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明 細 書

放射体温計

技術分野

本発明は、熱放射エネルギーを検出して、非接触で温度を測る放射体温計に関するものであり、特に、光学系の温度補償に関するものである。

背景技術

以前から、短時間で体温測定をするために、測定部位として鼓膜を選び、その温度を非接触で測る放射体温計が提案されている。

たとえば、特開昭61-117422号公報に開示された放射体温計である。この放射体温計は、外耳道にプローブユニットのヘッド部を挿入し、ヘッド部に配置された導光管によって鼓膜からの熱放射を赤外線センサに集光し、鼓膜温を測るものである。この赤外線センサを備えたプローブユニットにはリファレンス温度（36.5℃）に予熱するために加熱制御手段を設けてある。そして、予めヘッド部を体温に近い温度に予熱してあり、その状態でキャリブレーションをしてある。このようにすることにより、ヘッド部を外耳道に挿入してもヘッド部の温度には変化がなく、このため、ヘッド部の温度変化を要因とする測定誤差は解消される。つまり、導光管自体からの熱放射が測定誤差にならないようにするため、導光管の内面の温度を赤外線センサ自身の温度と同じ温度とする必要があった。そして、ヘッド部を外耳道に挿入しても、ヘッド部の温度に変化をなくすために、その温度をリファレンス温度（36.5℃）に安定化させている。そのことによって、導光管の内面からの熱放射を無視できるようにしている。

しかし、この特開昭61-117422号公報に開示された放射体温計は、コントロール精度の高い加熱制御装置を必要とするために、その構造および回路構成が複雑になって装置が大型化するとともにコストアップになるという問題がある。また、ヘッド部を予熱して一定の温度に制御するには長い安定時間を必要とした。さらに、加熱制御装置を駆動するには、大きなエネルギーが必要となり、小型電池をエネルギー源とする携帯型体温計には、この方式を採用することは不

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可能といえる。

そこで、加熱制御装置を持たない小型な携帯型体温計であって、しかも、鼓膜温を測るためにプローブを外耳道に挿入したときに、プローブの温度に変化が起るが、それによる誤差は起こらない検温精度の高い放射体温計が提案されている。

たとえば、特開平2-28524号公報に開示された放射体温計である。この特開平2-28524号公報に開示された放射体温計もまた、鼓膜からの熱放射を集光するために光学系として導光管を用いていることに関しては、特開昭61-117422号公報に開示された放射体温計と同じである。しかし、赤外線センサの加熱制御装置は持たず、赤外線センサおよび導光管の温度は、周囲環境の温度つまりほぼ室温になっている。そして、赤外線センサの近くに第1の感温センサを設けているほかに、導光管にも第2の感温センサを設け、赤外線センサと導光管の温度に基づいて温度測定をしている。そして、赤外線センサと導光管の温度差が異常に大きいときは測定を不許可とするが、その温度差が予め定めた設定値よりも小さければ、それらに温度差があっても測定を許可し、赤外線センサおよび導光管の温度を考慮した演算を行って、体温データを算出する。この放射体温計において体温データを算出する演算は、赤外線センサの出力電圧と、赤外線センサの温度を計温する第1の感温センサの出力温度と、導光管の温度を計温する第2の感温センサの出力温度とに基づいて、マイクロコンピュータによって行う。たとえば、プローブを外耳道に挿入しているときは、赤外線センサの温度はほとんど変わらないが導光管の温度は徐々に上昇する。このため、赤外線センサと導光管とには温度差が生ずるが、それらの温度を加味した演算を行って体温データを算出することによって、この温度差があっても、それによる誤差を解消することができる。

しかし、上述の特開平2-28524号公報に開示された放射体温計には次のような問題があった。すなわち、2つの感温センサの温度データと、赤外線センサの出力との合わせて3つの変数に基づいて複雑な方程式を使用して体温データを算出しているので、この演算のためマイクロコンピュータのプログラムが複雑になるとともに演算処理に時間を要することになってしまう。また、この演算に

用いる複雑な方程式には、導光管の放射率などの定数を予め測定し設定しておくなければならないが、この設定も難しいものであった。

そこで、本願出願人は、特開平6-142063号公報として、赤外線センサの出力電圧と、赤外線センサの温度を計温する第1の感温センサの出力温度と、導光管の温度を計温する第2の感温センサの出力温度とに基づき、第1の感温センサと第2の感温センサの温度差による誤差をアナログ回路を用いて補正を加える放射体温計について開示している。

また、米国特許第5,159,936号には、鼓膜からの熱放射と導光管自体からの熱放射とを受光する第1の赤外線センサと、導光管自体からの熱放射のみを受光する第2の赤外線センサとを設け、第1の赤外線センサの出力から第2の赤外線センサの出力を減算することによって、導光管と赤外線センサの温度差による誤差を補正する放射体温計が開示されている。

ところで、たとえば、特開平6-142063号公報に開示した放射体温計において、導光管の温度を計温できるように第2の感温センサをプローブユニットに取り付ける際には、個々の放射体温計ごとにその取付位置に微妙な違いが生じてしまう。このため、特開平6-142063号公報に開示した放射体温計では、大量の放射体温計を生産したときに個々の放射体温計ごとに測定結果の体温に微妙な誤差が生じてしまう。

また、米国特許第5,159,936号に開示された放射体温計のように単純に第1の赤外線センサの出力から第2の赤外線センサの出力を減算するのでは、第2の赤外線センサに測温対象からの熱放射が入射しないようにするための遮へい板の影響等のため、測定結果の体温に誤差が生じてしまう。

発明の開示

本発明の目的は、体温の測定結果の精度をより向上することができる放射体温計を提供することにある。

上記目的を達成するための本発明の構成は、被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射をこの赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号

を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、前記温度演算手段に、前記温度差信号の補正係数を調整するための補正係数調整手段を設けたことを特徴とする。

上記構成により本発明は、温度演算手段は、赤外線センサと導光手段との温度差を検出する温度差検出センサからの温度差信号の補正係数を調整するための補正係数調整手段を有するので、赤外線センサと導光手段との温度差に基づく誤差量を正しく調整して演算した温度データを算出することができ、測定精度がより向上した放射体温計を提供できる。

また本発明によれば、温度演算手段は、赤外線検出信号から温度差信号を演算する温度差補正手段と、該温度差補正手段の出力信号と基準温度信号とにより温度データ信号を算出する温度データ算出手段とから成り、前記温度差補正手段には前記補正係数調整手段が設けられており、この温度差補正手段はアナログ的な減算手段、またはデジタル的な減算手段で構成することもできるので、適宜に回路を構成できるものである。

また、補正係数調整手段も減算手段に対する温度差信号の寄与率を調整する手段であり、アナログ回路またはデジタル回路に対応して適宜に回路を構成することができる。

更に本発明によれば、赤外線センサと導光手段との間に2つの異なる温度差条件を構成し、その時々出力に基づいて補正係数調整手段の補正係数を調整するので、正しい補正係数を設定できるものである。

図面の簡単な説明

図1は本発明の第1の実施の形態による放射体温計の正面図、図2は図1に示した放射体温計のプロープ部分を切り欠いて示した断面図、図3は図1に示した放射体温計の赤外線センサと導光管との間の温度差に基づく誤差の補正量の調整を行う放射体温計と装置の概略ブロック図、図4は図3に示した温度差補正手段の回路図、図5は図4に示した補正係数調整手段を含む加算回路の回路図、図6は図3に示した各装置の外観図、図7は図3に示した装置によって放射体温計の

補正量を調整する工程を説明するフローチャート、図8はプローブを加熱する温度差条件を説明する図、図9は補正係数調整手段を設ける場所の別の例を説明する図、図10は補正係数調整手段を設ける場所の別の例を説明する図、図11は補正係数調整手段を設ける場所の別の例を説明する図、図12は本発明の第2の実施の形態による放射体温計の補正量の調整を行う放射体温計と装置の概略ブロック図、図13は図12に示した補正係数調整手段および減算手段のブロック図、図14は本発明の第3の実施の形態による放射体温計のプローブ部分を切り欠いて示した断面図、図15は図14に示した放射体温計の補正量の調整を行う放射体温計と装置の概略ブロック図、図16は図15に示した温度差補正手段と温度差検出手段の回路図である。

発明を実施するための最良の形態

以下本発明を図面に基づいて説明する。

図1は本発明の第1の実施の形態による放射体温計の正面図である。

この放射体温計1は鼓膜温を測る体温計であって、本体4とプローブ2とから構成されている。本体4には体温を表示するための液晶表示素子6と押しボタン構造の測定スイッチ5が設けられている。

放射体温計1の操作方法は次のように行う。まず、測定スイッチ5を押すと電源が入り、温度測定を開始させる。その後、プローブ2を被験者の外耳道に挿入して鼓膜にむけて、鼓膜温を測定する。プローブ2が鼓膜に正しく向けられた後に、外耳道からプローブ2を取り出す。ここで、液晶表示素子6には、測定した最高温度を示すようになっているので鼓膜温すなわち体温が表示されており、この表示を被験者の体温として読み取る。

図2は、図1に示した放射体温計1のプローブ2の部分を切り欠いて示した断面図である。

プローブ2の先端には透過波長特性のあるフィルタ7が備えてある。このフィルタ7は、シリコン(Si)やフッ化バリウム(BaF₂)などの光学結晶や、ポリエチレンなどの高分子から成っており、赤外波長の選択通過と防塵機能がある。

導光管8は、測温対象の鼓膜からの熱放射を効率よく集光するために設けられ

た管であり、銅、真鍮、ステンレスなどの金属パイプでできており、その内面は反射率を上げるために鏡面状で金（Au）メッキ処理を施してある。しかし、このような処理を施しても導光管8の内面を反射率を1.00の完全反射体とすることはできないため、導光管8の内面は多少の放射率を有することになる。

導光管9も導光管8と同じ材質で構成されており、その内面にも導光管8と同じ処理を施してあるが、その一端（フィルタ7側）を塞いであり、測温対象からの赤外線が入り込まないようにしてある。また、導光管9は、導光管8と同じ温度になるように、導光管8に近接して設けられている。導光管9に要求される条件は、導光管8と同じ温度になることであり、必ずしも、材質および内面状態と同じにする必要はないものである。

第1の赤外線センサ10は導光管8によって集光された測温対象からの赤外線を検出するセンサであるが、導光管8自体からの熱放射をも検出する。これに対して、第2の赤外線センサ11は導光管9の先端が塞がっているため、導光管9自体からの熱放射を検出する。また、第2の赤外線センサ11は、第1の赤外線センサ10と同じ温度になるように、第1の赤外線センサ10に近接して設けられている。感温センサ12は、この第1の赤外線センサ10および第2の赤外線センサ11の温度を測定するセンサである。

ここで、第1および第2の赤外線センサ10、11を用いた動作原理を簡単に説明する。導光管8と第1の赤外線センサ10とが同じ温度だと、第1の赤外線センサ10は見掛け上測温対象からの赤外線のみを検出することができる。これは、導光管8からも熱放射がされているが、赤外線センサ10と同一温度であるために、赤外線センサ10における入射と放射の差引きを考えると、導光管8からの熱放射を無視できるためである。しかし、導光管8と第1の赤外線センサ10との間に温度差が生じると導光管8の熱放射と第1の赤外線センサ10の熱放射に差が生じるので、第1の赤外線センサ10は測温対象からの熱放射と導光管8からの熱放射とを検出することになり、導光管8からの熱放射を無視できなくなる。そこで、この放射体温計1では、第2の赤外線センサ11を設け、導光管8と同じ温度条件である導光管9からの赤外線を第2の赤外線センサ11で検出し、導光管8の温度影響を持った第1の赤外線センサ10の出力から第2の赤

外線センサ 11 の出力を、適当な割合で、差し引くことにより導光管 8 の温度影響によらない測温対象からの赤外線を検出できる構成となっている。

図 3 は、図 1 に示した放射体温計 1 の赤外線センサと導光管との間の温度差に基づく誤差の補正量の調整（以下「補正量の調整」と略記する）を行う放射体温計 1 と装置の概略ブロック図である。

図 3 において、23、32、33 はそれぞれ放射体温計 1 の補正量の調整に用いる調整機、水温計、黒体である。

黒体 33 は後に図 6 に示すように恒温水槽から成り、水温計 32 は恒温水槽の水温すなわち黒体 33 の温度を測定する。

放射体温計 1 は、フィルタ 7 と導光管 8 とから成り測温対象からの熱放射を集光する導光手段 13 と、第 1 の赤外線センサ 10 と、導光管 9 と第 2 の赤外線センサ 11 とから成る温度差検出手段 54 と、感温センサ 12 と、第 1 の赤外線センサ 10 と第 2 の赤外線センサ 11 と感温センサ 12 の出力に基づいて測温対象の温度を演算する温度演算手段 21 と、液晶表示素子 6 を有し温度演算手段 21 の演算結果の温度を表示する表示手段 22 とから成る。図 3 において測温対象は黒体 33 を示す。

また、温度演算手段 21 は、導光管 8 と第 1 の赤外線センサ 10 との間の温度差に基づく誤差を補正する温度差補正手段 18 と、アナログデータをデジタルデータに変換する A-D コンバータ 19 と、デジタル化された温度差補正手段 18 の出力と感温センサ 12 の出力とに基づいて測温対象の温度データを算出する温度データ算出手段 20 とから成り、温度差補正手段 18 は、第 1 の赤外線センサ 10 の検出信号を増幅する第 1 の初段増幅手段 14 と、第 2 の赤外線センサ 11 の検出信号を増幅する第 2 の初段増幅手段 15 と、第 2 の赤外線センサ 11 の検出信号を適当な量に調整するための補正係数を調整できる補正係数調整手段 16 と、第 1 の赤外線センサ 10 の検出信号から補正係数調整手段 16 で適当な量に調整された第 2 の赤外線センサ 11 の検出信号を減算する減算手段 17 とから成る。

