ABSTRACT: An electrode arrangement for taking plethysmographic capacitance measurements on a finger and the like having a supporting ring in which a flat spring metal strip is coiled in a radial plane to form a spiral whose ends overlap each other and are fastened to the ring by fastening assemblies of which one can be shifted circumferentially on the ring and the other radially. Abutments threaded on the ring for radial movement permit the shape of the spiral to be modified and are remotely operated by tubular handles of insulating material.
ADJUSTABLE ELECTRODE ARRANGEMENT FOR CAPACITANCE PLETHYSMOGRAPHY

BACKGROUND OF THE INVENTION

This invention relates to plethysmography, and particularly to an adjustable electrode arrangement for measuring volume changes in a finger or like elongated body portion by sensing the capacitance between the finger and an electrode. It has been found that valuable data can be derived from information on changes in one or more longitudinal sections of a finger. The electrode assembly now available provides only information on volume changes over the entire length or a major portion of the length of a finger. Such electrode assemblies, however, do not give a possibility of adjusting their shape precisely to the body surface under investigation and consequently the measurements materialized by them cannot be precise enough.

The object of the invention is the provision of an electrode assembly which permits capacitance measurements to be taken with great precision on a very short section of a human finger or like body parts of a man or animal. Several such electrode assemblies when used combined together provide a more precise information on volume and volume changes over the entire length or a major portion of the length of the organ under investigation.

SUMMARY OF THE INVENTION

In one of its aspects, the invention resides mainly in an electrode arrangement in which an elongated electrode member of flexible, electrically conductive material is fastened by its two ends to a support in a position in which the electrode member extends about an axis in a radial plane to form a spiral, the two ends being radially offset in the plane. The fastening means which fastens one end of the electrode member to the support is provided with securing means permitting the fastening means to be secured to the support in a plurality of positions circumferentially offset relative to the axis.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing which is on a scale of approximately 2:1, FIG. 1 shows an electrode arrangement of the invention in front elevation and partly in section; and FIG. 2 shows the device of FIG. 1 in side-elevational section on the line II-12.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing in detail, there is seen a supporting structure mainly consisting of a horizontal baseplate 25 and a ring 20 mounted on the plate 25 by means of a short column 24. The ring is a short section of a hollow cylinder having a horizontal axis.

A strip 10 of spring metal coated with an insulating lacquer not specifically shown in the drawing and narrower than the axial length of the ring 20 forms a coil within the ring about the axis of the latter. The coil has approximately one and one-quarter turns which extend in a common radial plane so that the two longitudinal ends 11, 12 of the strip 10 are radially offset in the common plane.

The end 11 is fastened to the ring 20 by a pin 41 which passes radially outward through a circumferentially elongated slot 21 in the ring. The outer end of the pin carries a knurled knob 40 provided with corrugations 44 whose projections and recesses are held in engagement with corresponding corrugations 28 of the ring 20 along the slot 21 by a resilient collar 45 between the enlarged inner end 42 of the pin 41 and the inner wall of the ring 20, the end 11 of the strip 10 being fixedly fastened to the inner end 42 by soldering in a manner not shown.

A portion of the strip 10 intermediate the ends 11, 12 is received with ample clearance in a circumferential passage in the enlarged inner end portion 30 of a fastening pin 34 radially slidable in a bore of the ring 20 and secured against rotation by a key or spline 33. The second end 12 of the strip 10 is attached to the end portion 30 of the pin 34.

The outer end portion 31 of the pin 34 is threaded and carries a knurled nut 32 secured against radial movement by a flange 23 fixed on the outer circumference of the ring 20 which engages an annular groove in the nut 32. When the nut is turned, the pin 34 moves the end 12 of the metal strip 10 toward and away from the axis of the ring 20.

The other end 11 may be shifted circumferentially by pulling the knob 40 in a radially outward direction against the resilient restraint of the collar 45 until the serrations 44 clear the serrations 29 whereupon the pin 41 may be moved in the slot 21. Even when the spiral of the strip 10 is tightened as far as the slot 21 permits, the inner diameter of the spiral is still several times the axial width of the strip 10, and approximately three times that width in the illustrated embodiment.

