeve on which said tubular body member is slidably mounted, said sleeve being adapted to be positioned on said tube, and a micrometer carried by the tubular body member for measuring the position of the body member with respect to the sleeve when said magnet members are in alignment whereby deflection of the movable member may be measured by comparing successive measurements of the position of said first named magnet member, said tubular body member with the magnet member and micrometer carried by it and said tubular sleeve together forming a portable measuring instrument.

2. A portable instrument for use in indicating the position of a magnet member in a tube comprising a tubular body member, a magnet member pivotally mounted on the body member to swing on an axis transverse to the body member, a reference scale carried by the body member, an indicating needle carried by the pivoted magnet member which moves over said scale, a sleeve on which the tubular body member is slidably mounted, said sleeve being adapted to be positioned on the tube, and a micrometer carried by the tubular body member with the end of its rod positioned to engage the sleeve for measuring the position of the body member with respect to the sleeve.

3. A portable instrument for use in indicating the position of a magnet member in a tube comprising a tubular body member open at one end and having an end wall closing the other end, a magnet member pivotally mounted on said body member to swing on an axis transverse to the body member, a reference scale carried by the body member, an indicating needle carried by the pivoted magnet member which moves over said scale, a sleeve within the body member on which the body member is slidably mounted, said sleeve having an end wall adjacent the end wall of said body member and being adapted to be positioned on the tube, and a micrometer carried by the end wall of the body member with its rod directed toward and adapted to engage the end wall of said sleeve for measuring the position of said end walls with respect to each other.

4. Apparatus for measuring the position of a movable member in a sealed casing comprising a tube attached at one end to the outer surface of the casing, a rod connected at one end to the movable member and projecting out through the casing into said tube, a magnet member fixed on the rod within the tube, a tubular body member open at one end and having an end wall closing the other end, a magnet member pivotally mounted on said body member to swing on an axis transverse to the body member, a sleeve within the body member on which the body member is slidably mounted, said sleeve having an end wall adjacent the end wall of said body member and being adapted to be positioned on the tube, a micrometer carried by the end wall of the body member with its rod directed toward and adapted to engage the end wall of said sleeve for measuring the position of said end walls with respect to each other when the magnet members are in alignment, and means carried by the body member for indicating when the magnets are in alignment.

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