調整機 23 は、放射体温計 1 の補正量の調整の開始を指示するスイッチ 24 と、スイッチ 24 を ON してから所定時間の経過を監視するタイマー 25 と、放

射体温計 1 に調整モード中であることを通知する調整モード通知手段 26 と、A-Dコンバータ 19 を介して出力されるデジタル化された温度差補正手段 18 の出力を記憶する第 1 のメモリ 30 と、タイマー 25 により所定時間の経過が確認された後の A-Dコンバータ 19 を介して出力されるデジタル化された温度差補正手段 18 の出力を記憶する第 2 のメモリ 31 と、第 1 のメモリ 30 に記憶された値と第 2 のメモリ 31 に記憶された値とを比較する比較手段 29 と、比較手段 29 による比較結果に基づいて補正係数調整手段 16 に対して新たな補正係数を出力する補正係数発生手段 28 と、比較手段 29 による比較結果に基づいて補正係数調整手段 16 に対して現在設定されている補正係数の記憶を指示する記憶指示手段 27 とから成る。

ところで、補正量の調整において、第 1 のメモリ 30 に出力を記憶したときと、第 2 のメモリ 31 に出力を記憶したときとは、黒体 33 の温度が変化することがあるため、その都度水温計 32 によって黒体 33 の温度を測定して、その水温、すなわち黒体 33 の温度を第 1 のメモリ 30 および第 2 のメモリ 31 に記憶する。そして、比較手段 29 における第 1 のメモリ 30 に記憶された値と第 2 のメモリ 31 に記憶された値との比較の際には、その水温も加味して比較されている。

図 4 は図 3 に示した温度差補正手段 18 の回路図である。

図 3 に示した補正係数調整手段 16 および減算手段 17 は図 4 に示す加算回路 35 で実現される。また、補正係数調整手段 16 は、外部から変更され得る可変抵抗器で実現される。

なお、本実施の形態においては、減算手段 17 を含む温度差補正手段 18 を加算回路 35 で実現しているが、加算回路 35 へ入力される第 2 の赤外線センサ 11 は、その極性が第 1 の赤外線センサ 10 の極性と異なっているので、加算回路 35 は実質的に第 1 の赤外線センサ 10 の出力から第 2 の赤外線センサ 11 の出力を減算するように動作するものである。また、第 1 および第 2 の赤外線センサ 10、11 の出力にそれぞれ初段増幅手段 14、15 を設けたが、センサ出力の度合いや、加算回路 35 の性能によっては必要としない場合もある。

図 5 は、図 4 に示した補正係数調整手段 16 を含む加算回路 35 の回路図であ

る。

補正係数調整手段16としては、図5に示すように、一般によく知られているR-2Rラダー抵抗型D-Aコンバータを応用して用いればよい。

36は補正係数発生手段28からの指示に基づいて補正係数が設定されるレジスタである。37は記憶指示手段27からの指示があったときにレジスタ36に設定されている補正係数を記憶するメモリである。38は、調整モード通知手段26から調整モードの通知を受けているときにはレジスタ36から出力されている補正係数を選択し、調整モード通知手段26から調整モードの通知を受けていないときにはメモリ37に記憶されている補正係数を選択し、その選択した補正係数に基づいて抵抗器に接続された各スイッチのON/OFFを制御するセレクトである。このON/OFF制御によってR-2Rラダー抵抗型D-Aコンバータは、その合成抵抗値が変化する。

図6は図3に示した各装置の外観図である。

黒体33は、プローブ2を差し込むためのくぼみ（以下「黒体空洞」という）を有する恒温水槽44を水48で満たし、水48を温めるためのヒータ46と、水48の温度の偏りをなくするための攪拌装置47とを備えて構成される。

図6では、放射体温計1の本体4を切り欠いて、電池42およびIC43等が搭載された基板が見えるように示している。放射体温計1は、基板コネクタ41を介して調整機23と接続され、調整機23に接続された昇降機40により昇降させられることによって、熱伝導性が高く、水温とほぼ同じ温度に保たれたプローブ保持部材45にプローブ2が挿入されて黒体空洞に固定される。調整機23の表示部39には、たとえば、補正係数や放射体温計1の調整工程の手順や調整の終了マーク等が表示される。

図7は、図3に示した装置によって放射体温計1の補正量を調整する工程を説明するフローチャートである。

まず、放射体温計1を周囲環境に放置して第1の赤外線センサ10、導光手段13および温度差検出手段54をほぼ室温の等温状態（第1の温度差条件）に保つ（F-1）。次に、昇降機40に放射体温計1をセットするとともに、基板コネクタ41を介して放射体温計1と調整機23とを接続する。調整機23は調整

モード通知手段26から補正係数調整手段16のセクタ38に対して信号を出力し、放射体温計1に調整モードで動作するように指示する。この調整モードではセクタ38がレジスタ36からの補正係数を選択し、この補正係数に基づいて抵抗値が決定される(F-2)。なお、基板コネクタ41が、放射体温計1に接続された初期状態では、補正係数発生手段28から、所定の補正係数が補正係数調整手段16のレジスタ36へ初期セットされるように構成されている。

次に、調整機23のスイッチ24をONすると、昇降機40は放射体温計1を下降させ、黒体33からの熱放射を受けるようにプローブ2をプローブ保持部材45に挿入して固定する(F-3)。

プローブ2がプローブ保持部材45に固定されたならば、調整機23は放射体温計1のA-Dコンバータ19から出力される温度データ(第1の温度データ)を第1のメモリ30に記憶する(F-4)。すなわち、導光管9と第2の赤外線センサ11との間には温度差がない等温状態に保たれているので、第2の赤外線センサ11の出力はゼロとなり、初期セットされた補正係数がいかなる値であっても、補正係数調整手段16の出力はゼロとなる。このようにすることにより導光手段13と第1の赤外線センサ10との温度差がない場合(第1の温度差条件)における黒体33の温度の測定結果が第1のメモリ30に記憶されることになる。

次に、タイマー25の作動により10秒間の経過を待ち(F-5)、その後、A-Dコンバータ19から出力される温度データ(第2の温度データ)を第2のメモリ31に記憶する(F-6)。ここで、プローブ保持部材45は、水温とほぼ同じ温度に保たれているので、10秒間経過することにより、プローブ2に近接した導光手段13の温度は上昇する。これに対し、第1の赤外線センサ10はプローブ保持部材45から離れているため、依然としてほぼ室温の状態に保たれているので、導光手段13と第1の赤外線センサ10の間には温度差が生じる(第2の温度差条件)。同様に導光管9と第2の赤外線センサ11の間にも同じ温度差が生じる。従って、第2の赤外線センサ11からはこの温度差に応じた出力が発生する。補正係数調整手段16は、予め初期セットされた補正係数に基づいて、第2の赤外線センサ11の出力を補正した出力が発生する。減算手段

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17は、第1の赤外線センサ10の出力から補正された第2の赤外線センサ11の出力を減算する。A-Dコンバータ19は減算手段17の出力をデジタル値に変換した温度データ（第2の温度データ）を出力するので、調整機23は第2のメモリ31に第2の温度データを記憶する。

次に、比較手段29は、第1のメモリ30に記憶された第1の温度データと第2のメモリ31に記憶された第2の温度データとを比較し（F-7）、比較結果が等しくなければ（F-8）、補正係数発生手段28から補正係数調整手段16のレジスタ36に対して新たな補正係数を出力してレジスタ36が出力する補正係数を変更し（F-9）、第2の温度データの採取からやり直す（F-6）。すなわち、比較結果が等しくないということは、第2の温度差条件で記憶した第2の温度データが、第1の赤外線センサ10と導光手段13との間の温度差がない第1の温度差条件で記憶した第1の温度データと異なっていることであり、本来等しくなるべき第1および第2の温度データが異なるということは、第2の赤外線センサ11の補正量が正しくないことを意味している。従って、正しい補正量が決定されるまで補正係数を変更し、温度差条件が変わったとしても放射体温計1が測定した黒体33の温度が同じになるような補正係数調整手段16の抵抗値を探し出す。

ステップ（F-8）において、比較結果が等しくなれば、記憶指示手段27から補正係数調整手段16のメモリ37に対して信号を出力して、そのときのレジスタ36に設定されている補正係数をメモリ37に記録する（F-10）。そして、昇降機40によって放射体温計1を上昇させるとともに、基板コネクタ41から放射体温計1を取り外す（F-11）。このように放射体温計1と調整機23とを切り離すことにより、補正係数調整手段16のセクタ38へは調整モードである旨の信号が出力されなくなり、セクタ38はメモリ37からの補正係数を選択し、この補正係数に基づいて抵抗値が決定される。

ところで、第1の温度差条件のときと第2の温度差条件のときとは黒体33の温度が微妙に変化することが考えられる。このため、上述の第1の温度データおよび第2の温度データを得る際に、その都度水温計32によって黒体33の実際の温度を測定し、そのそれぞれを第1のメモリ30および第2のメモリ31に

記憶しておくようにし、比較手段29において第1の温度データと第2の温度データとを比較する際に考慮に入れるようにするとよい。すなわち、第1の赤外線センサ10と導光手段13との間に温度差がない場合でも、黒体33の温度が変化すれば、それに応じてA-Dコンバータ19の出力も変化する。従って、第1の温度データを記憶したときの黒体33の温度と第2の温度データを記憶したときの黒体33の温度とに差があれば、その差に応じて第1の温度データと第2の温度データに差をつけて調整してやればよい。

なお、本実施の形態では、第1の温度差条件として導光手段13と第1の赤外線センサ10とが等温状態である場合を例示したが、本発明はこれに限定されるものではなく、所定の温度差を持たせてもよい。

また、本実施の形態では第1の温度差条件と第2の温度差条件の2種類の温度差条件において放射体温計1が測定する黒体33の温度が等しくなるよう補正量を調整するようにしたが、本発明はこれに限定されるものではなく、3つ以上の温度差条件において放射体温計1が測定する黒体33の温度がほぼ等しくなるような調整を行ってもよい。

また、本実施の形態では、調整機23は、第1の温度データと第2の温度データとが等しくなるまで補正量を調整しているが、本発明はこれに限定されるものではなく、第1および第2の温度データの差が所定範囲（測定精度に影響しない範囲）内におさまるように調整してもよい。

また、本実施の形態では、黒体33内のプローブ保持部材45にプローブ2を所定時間保持することにより、第2の温度差条件を作っていたが、本発明はこれに限定されるものではなく、図8に示すように、ヒーター装置50によって加熱されたヒータブロック49によってプローブ2を加熱し、これを第2の温度差条件にしてもよい。

また、本実施の形態では、図4に示したように加算回路35内に補正係数調整手段16を設けたが、本発明はこれに限定されるものではなく、たとえば、図9に示すように第2の初段増幅手段51内に補正係数調整手段34を設けてもよい。

また、本実施の形態では、図3に示したように第2の赤外線センサ11からの

信号の補正係数を調整する補正係数調整手段16を設け、第1の赤外線センサ10の出力から、調整された第2の赤外線センサ11の出力を差し引いていたが、本発明はこれに限定されるものではなく、たとえば、図10に示すように第1の赤外線センサ10からの出力を適当な割合に調整する補正係数調整手段83を設け、調整された第1の赤外線センサ10の出力から第2の赤外線センサ11の出力を差し引くことにより、導光管8の温度影響によらない測温対象からの赤外線を検出することができる構成となっている。これに対応し、図10に示した温度差補正手段85の回路図は図11に示すようになる。

また、本実施の形態では、第1の温度データおよび第2の温度データをA-Dコンバータ19の出力から得るようにしたが、本発明はこれに限定されるものではなく、たとえば、図3や図10に破線の矢印で示すように、温度データ算出手段20の出力を第1の温度データおよび第2の温度データとして得るようにしてもよい。

また、第1および第2のメモリ30、31や比較手段29などを調整機23に設けたが、放射体温計1にこれらの構成を持たせるようにしてもよい。

次に、図12は、本発明の第2の実施の形態による放射体温計の補正量の調整を行う放射体温計55と装置の概略ブロック図である。図3と同じ構成部分には同じ参照番号を付し、説明を省略する。

本実施の形態においては、温度差補正手段61内にあるA-Dコンバータ57および56によって、補正係数調整手段59および減算手段60の前段においてデジタル変換を行うようにした。なお、58は感温センサ12の出力をデジタル変換するA-Dコンバータである。

図13は、図12に示した補正係数調整手段59および減算手段60のブロック図である。

補正係数調整手段59は、調整モード通知手段26と記憶指示手段27と補正係数発生手段28とからの信号に基づいて寄与率を設定し出力する寄与率設定手段63と、寄与率設定手段63からの寄与率とメモリ66に記録されたA-Dコンバータ57の出力とを乗算して補正された第2の赤外線センサ11の出力を算出する乗算回路64と、第2の赤外線センサ11の出力に代えて補正された第2

の赤外線センサ 11 の出力を記憶するメモリ 66 とから成る。

減算手段 60 は、A-D コンバータ 56 の出力を記憶するメモリ 65 と、メモリ 65 に記憶された第 1 の赤外線センサ 10 の出力からメモリ 66 に記憶された補正された第 2 の赤外線センサ 11 の出力を減算する減算回路 67 とから成る。

ここで、本実施の形態における補正量の調整は以下のとおりである。まず、補正係数発生手段 28 からの補正係数に基づいて寄与率設定手段 63 の寄与率を設定し、設定された寄与率に基づいて第 2 の赤外線センサ 11 の出力を乗算回路 64 にて補正する。減算回路 67 は第 1 の赤外線センサ 10 の出力から補正した第 2 の赤外線センサ 11 の出力を減算する。ここで、第 1 および第 2 の温度差条件において、第 1 および第 2 のメモリ 30、31 に記憶された減算回路 67 の出力が等しくなる寄与率が決定されるまで調整されるものである。なお、温度差条件の作り方は第 1 の実施の形態と同様なので説明を省略する。

