

Sept. 5, 1967

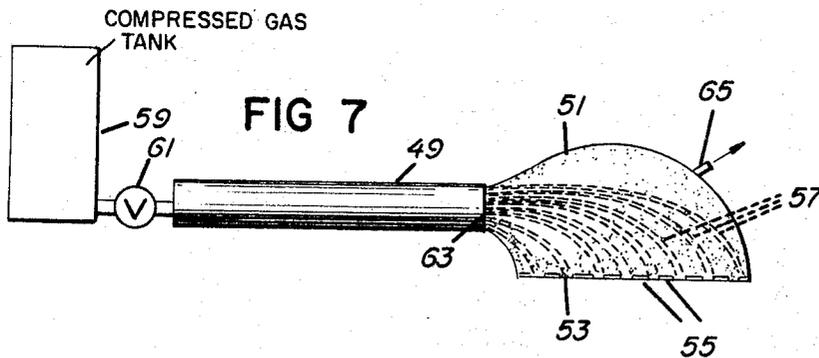
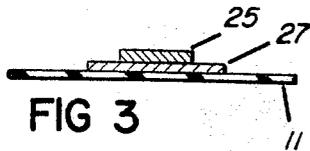
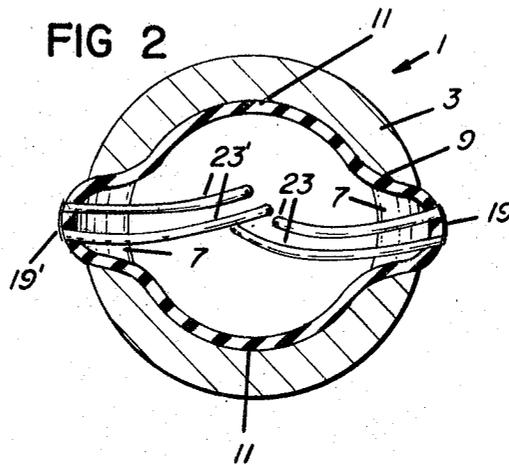
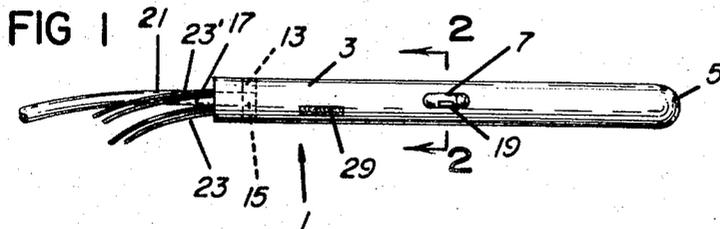
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3,339,542

APPARATUS FOR USE IN DIFFERENTIAL CLINICAL THERMOMETRY

Filed Feb. 3, 1964

3 Sheets-Sheet 1



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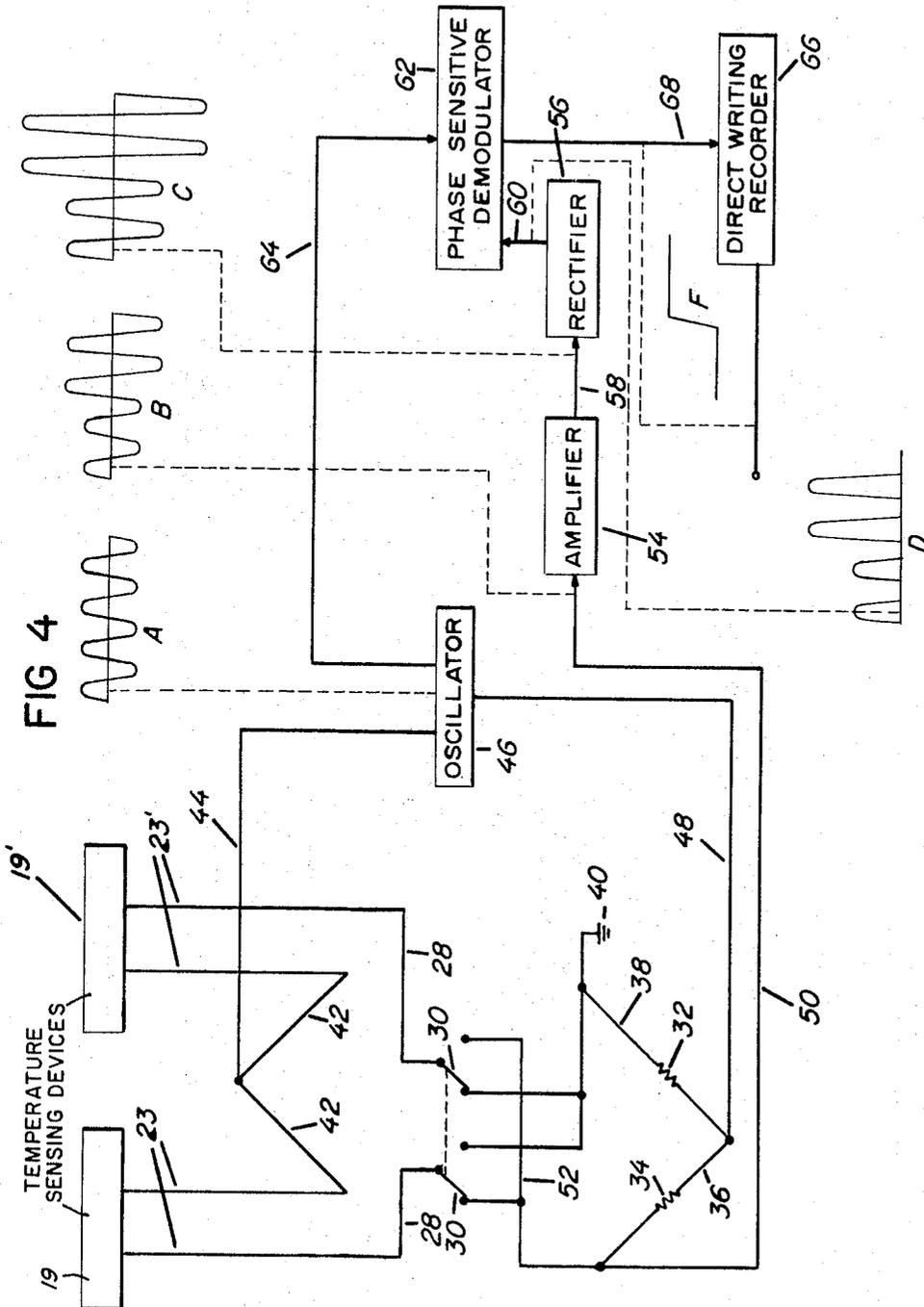
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APPARATUS FOR USE IN DIFFERENTIAL CLINICAL THERMOMETRY