The spiral shape of the strip 10 may be modified by threaded abutment spindles 26 of which only one is shown in the drawing. The spindles may be inserted as needed into internally threaded radial openings 22 in the ring 20 which are distributed over the circumference of the latter. Each spindle 26 is radially shifted by a means of a flexible plastic tube 27 slipped in tight engagement over the radially outer end of the spindle 26, thereby permitting the spindle to be turned from a remote location without interference of the operator's body with the capacitance measurements taken.

As is indicated in FIG. 2 in broken lines, additional rings 20', 20', equipped in the same manner as the ring 20 may be mounted in axial alignment on the base 25 for taking simultaneous capacitance readings on sequential longitudinal portions of a finger whose tip is supported on a plate 29.

The electrical circuit in which the metal strip 10 forms hot plate or electrode of a capacitor using ambient air as the dielectric and the tested finger as the other plate has not been shown since it may be entirely conventional and not directly relevant to this invention. Insulating material employed for insulating the electrode 10 from ground has not been specifically indicated in the drawing. It is normally adequate to attach the zero potential of a capacitance bridge to the ring 20 which is nonconductively connected to the electrode 10 by the pins 34, 41 and the spindles 26. The ring 20 is made of metal and grounded thus forming screening of the spiral 10.

The tested finger is also grounded. The insulating lacquer provided at least on the radially inner major face of the strip 10 prevents a short circuit in the measuring circuit if the tested finger should touch the strip 10.

The arrangement illustrated permits the electrode strip to be adjusted for a small clearance between the strip and the circumference of a narrow longitudinal zone of the tested finger, thereby improving the sensitivity of the plethysmographic equipment. If several electrode arrangements are axially juxtaposed as indicated in FIG. 2, the electrode of each may be adjusted to fit the different circumferential configurations of the several longitudinal finger portions respectively received therein.

While the invention has been described with particular reference to a specific embodiment, it is to be understood that it is not limited thereto, but is to be construed broadly and restricted solely by the scope of the appended claims.

I claim:

1. An electrode for use in an arrangement for measuring volume changes in a finger and the like by capacitance plethysmography, comprising in combination:
   a. a support;
   b. an elongated electrode member of flexible, electrically conductive material;
c. first and second fastening means fastening the longitudinal ends of said electrode member to said support in a position in which said electrode member extends about an axis in a radial plane and forms a spiral defining a space adapted to receive a section of a finger or body part, the ends of said electrode member being radially offset in said plane;
d. securing means for securing said first fastening means to said support in a plurality of positions circumferentially offset relative to said axis;
e. wherein a portion of said support is annular about said axis and formed with a circumferential slot therein, said first fastening means including a pin member attached to one of the ends of said electrode member and partly received in said slot for circumferential movement when released by said securing means, the securing means including a clamping member movable on said pin member toward and away from a position of clamping engagement with said annular portion.

2. An arrangement as set forth in claim 1, wherein said second fastening means include a fastening member attached to said annular portion and to the other end of said electrode member, said fastening member being formed with a passage extending circumferentially therethrough, a portion of said electrode member intermediate said ends thereof being received in said passage.

3. An arrangement as set forth in claim 2, wherein said fastening member is elongated radially relative to said axis, an end portion of said fastening member adjacent said axis being formed with said passage, and threaded means for radially moving said fastening member on said annular portion.

4. An arrangement as set forth in claim 1, at least one abutting member mounted on said annular portion for radial movement in said plane toward and away from a position of abutting engagement with said electrode member for modifying the shape of said spiral.

5. An arrangement as set forth in claim 4, wherein said annular portion is formed with at least one internally threaded opening radially therethrough, said abutting member being threadedly received in said opening, the arrangement further comprising an elongated operating member of electrically insulating material attached to said abutting member for turning the same.

6. An arrangement as set forth in claim 1, wherein said electrode member is a flat strip having respective opposite faces directed radially toward said axis and toward said annular portion, at least one of said faces carrying a coating of electrically insulating material.

7. An arrangement as set forth in claim 6, the width of said faces being much smaller than the inner diameter of said spiral.

8. In an arrangement as set forth in claim 1, said clamping member and said annular portion being formed with radial projections and recesses conformingly engaged in said position of clamping engagement to prevent circumferential movement of said pin member, the arrangement further comprising yieldable resilient means biasing said clamping member toward the last mentioned position.