また、本実施の形態では、図 12 に示したように第 2 の赤外線センサ 11 からの信号の補正係数を調整する補正係数調整手段 59 を設けたが、本発明はこれに限定されるものではなく、たとえば、第 1 の赤外線センサ 10 からの信号の補正係数を調整する補正係数調整手段を設けるようにしてもよい。

図 14 は、本発明の第 3 の実施の形態による放射体温計のプロープの部分の切り欠いて示した断面図である。図 2 と同じ構成部分には同じ参照番号を付し、説明を省略する。

前述の第 1 および第 2 の実施の形態では、温度差検出手段 54 を導光管 9 と第 2 の赤外線センサ 11 とで構成していたが、本実施の形態では、導光管 70 の温度を測定する第 2 の感温センサ 69 と赤外線センサ 71 の温度を測定する第 1 の感温センサ 72 とで温度差検出手段 75 を構成した実施形態である。

70 は測温対象の鼓膜からの熱放射を効率よく集光するために設けられた導光管であり、材質や内面処理については図 2 に示した導光管 8 と同様である。69 は導光管 70 の温度を測定する第 2 の感温センサである。71 は導光管 70 によって集光された測温対象からの熱放射を検出するセンサであるが、赤外線センサ 71 と導光管 70 との間に温度差がある場合には導光管 70 自体からの熱放射

をも検出する。72は赤外線センサ71の温度を測定する第1の感温センサである。

図15は、図14に示した放射体温計の補正量の調整を行う放射体温計73と装置の概略ブロック図である。図3と同じ構成部分には同じ参照番号を付し、説明を省略する。

図15において、放射体温計73は、フィルタ7と導光管70とから成り黒体33からの熱放射を集光する導光手段74と、赤外線センサ71と、第2の感温センサ69と第1の感温センサ72とから成る温度差検出手段75と、温度差検出手段75と赤外線センサ71と第1の感温センサ72の出力に基づいて測温対象の温度を演算する温度演算手段81と、温度演算手段81の演算結果の温度を表示する表示手段22とから成る。

また、温度演算手段81は、導光管70と赤外線センサ71との間の温度差に基づく誤差を補正する温度差補正手段79と、アナログデータをデジタルデータに変換するA-Dコンバータ80と、デジタル化された温度差補正手段79の出力と第1の感温センサ72の出力とに基づいて測温対象の温度データを算出する温度データ算出手段20とから成り、温度差補正手段79は、赤外線センサ71の検出信号を増幅する初段増幅手段77と、前記温度差に基づく誤差を補正するために補正係数を調整する補正係数調整手段76と、赤外線センサ71の検出信号から補正係数調整手段76で適当な量に調整された温度差検出手段75の検出信号を減算する減算手段78とから成る。

図16は図15に示した温度差補正手段79と温度差検出手段75の回路図である。

補正係数調整手段76および減算手段78は図16に示す加算回路82で実現される。また、補正係数調整手段76は、図5に示した補正係数調整手段16と同様にR-2Rラダー抵抗型D-Aコンバータを応用して用いればよく、補正係数発生手段28からの指示に基づいて補正係数が設定されるレジスタ36と、記憶指示手段27からの指示があったときにレジスタ36に設定されている補正係数を記憶するメモリ37と、調整モード通知手段26から調整モードの通知を受けているときにはレジスタ36から出力されている補正係数を選択し、調整モー

ド通知手段26から調整モードの通知を受けていないときにはメモリ37に記憶されている補正係数を選択し、その選択した補正係数に基づいて抵抗器に接続された各スイッチのON/OFFを制御するセレクト38とを有し、このON/OFF制御によってR-2Rラダー抵抗型D-Aコンバータの合成抵抗値が変化する。

温度差検出手段75は、第1の感温センサ72と第2の感温センサ69とを直列に接続し、その両端はそれぞれ(+)電源と(-)電源に接続されている。そして、この電源は、+2.5Vと-2.5Vのように、基準電位に対して同電圧になっている。そして、第1の感温センサ72と第2の感温センサ69とによって分圧された温度差信号Tdを出力している。なお、この2つの感温センサ72、69は電気特性がよく似ているサーミスタでできている。

ここで、本実施の形態における補正量の調整は以下のとおりである。まず、補正係数発生手段28からの指示に基づいてレジスタ36に補正係数が設定され、この補正係数により補正係数調整手段76の抵抗値が決定される。そして、温度差検出手段75からの温度差信号Tdは、この抵抗値が決定された補正係数調整手段76を介することにより補正された温度差信号となる。減算手段78は、初段増幅手段77で増幅された赤外線センサ71の出力から、上記補正された温度差信号を減算する。ここで、第1および第2の温度差条件において、第1および第2のメモリ30、31に記憶されたA-Dコンバータ80の出力が等しくなる補正係数が決定されるまで調整されるものである。なお、温度差条件の作り方は、第1の実施の形態と同様なので説明を省略する。

また、本実施の形態では、図15に示したように温度差検出手段75からの信号の補正係数を調整する補正係数調整手段76を設けたが、本発明はこれに限定されるものではなく、たとえば、赤外線センサ71からの信号の補正係数を調整する補正係数調整手段を設けるようにしてもよい。

なお、本発明において、赤外線センサとしては、たとえばサーモパイルや焦電素子を用いたものが適用できる。また、感温センサとしてはサーミスタに限るものではなく、温度特性がある素子ならばよく、たとえばダイオードなどでもよい。

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産業上の利用可能性

本発明は放射体温計について開示したが、放射温度計一般に適用することができる。

請 求 の 範 囲

1. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

前記温度演算手段は、前記温度差信号または前記赤外検出信号の補正係数を調整するための補正係数調整手段を設けたことを特徴とする放射体温計。

2. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

前記温度演算手段は、前記温度差信号の補正係数を調整するための補正係数調整手段を設けたことを特徴とする放射体温計。

3. 前記温度演算手段は、前記赤外検出信号から前記温度差信号を減算する温度差補正手段と、該温度差補正手段の出力信号と前記基準温度信号とにより前記温度データ信号を算出する温度データ算出手段とから成り、前記温度差補正手段には前記補正係数調整手段が設けられていることを特徴とする請求の範囲第2項に記載の放射体温計。

4. 前記温度差補正手段は、前記赤外検出信号から前記温度差信号をアナログ的に減算する減算手段であり、前記補正係数調整手段は、前記減算手段に対する前記温度差信号の寄与率を調整する調整手段であることを特徴とする請求の範囲第3項に記載の放射体温計。



5. 前記減算手段は、前記赤外検出信号と前記温度差信号を入力するオペアンプによる加算回路であり、前記補正係数調整手段は、温度差信号用入力抵抗の抵抗値を可変する抵抗値調整手段であることを特徴とする請求の範囲第4項に記載の放射体温計。

6. 前記抵抗値調整手段は、複数の抵抗と、該抵抗を切り換え接続するスイッチング手段と、該スイッチング手段を制御する制御回路とから構成されることを特徴とする請求の範囲第5項に記載の放射体温計。

7. 前記温度差補正手段は、前記赤外検出信号から前記温度差信号をデジタル的に減算する減算手段であり、前記補正係数調整手段は、前記減算手段に対する前記温度差信号の寄与率を調整する調整手段であることを特徴とする請求の範囲第3項に記載の放射体温計。

8. 前記減算手段は、前記赤外検出信号と前記温度差信号をそれぞれデジタル値として記憶する赤外検出信号メモリおよび温度差信号メモリと、該2つのメモリデータを減算するデジタル減算回路とから構成され、且つ前記補正係数調整手段は、前記温度差信号メモリの記憶値に前記寄与率を乗算する乗算回路と、前記寄与率を設定する寄与率設定手段とから構成されることを特徴とする請求の範囲第7項に記載の放射体温計。

9. 前記導光手段は、先端が開口した第1の導光部で構成され、前記赤外線センサは、前記第1の導光部材後端に配設された第1の赤外線センサであり、前記温度差検出手段は、前記第1の導光部とほぼ同一の温度状態に保たれ、且つ先端が閉鎖された第2の導光部と、該第2の導光部後端に配設された第2の赤外線センサであることを特徴とする請求の範囲第3項に記載の放射体温計。

10. 前記導光手段は先端が開口した導光部材であり、前記赤外線センサは前記導光部材後端に配設されたサーモパイルであり、前記温度差検出手段は、前記導光部材の温度を測定する第1の感温センサと、前記サーモパイルの温度を測定する第2の感温センサとで構成されていることを特徴とする請求の範囲第3項に記載の放射体温計。

11. 前記温度差補正手段は、前記第1の赤外線センサから出力される前記赤外検出信号と、前記第2の赤外線センサから出力される前記温度差信号とをアナ



ログ的に減算する減算手段であり、前記補正係数調整手段は、前記減算手段に対する前記温度差信号の寄与率を調整する調整手段であることを特徴とする請求の範囲第9項に記載の放射体温計。

12. 前記減算手段は、前記赤外検出信号と前記温度差を入力するオペアンプによる加算回路であり、前記補正係数調整手段は、温度差信号用入力抵抗の抵抗値を可変する抵抗値調整手段であることを特徴とする請求の範囲第11項に記載の放射体温計。

13. 前記抵抗値調整手段は複数の抵抗と、該抵抗を切り換え接続するスイッチング手段と、該スイッチング手段を制御する制御回路とから構成されることを特徴とする請求の範囲第12項に記載の放射体温計。

14. 前記温度差補正手段は、前記第1のサーモパイルから出力される前記赤外検出信号を増幅する第1の初段増幅手段と、前記第2のサーモパイルから出力される前記温度差信号を増幅する第2の初段増幅手段と、前記第1の初段増幅手段から出力される前記赤外検出信号から前記第2の初段増幅手段から出力される前記温度差信号をアナログ的に減算する減算手段とから構成されており、前記補正係数調整手段は、前記第2の初段増幅手段の増幅率調整手段であることを特徴とする請求の範囲第9項に記載の放射体温計。

15. 前記補正係数調整手段は、前記赤外線センサと前記導光手段の第1の温度差条件で出力される第1の出力データ信号と、第2の温度差条件で出力される第2の出力データ信号とに基づいて調整されることを特徴とする請求の範囲第2項に記載の放射体温計。

16. 前記第1の温度差条件は前記赤外線センサの温度と前記導光手段の温度とがほぼ等しく、前記第2の温度差条件は前記赤外線センサの温度と前記導光手段の温度とが異なることを特徴とする請求の範囲第15項に記載の放射体温計。

17. 前記第2の温度差条件は前記導光手段を加熱することにより設定されることを特徴とする請求の範囲第15項に記載の放射体温計。

18. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温



度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

前記赤外線センサと前記導光手段の温度差に基づいて生じる前記温度差信号または前記赤外検出信号の寄与率を調整する温度差補正手段を設け、一定の温度に保たれた黒体からの熱放射を受けるように放射体温計を配置する工程と、前記赤外線センサと前記導光手段の第1の温度差条件で出力される第1の出力データ信号を検出する工程と、前記赤外線センサと前記導光手段の第2の温度差条件で出力される第2の出力データ信号を検出する工程と、前記第1および第2の出力データを比較して比較データを出力する工程と、該比較データに基づき前記第1の出力データ信号と前記第2の出力データ信号とが一致するように前記温度差補正手段を調整する工程とから成ることを特徴とする放射体温計の温度誤差補正方法。

19. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

黒体の温度を測定する温度測定手段と、前記赤外線センサと前記導光手段の温度差に基づいて生じる前記温度差信号または前記赤外検出信号の寄与率を調整する温度差補正手段を設け、前記黒体からの熱放射を受けるように放射体温計を配置する工程と、前記赤外線センサと前記導光手段の第1の温度差条件で出力される第1の出力データ信号を検出する工程と、前記赤外線センサと前記導光手段の第2の温度差条件で出力される第2の出力データ信号を検出する工程と、前記第1の温度差条件における前記黒体の測定温度と前記第2の温度差条件における前



記黒体の測定温度との測定温度差を測定する工程と、前記第1の出力データ信号と前記第2の出力データ信号との温度差を出力する工程と、該温度差と前記測定温度差とが一致するように前記温度差補正手段を調整する工程とから成ることを特徴とする放射体温計の温度誤差補正方法。

20. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

前記赤外線センサと前記導光手段の温度差に基づいて生じる前記温度差信号の寄与率を調整する温度差補正手段を設け、一定の温度に保たれた黒体からの熱放射を受けるように放射体温計を配置する工程と、前記赤外線センサと前記導光手段の第1の温度差条件で出力される第1の出力データ信号を検出する工程と、前記赤外線センサと前記導光手段の第2の温度差条件で出力される第2の出力データ信号を検出する工程と、前記第1および第2の出力データを比較して比較データを出力する工程と、該比較データに基づき前記第1の出力データ信号と前記第2の出力データ信号とが一致するように前記温度差補正手段を調整する工程とから成ることを特徴とする放射体温計の温度誤差補正方法。

21. 被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を該赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、前記赤外線センサと前記導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、前記赤外検出信号と前記基準温度信号と前記温度差信号とを入力し、前記温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、