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3 Sheets-Sheet 2



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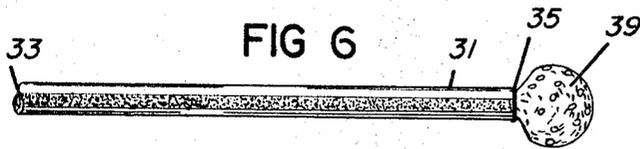
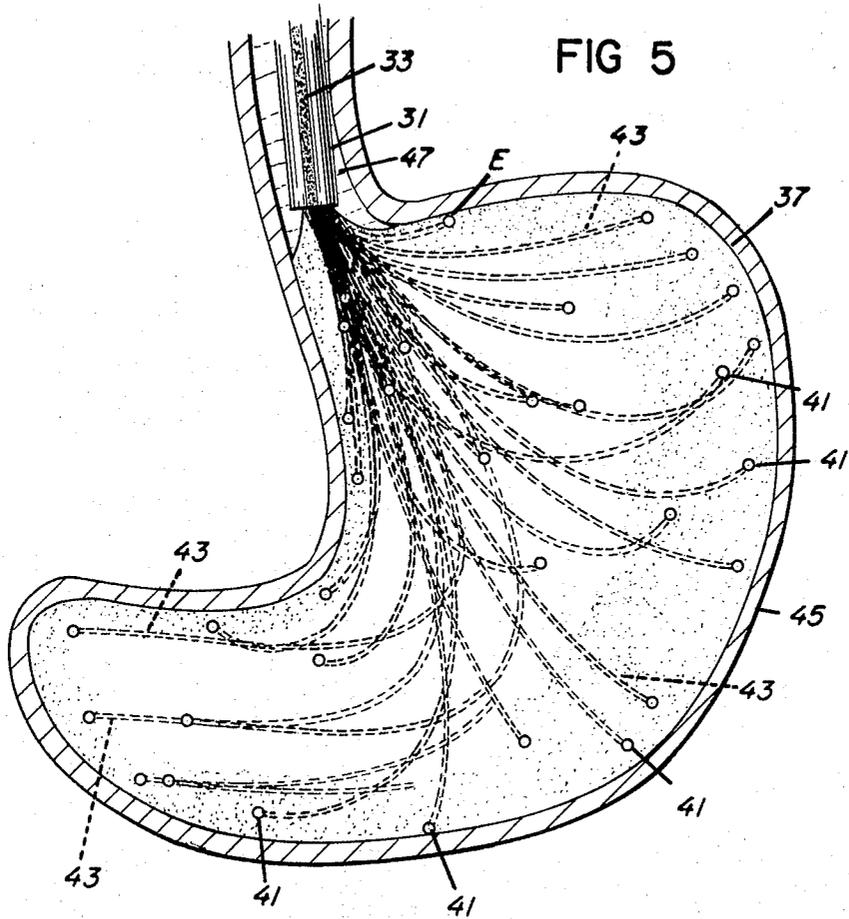
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APPARATUS FOR USE IN DIFFERENTIAL CLINICAL THERMOMETRY

Filed Feb. 3, 1964

3 Sheets-Sheet 3



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3,339,542

**APPARATUS FOR USE IN DIFFERENTIAL  
CLINICAL THERMOMETRY**

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13 Claims. (Cl. 128-2)

This invention relates broadly to the art of clinical thermometry, and in its more specific aspects it relates to apparatus for use in the determination of temperature differentials between adjacent tissues or body surfaces; and the nature and objects of the invention will be readily recognized and understood by those skilled in the art to which it relates in the light of the following explanation and detailed description of the accompanying drawings illustrating what I at present believe to be the preferred embodiment or mechanical expressions of my invention from among various other forms, arrangements, combinations and constructions, of which the invention is capable within the spirit and scope thereof.

In the study of tissue and body surfaces to locate the presence of malignancies, abscesses, altered blood supply and the like, it has long been medical practice to perform biopsies to determine the condition of the suspected tissue or body part. My invention aids the examining physician to determine sites for biopsy most likely to reveal diseased tissue or the like.