黒体の温度を測定する温度測定手段と、前記赤外線センサと前記導光手段の温度差に基づいて生じる前記温度差信号の寄与率を調整する温度差補正手段を設



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け、前記黒体からの熱放射を受けるように放射体温計を配置する工程と、前記赤外線センサと前記導光手段の第1の温度差条件で出力される第1の出力データ信号を検出する工程と、前記赤外線センサと前記導光手段の第2の温度差条件で出力される第2の出力データ信号を検出する工程と、前記第1の温度差条件における前記黒体の測定温度と前記第2の温度差条件における前記黒体の測定温度との測定温度差を測定する工程と、前記第1の出力データ信号と前記第2の出力データ信号との温度差を出力する工程と、該温度差と前記測定温度差とが一致するように前記温度差補正手段を調整する工程とから成ることを特徴とする放射体温計の温度誤差補正方法。

22. 前記第1の温度差条件は前記赤外線センサの温度と前記導光手段の温度とがほぼ等しく、前記第2の温度差条件は前記赤外線センサの温度と前記導光手段の温度とが異なることを特徴とする請求の範囲第20項または第21項に記載の放射体温計の温度誤差補正方法。

23. 前記第2の温度差条件は前記導光手段を加熱することにより設定されることを特徴とする請求の範囲第20項または第21項に記載の放射体温計の温度誤差補正方法。

24. 前記温度補正手段は、前記赤外検出信号と前記温度差信号を入力するオペアンプによる加算回路であり、前記温度差補正手段を調整する工程は、前記オペアンプの温度差信号用入力抵抗の抵抗値の調整であることを特徴とする請求の範囲第20項または第21項に記載の放射体温計の温度誤差補正方法。

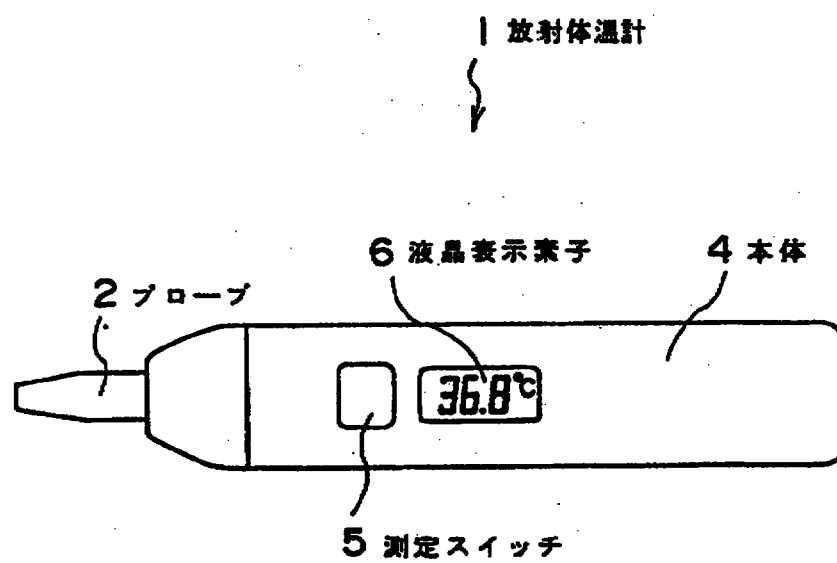
25. 前記第1および第2の出力データ信号が前記加算回路を構成するオペアンプの出力信号であることを特徴とする請求の範囲第24項に記載の放射体温計の温度誤差補正方法。

26. 前記第1および第2の出力データ信号が温度データ信号であることを特徴とする請求の範囲第20項または第21項に記載の放射体温計の温度誤差補正方法。



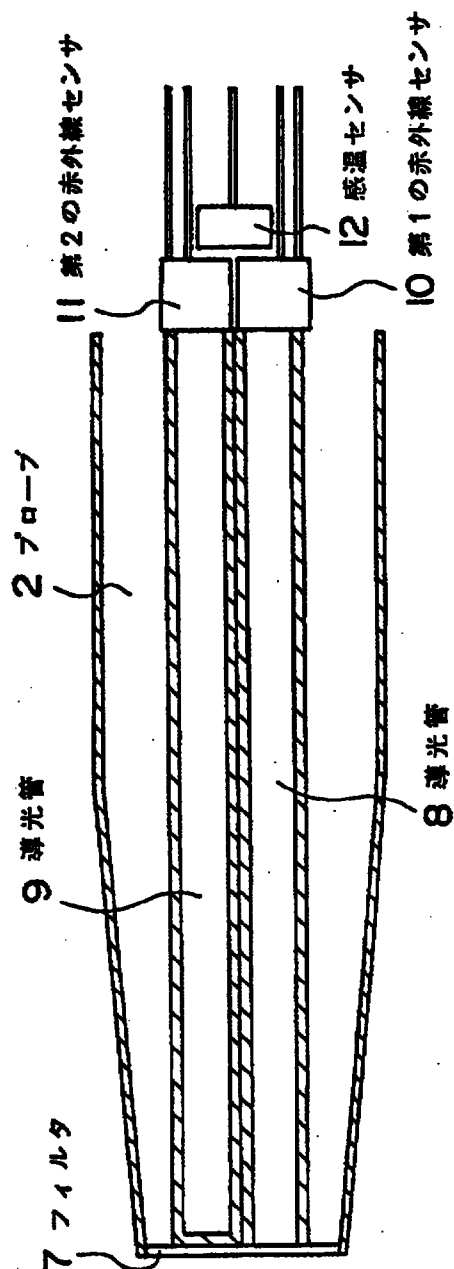
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FIG. 1



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FIG. 2



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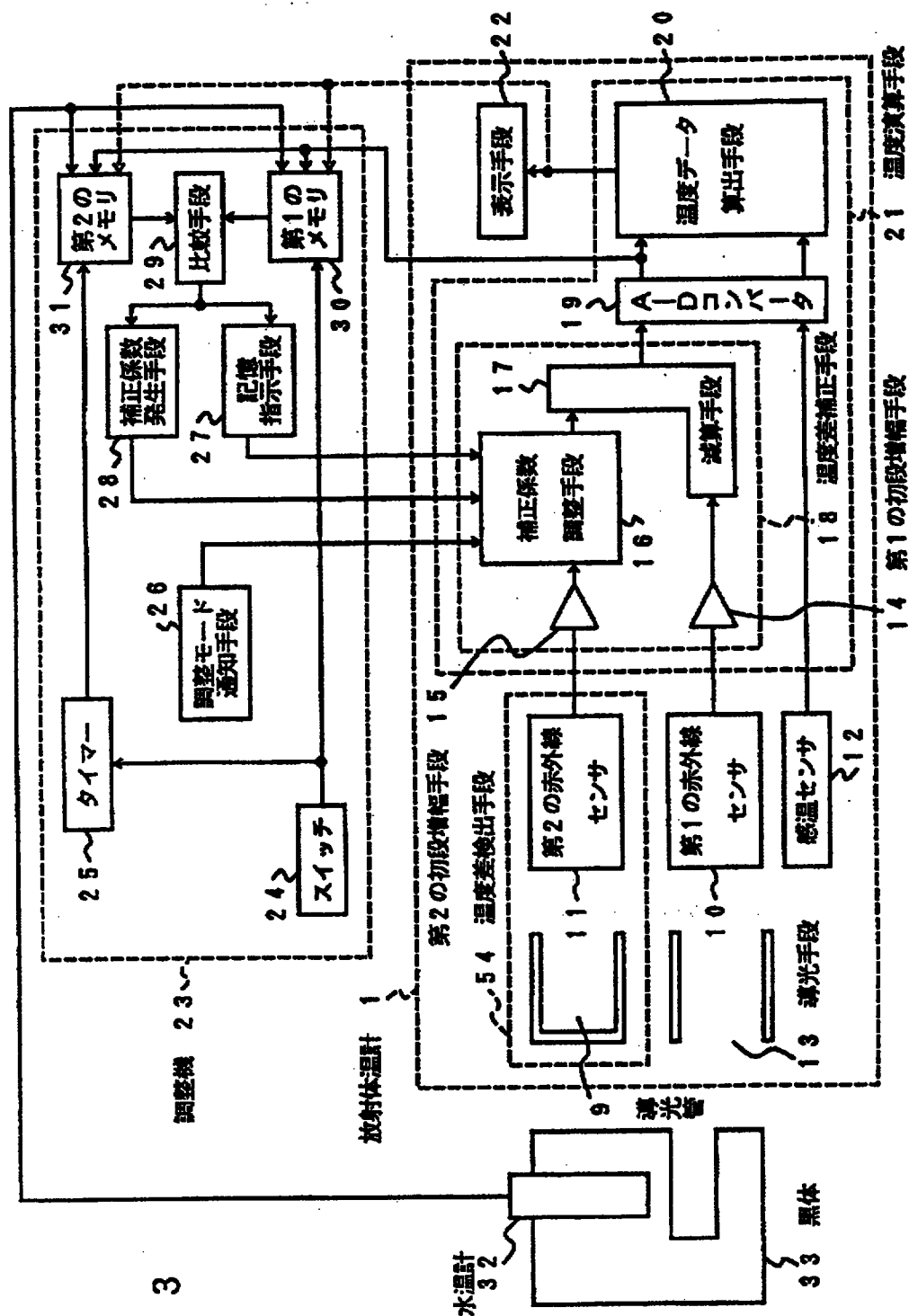


FIG. 3

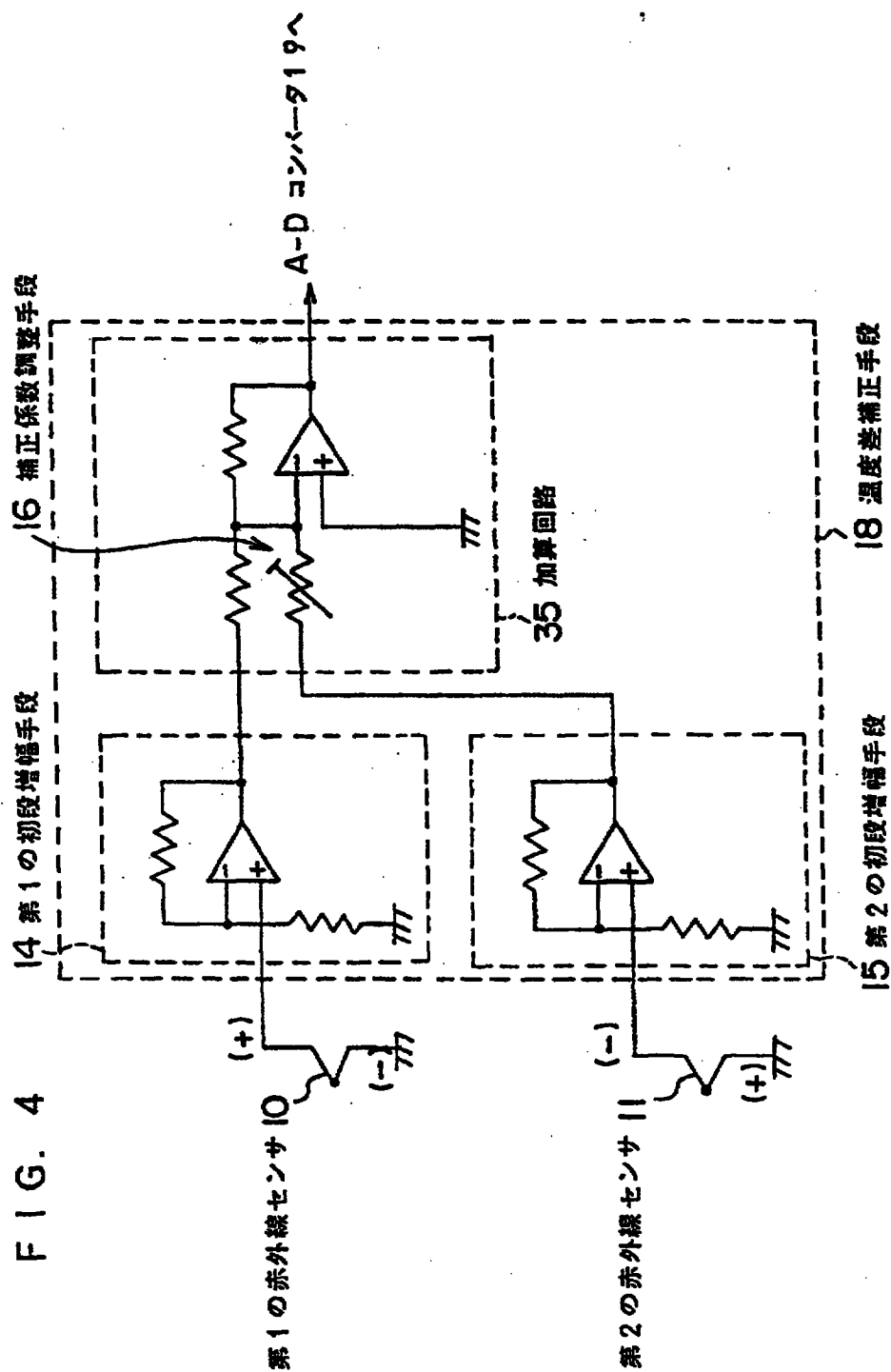
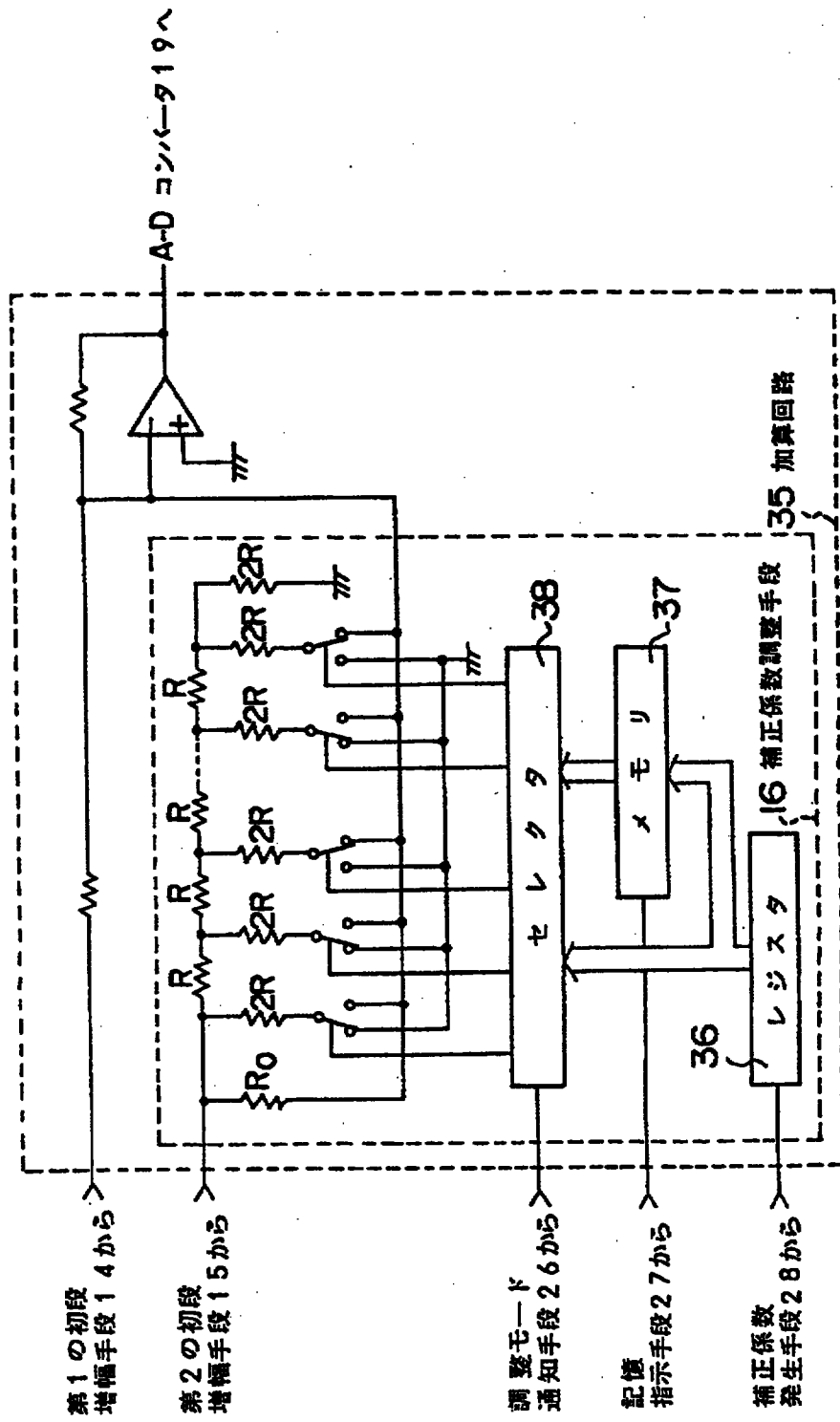
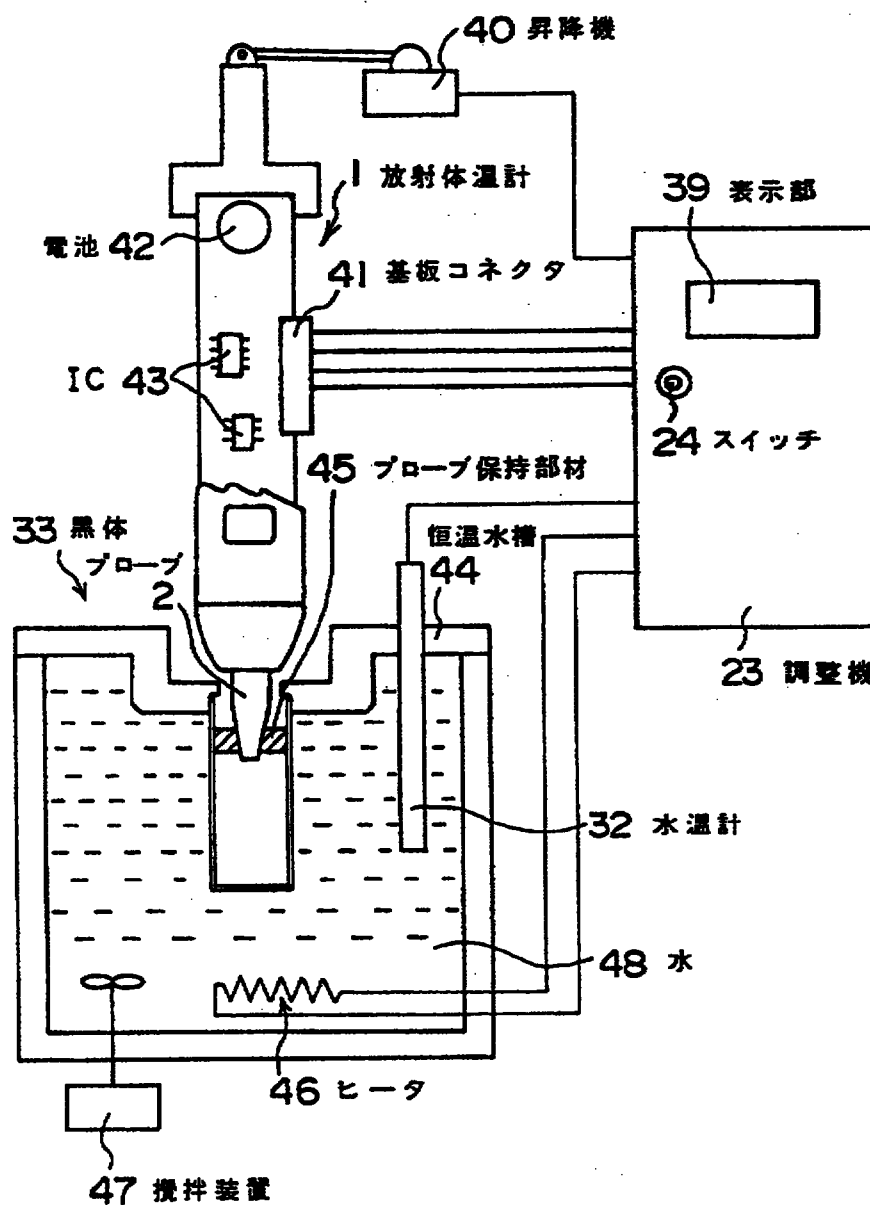


FIG. 5



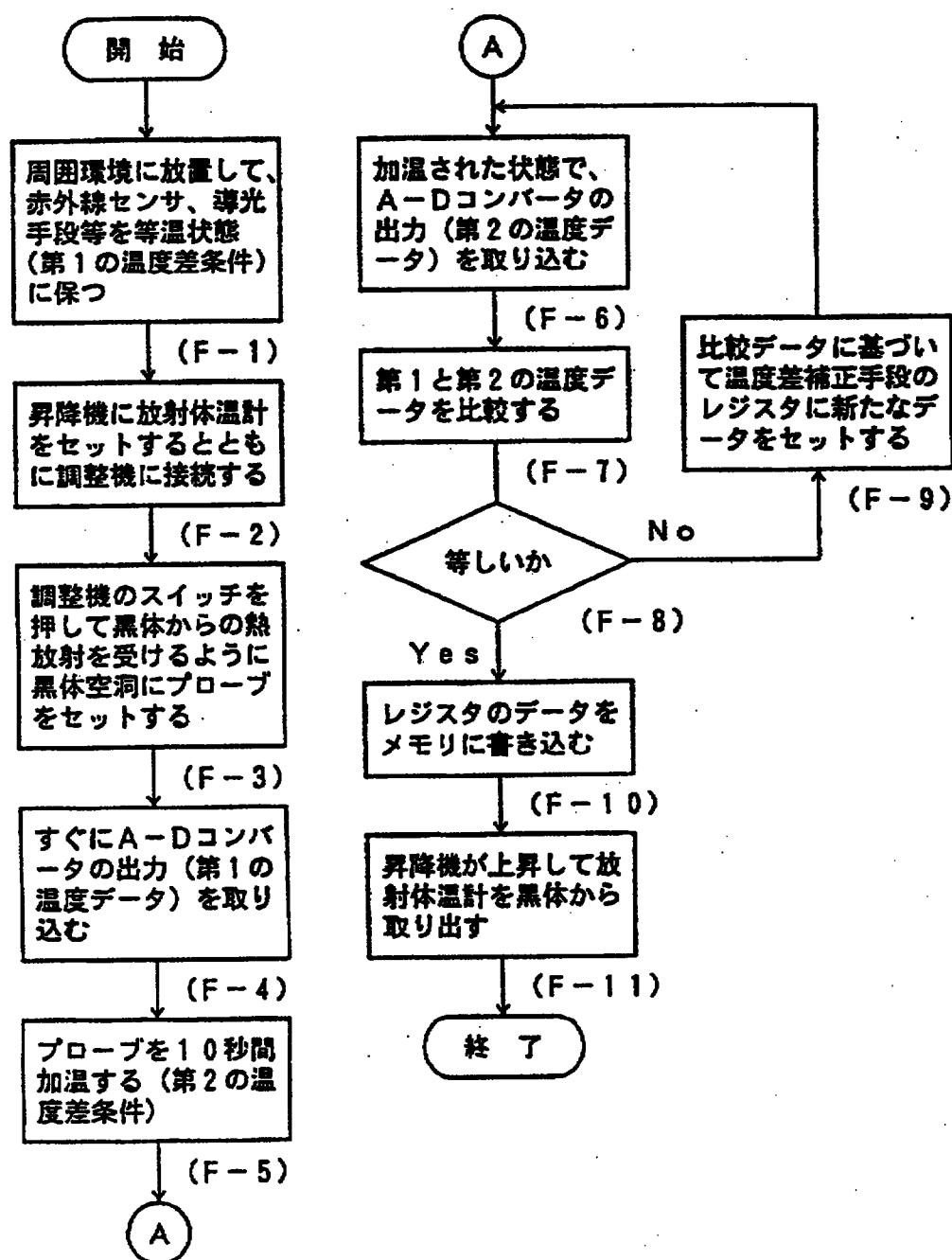
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FIG. 6