Other apparatus and methods have been developed in recent years for the determination of the condition of body surfaces which do not involve the withdrawal from the patient of a sample of the suspected tissue. For instance, infra-red scanning techniques were developed during World War II and in the Korean conflict and have been recently applied to clinical medicine with interesting results. Research has found that skin surfaces over malignant tumors emit significantly more infra-red radiation (heat up to 2° C.) than the surrounding skin overlying points on the contralateral side of the body. This method has also included delineation of third degree burns ("cold" spot over area), localization of placental attachment (increased blood supply showing "hot" spot) estimation of blood flow to extremities in occlusive vascular disease (involved limb being cooler) and as a guide to therapy in rheumatoid arthritis (effective therapy leading to a reduction in temperature).

While these techniques have supplied useful information, their use in clinical medicine is clumsy and fraught with error and do not solve all of the problems inherent in the present methods and means for determining surface and sub-lying malignancies and the like. In following the techniques briefly outlined above the patient must be kept in a cold room and only partially clothed for prolonged periods. The slightest drafts, or heat emission from other bodies in the room will distort the results. Moreover, skin temperature is widely fluctuant due to variability of blood flow, and cooling as a result of evaporation. For instance, blood flow will vary as a result of emotions, environment and other factors. Finally, emission of infra-red radiation from the body surface alone can not be expected to detect deep lying malignancies or alterations in the blood supply.

I have devised a method and apparatus which overcomes the problems and uncertainties which are characteristic of infra-red scanning techniques, and permits testing of deep lying tissue, and my apparatus and method involves the general principles of thermometry. Contact thermometry, if employed with precision, eliminates environmental factors and allows for exploration of body cavities which is not possible with skin surface scanning by infra-red radiation. In the practice of contact thermometry one of the major problems in the precision use

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thereof, and a limitation on its use, has been variability resulting from differences in contact pressures between the temperature sensing devices and tissues or body surfaces.

The device which I have evolved employing the principles involved in contact thermometry has overcome this problem of temperature variations resulting from differences of contact pressures between a pair or a plurality of temperature sensing devices and the tissues or body surface with which they are in contact.

In the consideration of the problems of contact thermometry where a pair or a plurality of temperature sensing devices are employed for contact with tissues or body surfaces to indicate and/or record temperature differentials, it must be recognized that difference in pressure of the temperature sensing devices with the tissue or body surfaces will cause variation in recorded temperature. Thus, in order to produce a precise and accurate indication it is essential to provide an arrangement insuring that each temperature sensing device be applied in contact with tissue or body surface at the same pressure. If the temperature sensing devices are not applied at the same application or contact pressures, the recorded temperature will vary even through such temperature variance is not actually present in the tissues or body surfaces. Thus, equalization of contact pressure of the temperature sensing devices is indispensable for the proper operation and indication of devices of this type for use in differential clinical thermometry.

The invention involved in this application provides means for equalizing pressures at two or more points, as well as a means for checking the accuracy of such pressure equalities. For instance, as pressures are increased on the temperature sensing devices, if the contact pressures are the same the temperature differentials, if any, should remain constant, if they do not this is an indication that the pressures are unequal, or that the circuitry used for the indications is inoperative or improperly working.

My invention provides means for exploring body cavities in a relatively simple manner to determine temperature differentials between adjacent tissue, to thereby indicate to the examining physician the presence or absence of diseased tissue. The devices which I have devised for exploring body cavities to determine whether adjacent tissues have the same temperature is precise and accurate in its indication due to the fact that such devices comprise means insuring that the temperature sensing means on the device are applied at the same pressure to make certain that temperature variations will not be caused by differing contact pressures.

Since my apparatus requires that the temperature sensing devices be applied to the tissues, or the like, at the same pressures, it will be appreciated that it is significant that it is not a difficult matter to test the accuracy of the apparatus as described above, and particularly whether the application pressures of the temperature sensing devices are the same.

My invention, as will become apparent, is also applicable to external body surfaces to determine temperature differences between different external areas, and with devices which I have designed for this particular use I have also provided means which cause the two or more temperature sensing elements to be applied to the body surfaces at the same pressures to thereby insure a true indication of temperature differential of the body surfaces.

It is significant to understand in consideration of this development that actual temperatures of tissue are neither obtainable with complete accuracy nor are they pertinent in the obtaining of indications to point to malignancy in tissue or body surfaces. Infra-red emissivity of neither skin or mucous membrane is known. The important ob-

tainable data is the difference in temperature in the vicinity of a lesion as compared to adjacent tissue or corresponding surface on the contralateral side of the body. The present devices and method provides a means for obtaining this differential with practical accuracy.

This invention provides devices and a method of obtaining the temperature differentials desired to provide an indication of the presence of a malignancy or the like in a minimum of time and with relatively less discomfort to the patient. The devices I have designed are relatively inexpensive to produce and will require little maintenance under normal use conditions.

It is of substantial advantage in the use of the instruments which I have designed to exclude environmental air from the areas under test, and this is accomplished automatically by my instrument.

My device for discovering the temperatures of adjacent body tissues is highly advantageous for it pushes aside or excludes secretions which may be of different temperatures so that the device will be unaffected thereby, and it is so formed that the heat at the areas under test is held in place which results in a magnification of any heat differential which may be present in the two areas being tested. The device has been so designed and constructed that it may be placed and operated in close proximity to the lesions and the devices may be readily calibrated.

The instrumentation used with the devices is simplified due to the fact that rather than actual temperature estimations, differential temperature estimations are given.