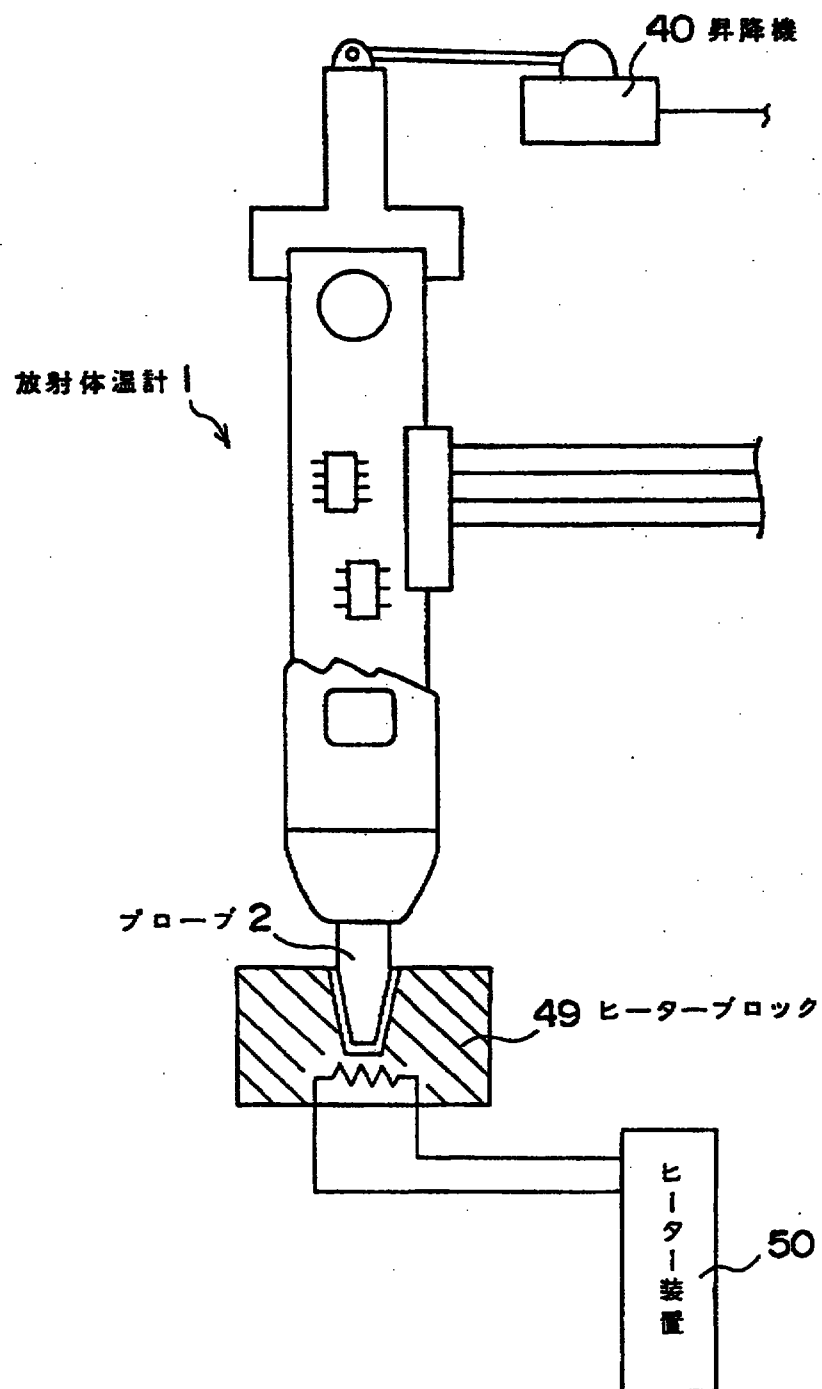
7/16

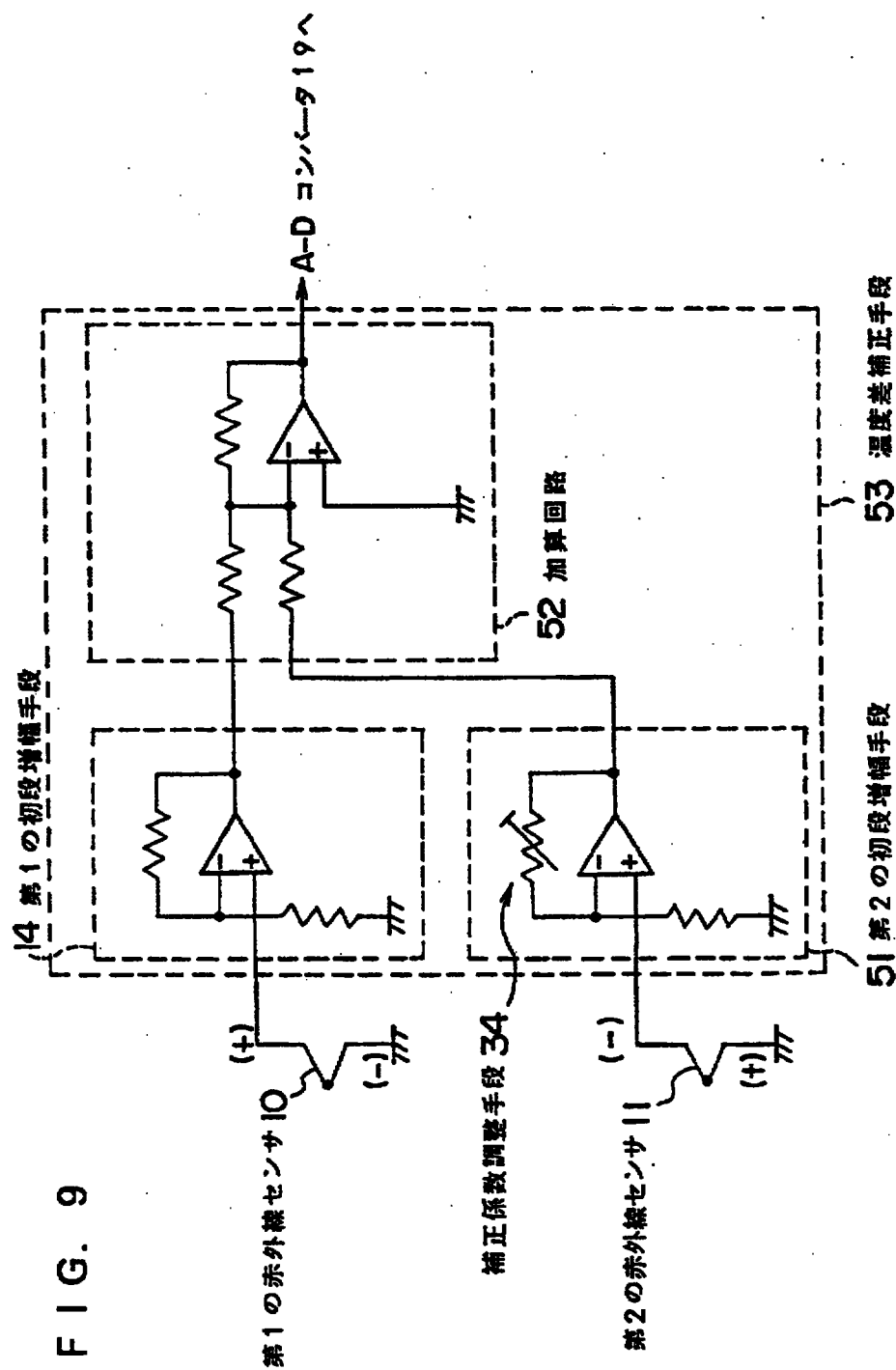
FIG. 7

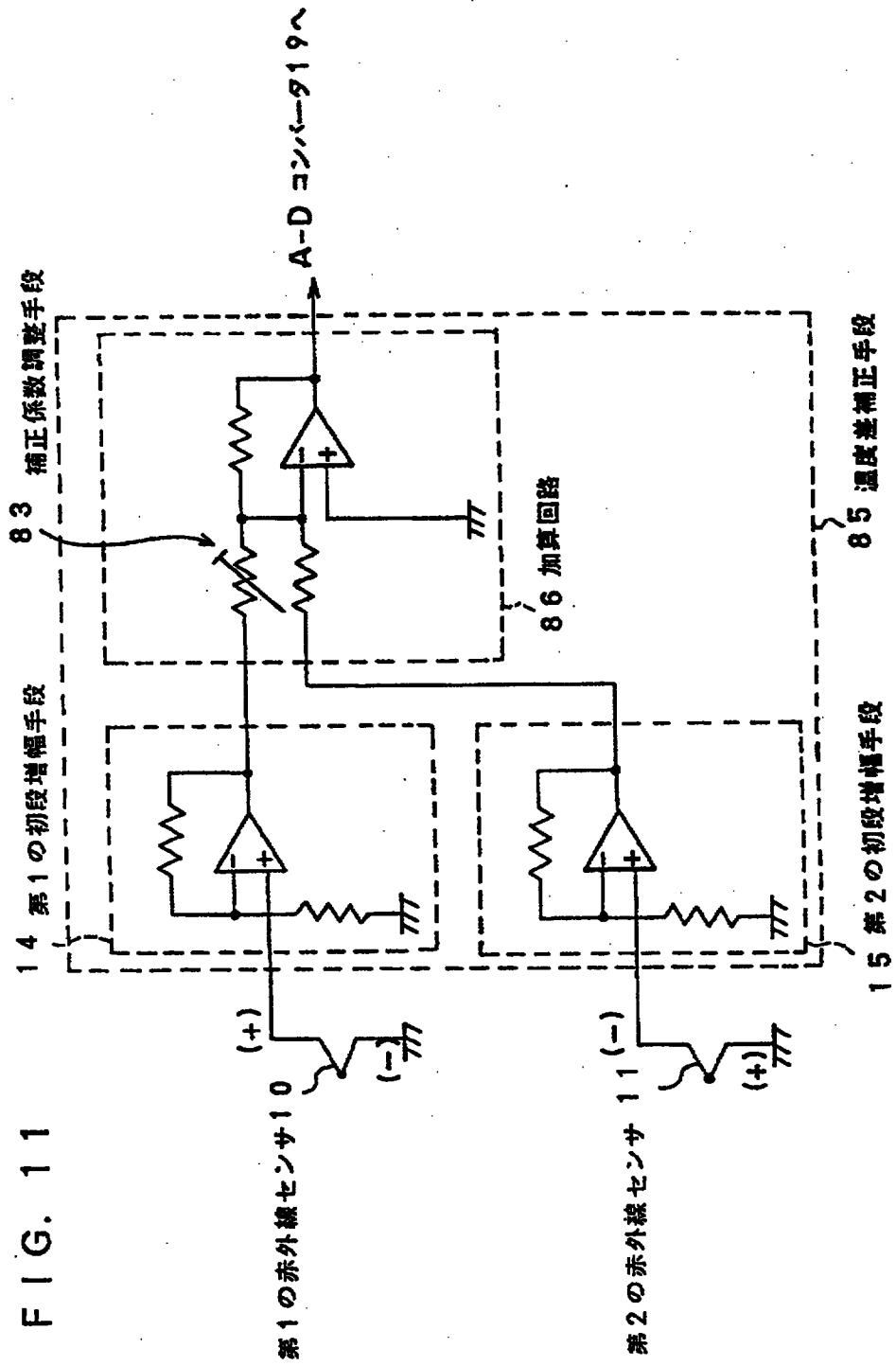


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FIG. 8







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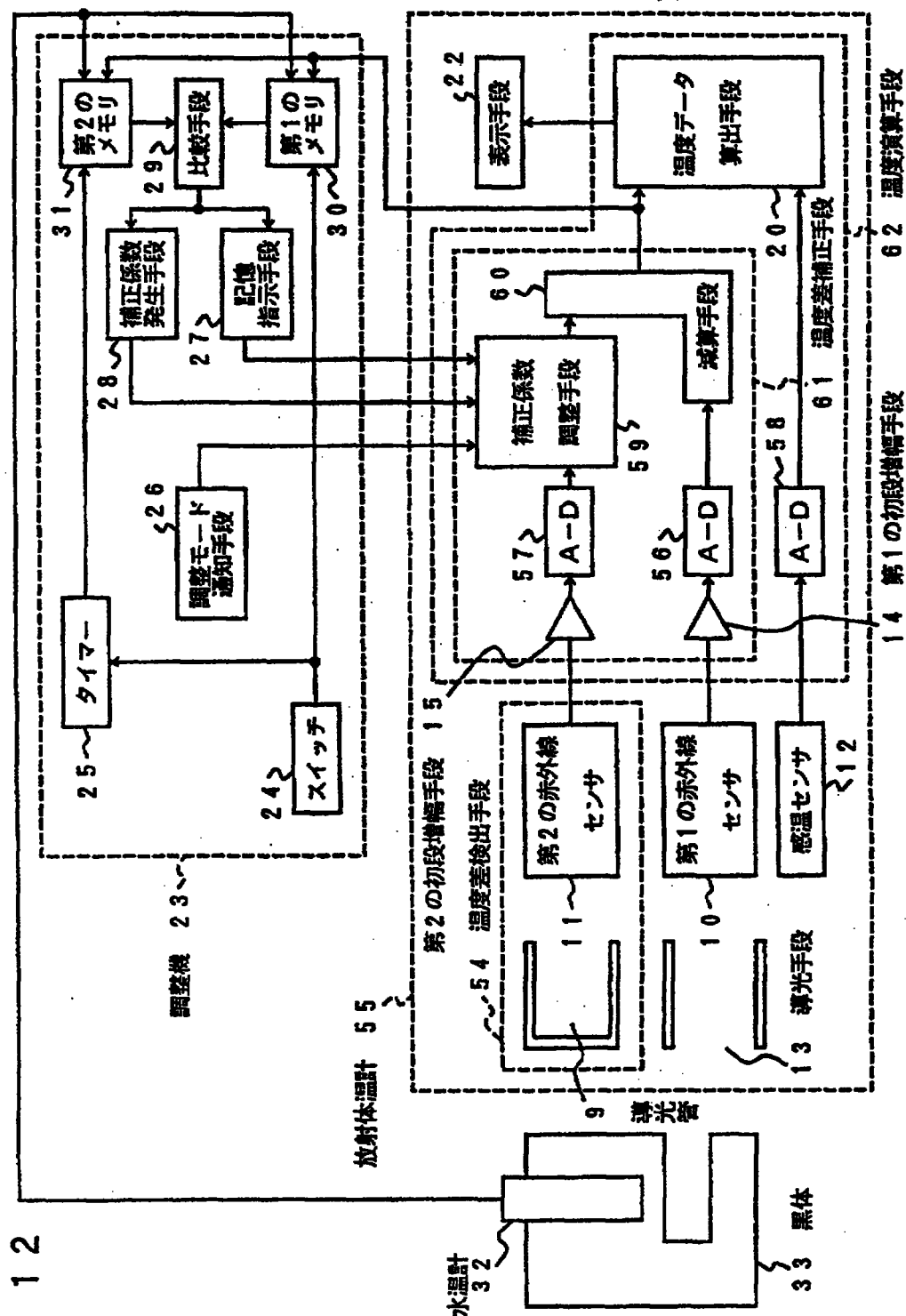
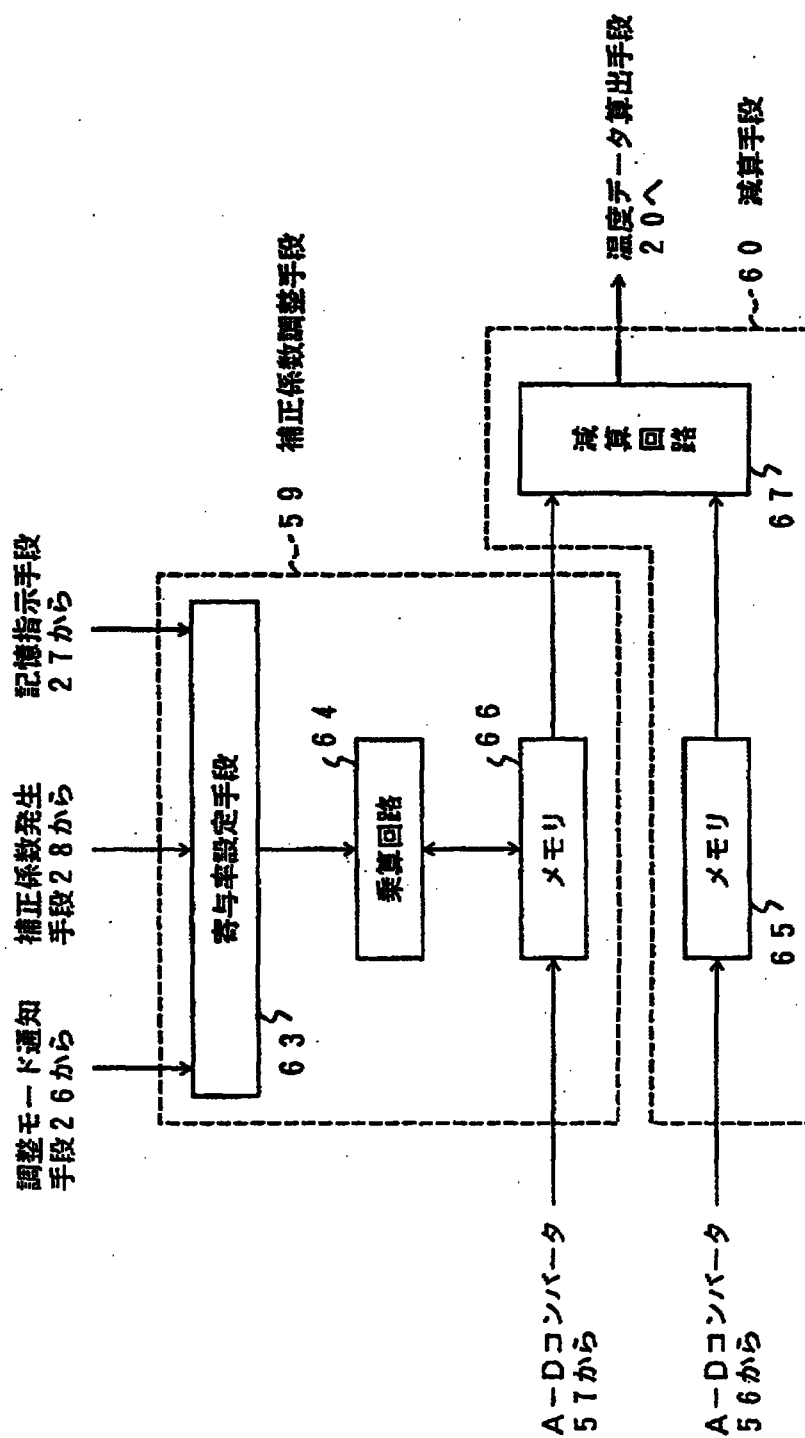


FIG. 12

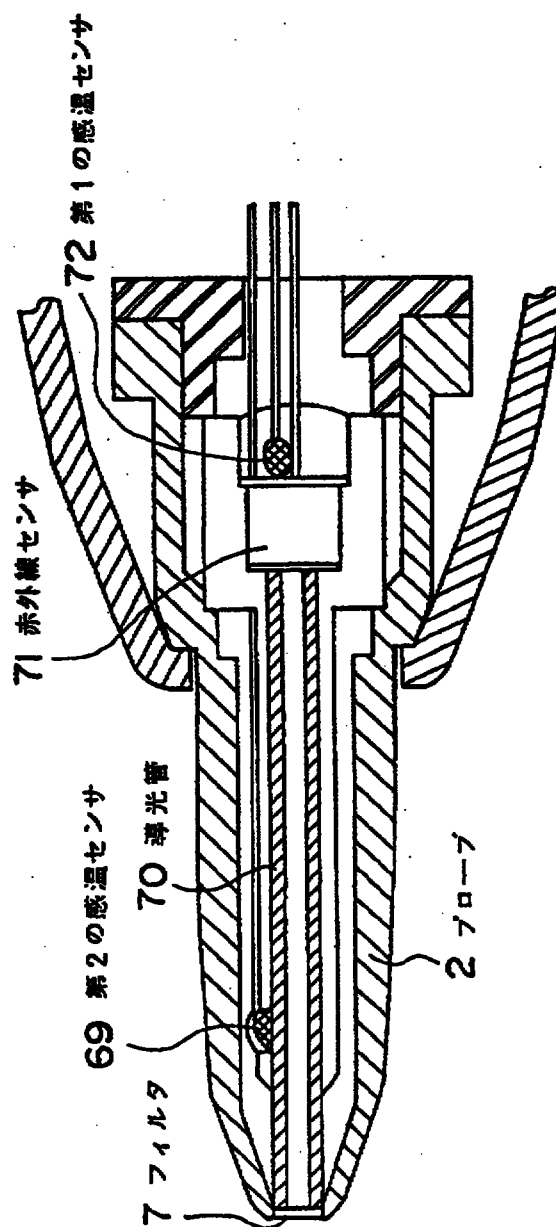
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FIG. 13



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FIG. 14



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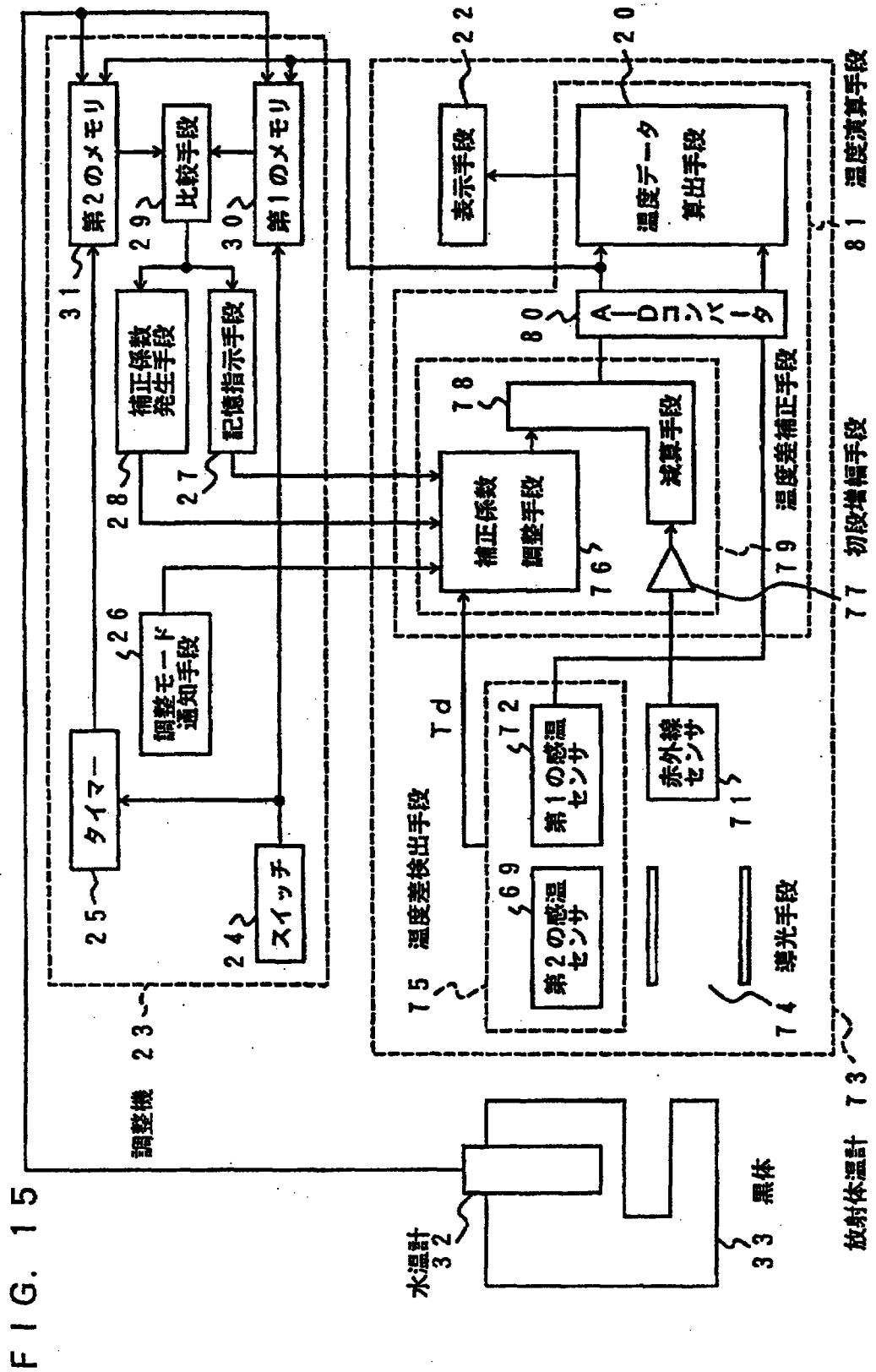
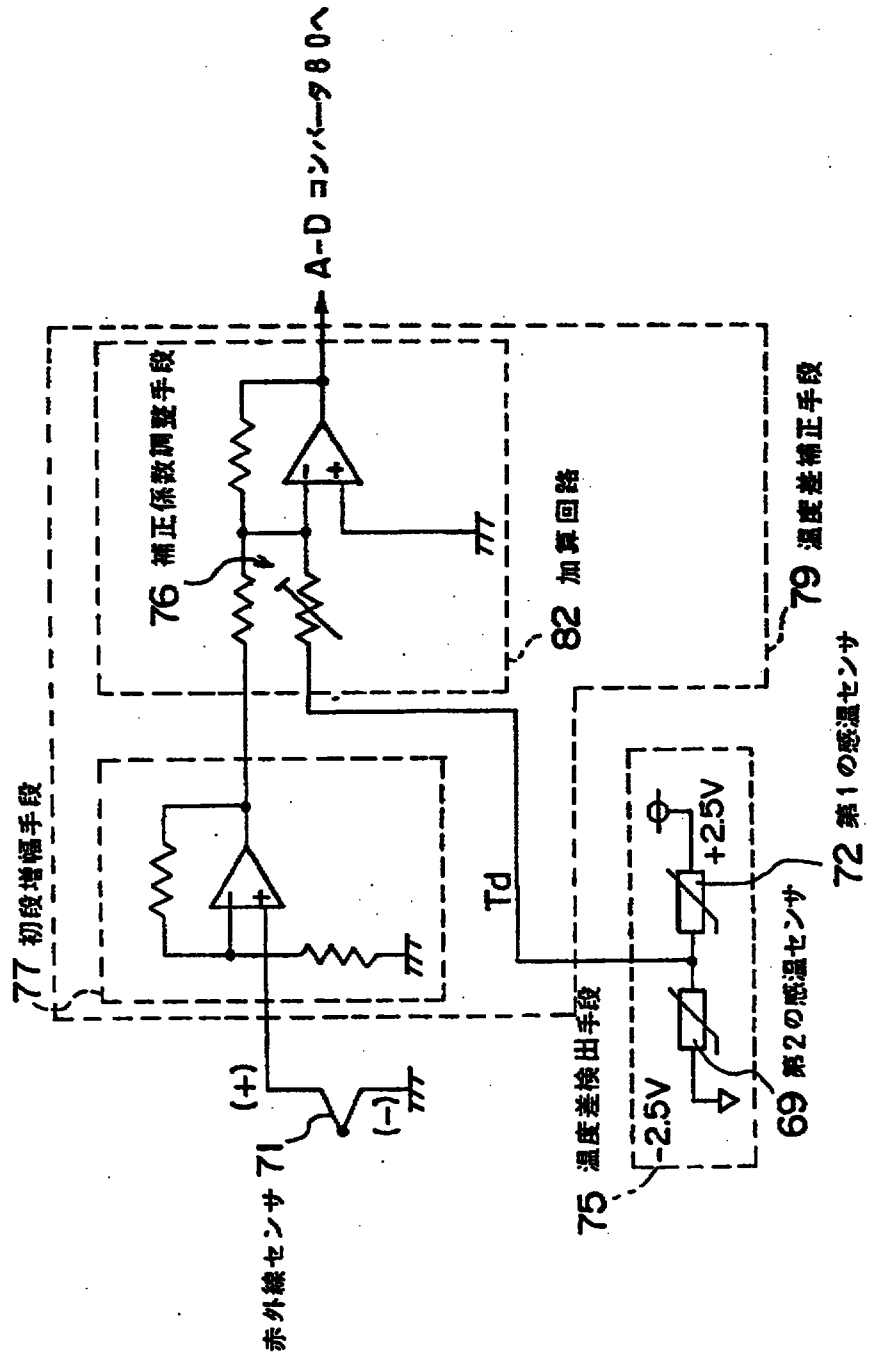


FIG. 16



S P E C I F I C A T I O N
Radiation Clinical Thermometer

[Technical Field]

The present invention relates to a radiation clinical thermometer for performing noncontact temperature measurement by detecting thermal radiation energy and, more particularly, to temperature compensation in an optical system.

[Background Art]

A radiation clinical thermometer has been proposed to measure a body temperature within a short period of time. This instrument is designed to perform noncontact measurement of the temperature of an eardrum selected as a measurement portion.

For example, such radiation clinical thermometer is disclosed in Japanese Unexamined Patent Publication No. 61-117422 wherein the head portion of the probe unit is inserted into the external acoustic meatus, and thermal radiations from the eardrum are focused to an infrared sensor by an optical waveguide placed in the head portion, thereby measuring the eardrum temperature. The probe unit with this infrared sensor includes a heating control means for preheating the head portion to a reference temperature (36.5°C). The head portion is preheated to a temperature near the body temperature, and calibration is performed in

advance in this state. With this operation, when the head portion is inserted into the external acoustic meatus, the temperature of the head portion undergoes no change. For this reason, measurement errors caused by changes in the temperature of the head portion can be eliminated. That is, the inner surface of the optical waveguide must be set equal in temperature to that of the infrared sensor itself so as to prevent thermal radiations from the optical waveguide itself from causing measurement errors. In order to prevent a change in the temperature of the head portion upon insertion into the external acoustic meatus, the temperature of the head portion is stabilized at the reference temperature (36.5°C). With this setting, thermal radiations from the inner surface of the optical waveguide can be neglected.

The radiation clinical thermometer disclosed in Japanese Unexamined Patent Publication No. 61-117422, however, requires a heating control device with a high control accuracy. For this reason, the structure and circuit configuration of this instrument are complicated, and its size increases, resulting in an increase in cost. In addition, a long stabilization time is required to preheat the head portion and control its temperature to a constant temperature. Furthermore, high energy is required to drive the heating control device. This scheme cannot therefore be applied to a portable clinical thermometer using a compact battery as an energy source.

Under the circumstances, a radiation clinical thermometer with a high temperature measurement accuracy has been proposed, which is a compact, portable clinical thermometer having no heating control device. When the probe of this instrument is inserted into the external acoustic meatus to measure the eardrum temperature, the temperature of the probe changes. However, this change causes no error.