One of the many advantages of the system and instrument which I have devised resides in the provision of a controlled environment in the vicinity of the tests being made. In this particular aspect of my invention I provide means at temperature sensing devices which ensures a constant temperature and a constant pressure, so that the environmental condition at the vital area or areas is constant and controlled.

The temperature differential signals which are generated by my device may be recorded on a galvanometer, twin or multiple beam oscilloscopes, or the signals may be used for mapping to provide "photograph" of the mapped area.

With the foregoing general objects, features and results in view, as well as certain others which will be apparent from the following explanation, the invention consists in certain novel features in design, construction, mounting and combination of elements, as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawings:

FIG. 1 is a view in side elevation of a carrier, probe, catheter or similar instrument embodying the construction of this invention.

FIG. 2 is a view taken on line 2—2 of FIG. 1.

FIG. 3 is a detailed view showing one manner of attaching the temperature sensing devices, resistors or thermistors to the inflatable member.

FIG. 4 is a diagrammatic showing of one type of electric circuit and indicating means which may be used with the instrument illustrated in FIG. 1.

FIG. 5 illustrates a further form of my invention and shows the instrument in operative position within a body cavity, such as a stomach.

FIG. 6 is a side elevational view of the instrument illustrated in FIG. 5, before inflation of the inflatable member.

FIG. 7 is a side elevational view of another form of instrument which is particularly designed for use on external body parts, and uses a compressed inert gas as the pressure medium.

In the accompanying drawings, and particularly FIGS. 1 and 2 thereof, I have used the numeral 1 to designate

in its entirety an instrument which is provided with means for determining differential temperatures of adjacent tissues within the body, and of insuring that the electrical temperature sensing devices are applied to the tissues at equalized pressures. The instrument 1 comprises a tubular body member or carrier 3, and may constitute a catheter, probe or any suitable type of instrument which is adapted to be inserted into body cavities, ducts and the like, and the length of the instrument may vary according to the use to which it is to be put, i.e., the length of the body duct, or the distance of the cavity from an entrance thereto. The diameter of the instrument may likewise be dependent upon the use to which it is to be put. The tubular body member may be slightly flexible, or it may be rigid depending upon the internal being probed. The tubular body member or carrier 3 is closed at its forward end as at 5, and, in the example illustrated, is provided along its length with diametrically opposed generally oval shaped or elongated apertures or openings 7, the inner edges of such openings preferably being bevelled as at 9. For clarity of explanation and description I shall term the openings 7 as "test openings," and it is to be understood that it is within my contemplation to provide more than two openings (test openings) in the tubular body member 3 dependent upon the use being made of the instrument, and it should also be appreciated that it is not necessary for the success of the instrument to position the test openings at diametrically opposed points.

With the exception of the test openings 7 in the tubular body member 3, and one open end, the remainder thereof is imperforate, for reasons which will become apparent as this description proceeds.

Positioned within the tubular body member 3 of the instrument 1 is an inflatable member 11, or what I may term a "balloon or pressure equalizing member." This inflatable member may be formed of any suitable thin flexible material, such as rubber or certain plastics, and is of generally elongated shape of a length and diameter generally the same as that of the tubular body member or carrier 3, so that it will be housed therein. After the inflatable member 11 is housed within the tubular body member 3 of the instrument the rear end of the tubular member is closed by means of a disc plug 13 having a central opening 15 therethrough, through which extends the inflation neck or stem 17 of the inflatable member. I affix in any suitable manner on the exterior of the inflatable member at diametrically opposed points thereon electrical temperature sensing elements 19 and 19' which are fixed on the exterior of the inflatable member for reasons which will presently become clear and apparent. These temperature sensing elements or devices may be resistors, thermistors, or the like, the conductivity of which vary in accordance with the temperature thereof. The electrical temperature sensing devices 19 and 19' are affixed on the inflatable member in such positions thereon that they will be adjacent to the windows or test openings 7 in the tubular body member 3 when the inflatable member is inflated, as will be explained hereinafter. It will be appreciated that in the construction where the tubular body member 3 is provided with more than a pair of test openings 7, the inflatable member will be provided with a temperature sensing device for each such test opening, and that such temperature sensing devices will be positioned on the inflatable member adjacent the test openings.

As mentioned above, the inflatable member 11 is formed with a stem or neck 17 which is in communication with the interior of the inflatable member, and this neck extends from the inflatable member through the opening 15 in the end closure disc 13 and to the exterior of the instrument 1. The stem or neck 17 receives therein an inflation tube 21 which may be connected to a pump or other air pressure means for inflating the inflatable member within the tubular body member 3. Any suitable

means may be used for closing the stem or neck 17 of the inflatable member after it has been inflated so that the pressured air or gas will be maintained therein.

Each temperature sensing device 19 and 19' is connected into an electric circuit for giving temperature differential indications, which electric circuit will be described hereinafter. The temperature sensing devices are connected into the circuit by leads, a pair of leads 23 being connected to temperature sensing device 19, and a pair of leads 23' being connected to sensing device 19'. Each pair of leads extends from the rear end of the instrument, and thereinto through the opening 15 in the disc 13, and through the inflatable member to the temperature sensing devices, it being understood that the leads extend through the inflatable member to the temperature sensing devices which, as I have explained, are fixed on the exterior surface of the inflatable member.

When the instrument 1 is inserted into a body cavity or the like, the tissues of which are to be tested, the inflatable member 11 is inflated through the neck 17 which extends exteriorly of the body cavity and of the instrument. When the inflatable member is fully inflated, the portions thereof upon which the temperature sensing devices 19 and 19' are affixed will extend or bulge outwardly through the test openings 7 in the tubular body member as shown in FIG. 2, and the temperature sensing devices 19 and 19' will be pressed into testing contact with the tissue on opposite sides of the instrument. If the tissue which is contacted by one sensing device is malignant, diseased, or the like, the temperature of such tissue will be different from the temperature of the adjacent or other tissue which the other sensing device is in contact with, and the conductivity of the sensing devices will be different and such temperature differential will be indicated by the instrumentation which will be described hereinafter.

As has been stated above, it is important in obtaining a true indication of temperature difference at the sensing devices that each temperature sensing device be applied in contact with its adjacent tissue at the same pressure. I accomplish this desired pressure equalization by mounting the temperature sensing devices on a flexible inflatable member, so that if the pressure on one bulging portion of the inflatable member is greater or less than that on the other bulging portion, the pressure will be equalized due to the fact that the greater or less pressures will be transmitted by the air or gas within the inflatable member to increase or reduce the pressure at the other opening to cause pressure equalization. This equalization is aided and made certain by the construction whereby the inflatable member is inflated to a size greater than the interior of the tubular body member 3 so that bulging at the test opening must occur, and since the front, rear and circumferential walls of the tubular member in which the inflatable member is housed are imperforate, with the exception of the test openings 7, when the inflatable member is inflated to an amount to cause it to assume dimensions greater than those of the tubular body member it will obviously bulge and extend through the openings 7. Now, as an example, if the pressure is greater on the temperature sensing device 19 than on the sensing device 19', then the pressure will be transmitted through the contained air or gas to increase the pressure on device 19' to equalize the pressure between the two points. This is the case because the inflatable member being housed within a completely closed tubular member (with the exception of the test openings 7) has no other place to expand except at the opening at sensing device 19' to thereby equalize the pressures.

It will now be appreciated that I have provided a means for electrically determining differential temperatures at adjacent body tissues, and have also provided means which automatically ensures that the electric sensing devices at the adjacent tissues will be impressed on such tissues at the same pressure, which pressures may be checked in the manner to be described.

In FIG. 3 of the drawings I have illustrated a further manner of mounting the temperature sensing devices on the inflatable member in order to provide a more rigid connecting means which will eliminate any possible distortions which might otherwise occur. I have shown a temperature sensing device 25, which as is understood may be a resistor, thermistor, or the like. This temperature sensing device is fixed by cement, or in any other desirable and suitable manner to a supporting base 27, which may comprise a piece of fabric or the like material having sufficient body to make it more or less rigid. This supporting base or body 27 is in turn cemented or otherwise affixed to the inflatable member 11. It will now be recognized that this method of securing the electrical sensing devices to the inflatable member provides a more secure and rigid attachment and arrangement to provide more accurate results from the use of the instrument.

As I have stated there are many uses to which the instrument of FIG. 1 may be put in determining the malignancy, or the like of tissue, and there are many body locations in which it may be used. As one example, from among many, and as an illustration, the instrument 1 may be inserted into the urethra and between the lobes of the prostate gland so that one temperature sensing device 19 is in contact with one lobe and the other sensing device 19' is in contact with the other lobe of the prostate. As explained above the two sensing devices will engage the two lobes at the same pressure so that there will be no temperature differential which is caused by varying pressures at the points of resistor or sensing device contact. The instrument 1 may be provided with a marking 29 on the external circumference thereof to indicate to the user of the instrument where the sensing devices are located with respect to that part of the instrument which is externally disposed with respect to the body cavity of the patient. With the instrument inserted as described the indicating means which will be described will show that there is a temperature difference in the tissues contacted by the sensing means or devices to thereby indicate that one of the tissues is diseased. Similarly, lobes of the prostate gland may be examined by a probe, such as the instrument 1, inserted into the rectum. There is a thin tissue midway between the rectal wall which is between the lobes of the prostate, and by means of a proctoscopic examination the examining physician can tell whether such intervening rectal wall or thin tissue is diseased, and if it is not found to be diseased from this examination, then the instrument of this invention will give a true and accurate reading.

In FIG. 4 of the drawings I have illustrated one form, from among many, of circuitry which may be used to graphically indicate the temperature differential occurring at the temperature sensing device 19 and 19' of the instrument. It is preferable to use an A.C. circuit for this temperature differential measurement in order to nullify errors which are inherent in D.C. bridge circuits.

I have illustrated the pair of temperature sensing devices 19 and 19', which as I have pointed out, may be resistors, thermistors or the like device, the conductivity of which varies in accordance with the temperature. One of the leads, here designated as 28 for clarity, from each sensing device is connected into a bridge circuit through a switch 30 for function check, the bridge circuit including the resistors 32 and 34, one being connected in the arm 36 of the bridge and the other being connected in the arm 38 of the bridge. A common ground 40 is provided which is applicable for the entire circuit. The other lead, designated 42, from each temperature sensing device 19 and 19' is connected by means of conductor 44 to an oscillator 46, the other side of which is connected to the bridge by means of conductor 48. A conductor 50 connects the output of the bridge and the leads 28 by means of conductor 52 to an amplifier 54. I provide a rectifier 56 which is connected to the amplifier 54 by means of a conductor 58 and by means of conductor 60 to a phase

sensitive demodulator 62. The phase sensitive demodulator being connected to the oscillator by conductor 64 and to a direct writing recorder 66 by a conductor 68. Consideration of the graphs A, B, C, and D is indicative of the electrical output at the various stages of the circuit, with F showing the final reading in one direction. In connection with the illustrated circuit all wave forms are voltage  $\uparrow$  vs time  $\rightarrow$ .

It will be appreciated, by one skilled in the art, that a phase sensitive demodulator produces a direct current, either positive or negative, depending on the relationship of the phase of the reference signal originating in the oscillator and the amplified signal arising from the bridge. The value of the direct current is proportionate to the amplitude of the signal arising from the bridge.

It is well known in the electrical field that most phase sensitive demodulators include rectifiers or other non-linear elements. In order to more clearly illustrate the circuitry involved in this invention, applicant in FIG. 4, has shown the rectifier 56 separately from the phase sensitive demodulator, however, it is to be distinctly understood that the rectifier or rectifiers could comprise elements of the demodulator.

In FIGS. 5 and 6 of the drawings I have illustrated another form of my invention which also operates under the principles involved in differential clinical thermometry. In this form of my invention I provide a carrier, catheter, probe or the like 31 which comprises a tubular member adapted to be inserted into a body cavity, duct or the like, and functions in part as a holder or carrier for the inflatable member upon which is mounted the temperature sensing devices, such as resistors, thermistors and the like. The catheter or the like 31 is an elongated tubular member and is preferably provided with a reference line or marking 33 which extends along the length thereof so that the examining physician will know where the reference temperature sensing device is with respect to the remaining temperature sensing devices, as will be fully explained hereinafter.

The forward end of the tubular member or catheter 31 is open as at 35, and an inflatable member 37 is housed within the tubular member or catheter 31 and the bulbous portion 39 thereof extends out of the forward open end when the inflatable member is not inflated.

The rear end of the tubular member 31 may be closed by the same means and in the same manner as is the rear end of the tubular element 3 as illustrated in FIG. 1 of the drawings and described above in connection therewith. The leads from the temperature sensing devices will extend through the opening in the closure disc as will the neck of the inflatable member, all as explained in connection with the instrument disclosed in FIG. 1 of the drawings.

The tubular member 31 is completely closed except for the open forward end 35 through which the inflatable member extends as shown in FIG. 6 of the drawings. It is preferable, though not necessary, to form the inflatable member 37 with an elongated tubular portion having substantially the same dimensions as the inner diameter of the tubular member 31 for its housing therein, and to form the bulbous portion 39 on the end of the aforementioned tubular part or portion of the inflatable member. The tubular portion is, of course, in communication with the bulbous portion. Thus, when the instrument is not in use it will appear as disclosed in FIG. 6 of the drawings.

The bulbous portion 39 of the inflatable member 37 which extends outside the member 31 is provided with a plurality of electric temperature sensing devices 41 which are fixed thereto on the external surface thereof. Each temperature sensing device 41 is connected into an electric circuit by means of leads 43 which extend from their connection points with the temperature sensing devices through the bulbous portion of the inflatable member, and rearwardly therefrom and through the tubular portion of the inflatable member which, as explained, is

housed in the tubular member 31. Such leads extend from the instrument at the rear end thereof in the same manner as the leads extend from the instrument disclosed in FIG. 1 of the drawings. The temperature sensing devices 41 may, if found desirable, be fixed to the inflatable member in the same manner as disclosed in FIG. 3 of the drawings, or in any other suitable manner.

In FIG. 5 of the drawings I have shown one use to which the instrument of FIG. 6 may be put, and it is to be understood that the instrument may be used in many other ways than the one example shown in this figure of the drawings. In FIG. 6 I have illustrated generally a stomach designated by the numeral 45 and the esophagus 47 in communication therewith. The catheter, tubular member or instrument 31 is inserted through esophagus 47 until the end thereof from which the bulbous portion 39 of the inflatable member 37 is disposed at the exit of the esophagus into the stomach. The inflatable member is then inflated, as explained in connection with the type of instrument disclosed in FIG. 1 of the drawings, until the bulbous portion is expanded to substantially fit the stomach, that is until the walls of the bulbous portion are in engagement with the stomach walls as disclosed in FIG. 5 of the drawings. With the inflatable member in this inflated condition it will be appreciated that the plurality of temperature sensing devices 41 will be in engagement with the stomach walls at a multiplicity of points thereabout. It will also be appreciated that the pressure of each such temperature sensing device against the stomach wall will be substantially the same for the same reasons as those explained in connection with pressure equalization of the sensing devices 19 and 19' of FIG. 1. Thus, temperatures of the stomach walls as picked up by the sensing device will be unaffected by the pressures of the sensing devices since they will all contact the stomach at the same pressure.

In the use of the device illustrated in FIGS. 5 and 6 of the drawings where a plurality of temperature sensing devices are mounted in operative positions on the exterior of the inflatable member, I preferably pick one of such temperature sensing devices 41 as a reference point, and merely by way of example, I have selected the temperature sensing device designated E as shown in FIG. 5 of the drawings as the reference point for the remainder of the temperature sensing devices 41. Now, the examining physician will know where the particular reference temperature sensing device E is located within the stomach, or other cavity, since E will be related in any desired manner with respect to the reference line 33 on the instrument. The examining physician will also know where each of the other temperature sensing devices are located with respect to the reference sensing device E. In this connection, it will be appreciated, that each sensing device 41 will be located on the inflatable member at a specific location with respect to the sensing device E, and by means of a chart or other similar guide or reference means which will be supplied with the apparatus it will be known where all of the temperature sensing devices are located on the inflatable member, and due to the known locative relationship between the device E and guide line 33 the examining physician will know at what location on the wall of the body cavity each temperature sensing device is positioned.

In the use of this form of the apparatus, and referring to the circuit of FIG. 4 of the drawings we may consider the temperature sensing device 19 to be the reference temperature sensing device E of FIG. 5 of the drawings. Now, it is proposed to use a multiple electric selector switch of any conventional and well known type which is provided with a contact in electrical connection with each temperature sensing device 41 through the leads thereof, so that by operating such switch the examining physician may determine the temperature differential between each such temperature sensing device and the reference temperature sensing device E. Since the examin-

ing physical may determine the position of each such device 41, if and when a temperature differential is indicated on the indicating instrument he will know what part of the cavity wall has a temperature variation from that part of the wall in which the reference sensing device E is in contact with.

It will be understood that the multiple selector type switch may be used in the circuit shown in FIG. 4 of the drawings and will take the place of the temperature sensing device 19'.

In FIG. 7 of the drawings I have disclosed a form of my invention which is especially adapted for determining temperature variations between different external skin areas. In this form of my invention I have also disclosed and shall explain a method and apparatus for using a compressed inert gas as the means for inflating or filling the member upon which the temperature sensing devices are mounted. I have devised an apparatus whereby the gas is provided and is permitted to expand to provide a constant temperature at the area of operation of the temperature sensing devices, a constant pressure is also provided so that I obtain a controlled environment in the area and vicinity of operation.

The apparatus disclosed in FIG. 7 comprises a handle or carrier member 49 which houses the tubular part of an inflatable member, such inflatable member extending from the open end of the carrier 49, as at 51, and being of generally spherical configuration when inflated. On a portion of the external surface of the inflatable member is fixed, in any suitable manner, a plurality of temperature sensing devices 55. The temperature sensing devices have electric leads 57 which are connected into the circuit in the same manner as the leads 43 in FIG. 5. I provide a source 59, which may be portable with the instrument, of any suitable compressed inert gas which is fed through valve controlled duct 61 into the carrier 49 and the part of the inflatable member which is housed therein. The gas is fed into the inflatable member 51 through an inlet 63 and expands in said member and escapes therefrom through an exit 65 which is smaller than the inlet 63. It is within my contemplation to provide the member 51 without a neck or a portion which is housed within the carrier, in which event the member 51 would be affixed in any suitable manner to the outlet end of the carrier 49 and the duct 61 would be extended all the way through the carrier to the outlet duct 63.

The member 51 when inflated is of spherical shape, and when a portion of the circumference thereof is pressed against the skin area to be tested it will become generally flat as disclosed in FIG. 7. Due to this pressing action of an inflated flexible spherical member to produce the flat testing surface, it will be evident that the pressure of all of the electrodes on this flattened surface will be equalized. In this form of my invention, as in the form of FIG. 5, I may provide a reference sensing device and a multiple type selector switch for bringing each sensing device into the circuit for a reading of the differential temperature between it and the reference sensing device.

It will now be recognized that I have disclosed a method and apparatus in FIG. 7, wherein I am enabled to practice my testing of body surfaces and internal body tissues in a fully and completely controlled environment, which is of very substantial advantage. While I have disclosed the use of the inert gas as explained for testing body surfaces, it will be understood that the same principles may be utilized for testing tissues in body cavities and the like. Thus, I have devised a method and apparatus for using an inert gas under compression, which is fed into an expansion chamber to provide a constant temperature and a constant pressure, to provide a controlled environment in the vicinity of the body surface or internal tissue being tested.

I claim:

1. A device for determining temperature differential

between different areas of the body, including in combination, a single carrier member, electric temperature sensing devices, unitary means mounted on said single carrier member and mounting each of said electric temperature sensing devices in spaced positions thereon for contact with the different areas of the body, and said unitary means providing unitary pressure equalizing means insuring the contact of each of said electric temperature sensing devices with the different areas of the body at the same pressure, electric means located exteriorly of said single carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said single carrier and electrically connected to said electric temperature sensing devices and to said electric means.

2. A device for determining temperature differential between tissue at different areas of the body, including in combination, an elongated single carrier member adapted to be inserted within a body cavity, electric temperature sensing devices adapted to contact said tissue, unitary pressure equalizing means mounted on said single carrier member and each of said electric temperature sensing devices being affixed to said unitary pressure equalizing means to insure the contact of said electric temperature sensing devices with the tissue at the same pressure, electric means located exteriorly of said single carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said single carrier member, said leads being electrically connected to said electric temperature sensing devices and to said electric means.

3. A device for determining temperature differential between different areas of the body, including in combination, a single carrier member, electric temperature sensing devices, unitary means mounted on said single carrier member and mounting each of said electric temperature sensing devices in spaced positions thereon for contact with the different areas of the body, and further means coactive with each of said means and said electric temperature sensing devices for causing said electric temperature sensing devices to contact the different areas of the body at the same pressure and for maintaining a constant temperature at said means, electric means located exteriorly of said single carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said single carrier member and electrically connected to said electric temperature sensing devices and to said electric means.

4. A device for determining temperature differential between different areas of the body, including in combination, a carrier member, electric temperature sensing devices, means mounted on said carrier member and mounting said temperature sensing devices in position thereon for contact with the different areas of the body, and said means providing a gas expansion chamber and including a flexible member forming a wall of said expansion chamber and said temperature sensing devices being mounted on said flexible member, a pressured inert gas supply, an inlet line from said supply to said expansion chamber for constant flow of gas to said expansion chamber and expansion therein, and expansion of said flexible member causing contact of said temperature sensing devices with different areas of the body, and an outlet from said expansion chamber, and said outlet being of less dimensions than said inlet to maintain a constant pressure and temperature in said expansion chamber, whereby said temperature sensing devices will contact the different areas of the body at the same pressure, and electric means located exteriorly of said carrier member for indicating temperature differential between said temperature sensing devices, leads carried by said carrier and electrically connected to said temperature sensing devices and to said electric means.

5. A device for determining temperature differential between tissue at different areas within the body, includ-

ing an elongated tubular carrier member adapted to be inserted within a body cavity, said carrier member having openings therein, and an inflatable member housed within said carrier member and adapted to bulge outwardly through said openings when the inflatable member is inflated, electric temperature sensing devices fixed on the exterior of the inflatable member on those portions thereof adapted to bulge through the openings for contact of the electric temperature sensing devices with the tissue, electric means located exteriorly of the carrier member for indicating temperature differences between said electric temperature sensing devices, leads carried by said carrier member and electrically connected to said electric temperature sensing devices and to said electric means, and means for causing inflation of said inflatable member.

6. A device in accordance with claim 5, wherein said carrier member is open at one end for insertion of said leads, and the open end and the said openings constitute the sole openings in said carrier member.

7. A device for determining temperature differential between tissue at different areas of the body, including in combination, an elongated carrier member adapted to be inserted within a body cavity, an inflatable member fixed to said carrier member and extending from one end thereof, a plurality of electric temperature sensing devices fixed to said inflatable member in spaced relation on the exterior surface thereof, and said inflatable member when inflated adapted to assume the shape of the body cavity in which it is positioned for contact of said electric temperature sensing devices with the tissue about the cavity, electric means located exteriorly of said carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said member, said leads being electrically connected to said electric temperature sensing devices and to said electric means, and means for causing inflation of said inflatable member.

8. A device for determining temperature differential between tissue at different areas of the body, including in combination, an elongated carrier member adapted to be inserted within a body cavity, an inflatable member fixed to said carrier member and extending from one end thereof, a plurality of electric temperature sensing devices fixed to said inflatable member in spaced relation on the exterior surface thereof, said elongated carrier member having a reference guide marker thereon visible to the user of the device, one of said electric temperature sensing devices constituting a reference point and being located in a known position on the inflatable member with respect to the said reference guide marker on the elongated carrier member, and each of said other electric temperature sensing devices being located on the inflatable member in known relation with respect to said electric temperature sensing device constituting a reference point, and said inflatable member when inflated adapted to assume the shape of the body cavity in which it is positioned for contact of said electric temperature sensing devices with the tissue about the cavity, electric means located exteriorly of said carrier member for indicating temperature differential between said electric temperature sensing device constituting said reference point and each of said other electric temperature sensing devices, leads carried by said carrier member, said leads being electrically connected to said electric temperature sensing devices and to said electric means, and means for causing inflation of said inflatable member.

9. A device in accordance with claim 8, wherein said electric means includes a multiple selector switch and each of said other electric temperature differential sensing devices is connected to one contact of said multiple selector switch, whereby operation of the switch from con-

tact to contact indicates the temperature differential between each of said other electric temperature sensing devices and said electric temperature sensing device constituting a reference point.

10. A device for determining temperature differential between tissue at different areas of the body, including in combination, an elongated carrier member adapted to be inserted in a body cavity, a flexible and elastic member adapted to be fixed to said carrier member and being extendible to assume the shape of the cavity in which it is positioned, a plurality of electric temperature sensing devices fixed to said member on the exterior thereof and adapted to engage tissue when said flexible and elastic member is extended, and said flexible and elastic member including means when in extended condition causing each of said electric temperature sensing devices to contact the tissue at the same pressure, electric means located exteriorly of said carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said carrier member, said leads being electrically connected to said electric temperature sensing devices and to said electric means, and means for causing extension of said flexible and elastic member.

11. A device for determining temperature differential between different areas of the body, including, in combination, a carrier member, electrical elements having electrical signal transmitting characteristics which vary according to temperature, unitary means mounted on said carrier member and mounting said electrical elements in position thereon for contact with the different areas of the body, and said unitary means providing a single pressure equalizing means insuring the contact of said electrical elements with the different areas of the body at the same pressure, electric means located exteriorly of said carrier member for indicating temperature differential between said electrical elements, leads carried by said carrier and electrically connected to said electrical elements and to said electric means.

12. A device for determining temperature differential between tissue at different areas of the body, including in combination, a carrier member adapted to be inserted within a body cavity, said carrier member having openings therein, inflatable pressure equalizing means disposed within said carrier member, means for inflating said inflatable pressure equalizing means, electric temperature sensing devices mounted on said pressure equalizing means in position thereon for extension through said openings when said pressure equalizing means is inflated and portions thereof extend through said openings for contact of said electric temperature sensing devices with the tissue at equal pressures, electric means located exteriorly of said carrier member for indicating temperature differential between said electric temperature sensing devices, leads carried by said carrier member and electrically connected to said electric temperature sensing devices and to said electric means.

13. A device in accordance with claim 12, wherein said openings are oppositely disposed and said pressure equalizing means is composed of a flexible and elastic material.

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