For example, such radiation clinical thermometer is disclosed in Japanese Unexamined Patent Publication No. 2-28524. Similar to the radiation clinical thermometer disclosed in Japanese Unexamined Patent Publication No. 61-117422, the radiation clinical thermometer disclosed in Japanese Unexamined Patent Publication No. 2-28524 uses an optical waveguide as an optical system for focusing thermal radiations from the eardrum. However, this instrument has no heating control device for the infrared sensor, and hence the infrared sensor and the optical waveguide are kept at almost the ambient temperature, i.e., room temperature. The first temperature sensor is arranged near the infrared sensor, and the second temperature sensor is arranged in the optical waveguide. A temperature is measured on the basis of the temperatures of the infrared sensor and the optical waveguide. If the difference in temperature between the infrared sensor and the optical waveguide is extraordinarily large, measurement is inhibited. If the temperature difference is smaller than a

predetermined value, measurement is permitted in spite of the temperature difference. Body temperature data is then calculated in consideration of the temperatures of the infrared sensor and the optical waveguide. In this radiation clinical thermometer, an operation of calculating body temperature data is performed by a microcomputer on the basis of the output voltage from the infrared sensor, the output temperature from the first temperature sensor for measuring the temperature of the infrared sensor, and the output temperature from the second temperature sensor for measuring the temperature of the optical waveguide. When, for example, the probe is in the external acoustic meatus, the temperature of the optical waveguide gradually rises while the temperature of the infrared sensor hardly changes. For this reason, a temperature difference is caused between the infrared sensor and the optical waveguide. However, since body temperature data is calculated in consideration of these temperatures, an error caused by this temperature difference can be eliminated.

The following problems, however, are posed in the radiation clinical thermometer disclosed in Japanese Unexamined Patent Publication No. 2-28524. Since body temperature data is calculated by using a complicated equation based on a total of three variables, i.e., the temperature data obtained by the two temperature sensors and the output from the infrared sensor, the microcomputer requires a complicated program for this operation, and a

long time for arithmetic processing. Furthermore, in the complicated equation used for this operation, constants such as the emissivity of the optical waveguide must be measured and set in advance. However, this setting is also difficult to perform.

The present applicant has disclosed a radiation clinical thermometer is Japanese Unexamined Patent Publication No. 6-142063, which uses an analog circuit to correct an error caused by the difference in temperature between first and second temperature sensors on the basis of the output voltage from an infrared sensor, the output temperature from the first temperature sensor adapted to measure the temperature of the infrared sensor, and the output temperature from the second temperature sensor adapted to measure the temperature of an optical waveguide.

The radiation clinical thermometer disclosed in U.S. Patent No. 5,159,936 includes a first infrared sensor for receiving thermal radiations from the eardrum and thermal radiations from an optical waveguide itself, and a second infrared sensor for receiving only thermal radiations from the optical waveguide itself. This instrument is designed to correct an error caused by the difference in temperature between the optical waveguide and the infrared sensors by subtracting the output from the second infrared sensor from the output from the first infrared sensor.

Assume that the second temperature sensor is mounted on the probe unit of the radiation clinical thermometer

disclosed in Japanese Unexamined Patent Publication No. 6-142063 to measure the temperature of the optical waveguide. In this case, the mounting positions of such sensors slightly vary with radiation clinical thermometers. For this reason, when the radiation clinical thermometer disclosed in Japanese Unexamined Patent Publication No. 6-142063 is mass-produced, the measurement results obtained by the respective radiation clinical thermometers include slight errors.

If the output from the second infrared sensor is simply subtracted from the output from the first infrared sensor, as in the radiation clinical thermometer disclosed in U.S. Patent No. 5,159,936, a body temperature as a measurement result includes an error because of the influences and the like of a shielding plate for shielding the second infrared sensor from thermal radiations from an object to be measured.

[Disclosure of Invention]

It is an object of the present invention to provide a radiation clinical thermometer which can improve the accuracy of a body temperature as a measurement result.

In order to achieve the above object, according to an arrangement of the present invention, there is provided a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be

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measured, optical waveguide means for guiding the thermal radiations from the object to be measured to the infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between the infrared sensor and the optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error caused by the temperature difference, characterized in that the temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal.

According to the above arrangement of the present invention, since the temperature calculation means includes the correction coefficient adjusting means for adjusting the correction coefficient for the temperature difference signal from the temperature difference detection sensor for detecting the temperature difference between the infrared sensor and the optical waveguide means, a radiation clinical thermometer can be provided, which can calculate temperature data upon properly adjusting the error amount based on the temperature difference between the infrared sensor and the optical waveguide means, and improves the measurement accuracy.

This Sheet Has Been Replaced



According to the present invention, the temperature calculation means comprises temperature difference correction means for subtracting the temperature difference signal from the infrared detection signal, and temperature data calculation means for calculating the temperature data on the basis of an output signal from the temperature difference correction means and the reference temperature signal, the temperature difference correction means including the correction coefficient adjusting means. Since this temperature difference correction means can be constituted by an analog or digital subtraction means, a corresponding circuit can be formed, as needed.

In addition, the correction coefficient adjusting means is a means for adjusting the contribution of a temperature difference signal to the subtraction means, and a corresponding circuit can be formed in either an analog or digital circuit.

Furthermore, according to the present invention, two different temperature difference conditions are set between the infrared sensor and the optical waveguide means, and the correction coefficient in the correction coefficient adjusting means is adjusted on the basis of the output under each condition. A correct correction coefficient can therefore be set.

[Brief Description of Drawings]

Fig. 1 is a front view of a radiation clinical thermometer according to the first embodiment of the present invention, Fig. 2 is a partially cutaway sectional view of the probe of the radiation clinical thermometer in Fig. 1, Fig. 3 is a schematic block diagram showing the radiation clinical thermometer and a device which perform correction amount adjustment for the error based on the difference in temperature between the infrared sensor and optical waveguide of the radiation clinical thermometer in Fig. 1, Fig. 4 is a circuit diagram of a temperature difference correction means in Fig. 3, Fig. 5 is a circuit diagram of an addition circuit including the correction coefficient adjusting means in Fig. 4, Fig. 6 is a view showing the outer appearance of each device in Fig. 3, Fig. 7 is a flow chart for explaining the steps in adjusting the correction amount for the radiation clinical thermometer by using the device in Fig. 3, Fig. 8 is a view for explaining temperature difference conditions under which the probe is heated, Fig. 9 is a view for explaining another example of the place where the correction coefficient adjusting means is arranged, Fig. 10 is a view for explaining still another example of the place where the correction coefficient adjusting means is arranged, Fig. 11 is a view for explaining still another example of the place where the correction coefficient adjusting means is arranged, Fig. 12 is a schematic block diagram showing a radiation clinical

thermometer and a device which perform correction amount adjustment for the radiation clinical thermometer according to the second embodiment of the present invention, Fig. 13 is a block diagram showing a correction coefficient adjusting means and a subtraction means in Fig. 12, Fig. 14 is a partially cutaway sectional view of the probe of a radiation clinical thermometer according to the third embodiment of the present invention, Fig. 15 is a schematic block diagram showing a radiation clinical thermometer and a device which perform correction amount adjustment for the radiation clinical thermometer in Fig. 14, and Fig. 16 is a circuit diagram showing a temperature difference correction means and a temperature difference detection means in Fig. 15.

[Best Mode of Carrying Out the Invention]

The present invention will now be described with reference to the accompanying drawings.

Fig. 1 is a front view of a radiation clinical thermometer according to the first embodiment of the present invention.

A radiation clinical thermometer 1 is a clinical thermometer for measuring an eardrum temperature, and comprises a main body 4 and a probe 2. The main body 4 has a liquid crystal display element 6 for displaying a body temperature and a measurement switch 5 having a pushbutton structure.

The radiation clinical thermometer 1 is operated in the following manner. When the measurement switch 5 is depressed, the radiation clinical thermometer 1 is powered on to start temperature measurement. Thereafter, the probe 2 is inserted into the external acoustic meatus of an object toward the eardrum to measure the eardrum temperature. After the probe 2 is properly directed to the eardrum, the probe 2 is removed from the external acoustic meatus. In this case, since the highest temperature that has been measured is displayed on the liquid crystal display element 6, the eardrum temperature, i.e., the body temperature, is displayed on the liquid crystal display element 6. This display is read as the body temperature of the object.

Fig. 2 is a partially cutaway sectional view of the probe 2 of the radiation clinical thermometer 1 in Fig. 1.

A filter 7 having transmission wavelength characteristics is mounted on the distal end of the probe 2. This filter 7 consists of an optical crystal such as silicon (Si) or barium fluoride (BaF_2) or a polymer such as polyethylene, and has a function of selectively transmitting infrared wavelengths and a dustproof function.

An optical waveguide 8 is a pipe for efficiently focusing thermal radiations from the eardrum of the object, and consists of a metal pipe, e.g., a copper, brass, or stainless steel pipe. The inner surface of the optical waveguide 8 is a mirror surface plated with gold (Au) to have a high reflectance. Even with such a process, the

inner surface of the optical waveguide 8 cannot be made into a blackbody Planckian radiator having a reflectance of 1.00. The inner surface of the optical waveguide 8 therefore has a slight emissivity.

An optical waveguide 9 consists of the same material as that for the optical waveguide 8. The inner surface of the optical waveguide 9 has undergone the same process as that for the optical waveguide 8. However, one end (on the filter 7 side) of the optical waveguide 9 is sealed such that no infrared radiations from the object enter. The optical waveguide 9 is arranged near the optical waveguide 8 to have the same temperature as that of the optical waveguide 8. The condition required for the optical waveguide 9 is that it has the same temperature as that of the optical waveguide 8. That is, the optical waveguide 9 need not consist of the same material as that for the optical waveguide 8, and need not have the same inner surface state as that of the optical waveguide 8.

A first infrared sensor 10 is a sensor for detecting infrared radiations emitted from the object and focused by the optical waveguide 8. This sensor also detects thermal radiations from the optical waveguide 8 itself. In contrast to this, a second infrared sensor 11 detects thermal radiations from the optical waveguide 9 itself because the distal end of the optical waveguide 9 is sealed. The second infrared sensor 11 is arranged near the first infrared sensor 10 to have the same temperature as that of the first

infrared sensor 10. A temperature sensor 12 is a sensor for measuring the temperatures of the first infrared sensor 10 and the second infrared sensor 11.

The principle of the operation using the first and second infrared sensors 10 and 11 will be described below. If the temperature of the optical waveguide 8 is equal to that of the first infrared sensor 10, the first infrared sensor 10 can apparently detect only infrared radiations from the object, even though thermal radiations emitted from the optical waveguide 8. This is because, when the temperature of the optical waveguide 8 is equal to that of the first infrared sensor 10, thermal radiations from the optical waveguide 8 can be neglected in consideration of the balance between the radiations incident on the first infrared sensor 10 and the radiations emitted therefrom. When, however, a temperature difference occurs between the optical waveguide 8 and the first infrared sensor 10, the thermal radiations from the optical waveguide 8 differ from the thermal radiations from the first infrared sensor 10. The first infrared sensor 10 therefore detects both the thermal radiations from the first infrared sensor 10 and the thermal radiations from the optical waveguide 8, and the thermal radiations from the optical waveguide 8 cannot be neglected. For this reason, the radiation clinical thermometer 1 includes the second infrared sensor 11 to detect infrared radiations from the optical waveguide 9 under the same temperature condition as that for the optical

waveguide 8, and subtracts, at a proper ratio, the output from the second infrared sensor 11 from the output from the first infrared sensor 10 on which the influences of the temperature of the optical waveguide 8 are exerted, thereby detecting the infrared radiations from the object which are free from the influences of the temperature of the optical waveguide 8.

Fig. 3 is a schematic block diagram showing the radiation clinical thermometer 1 and a device which perform adjustment of the correction amount for an error (to be referred to as "correction amount adjustment" hereinafter) based on the difference in temperature between the infrared sensor and optical waveguide of the radiation clinical thermometer 1 in Fig. 1.

Referring to Fig. 3, reference numerals 23, 32, and 33 respectively denote an adjusting device, a water thermometer, and a blackbody which are used to perform correction amount adjustment for the radiation clinical thermometer 1.

As will be described later, the blackbody 33 is constituted by a thermostatic chamber, as shown in Fig. 6, and the water thermometer 32 measures the water temperature of the thermostatic chamber, i.e., the temperature of the blackbody 33.

The radiation clinical thermometer 1 comprises an optical waveguide means 13 constituted by the filter 7 and the optical waveguide 8 to focus thermal radiations from an

object to be measured, the first infrared sensor 10, a temperature difference detection means 54 constituted by the optical waveguide 9 and the second infrared sensor 11, the temperature sensor 12, a temperature calculation means 21 for calculating the temperature of the object on the basis of the outputs from the first infrared sensor 10, the second infrared sensor 11, and the temperature sensor 12, and a display means 22 which has the liquid crystal display element 6 and displays the temperature as the calculation result obtained by the temperature calculation means 21. Referring to Fig. 3, the object is the blackbody 33.

The temperature calculation means 21 comprises a temperature difference correction means 18 for correcting the error based on the difference in temperature between the optical waveguide 8 and the first infrared sensor 10, an A-D converter 19 for converting analog data into digital data, and a temperature data calculation means 20 for calculating the temperature data of the object on the basis of the digital output from the temperature difference correction means 18 and the output from the temperature sensor 12. The temperature difference correction means 18 comprises a first initial-stage amplifier 14 for amplifying the detection signal from the first infrared sensor 10, a second initial-stage amplifier 15 for amplifying the detection signal from the second infrared sensor 11, a correction coefficient adjusting means 16 capable of adjusting a correction coefficient for adjusting the detection signal

from the second infrared sensor 11 to a proper value, and a subtraction means 17 for subtracting the detection signal from the second infrared sensor 11, which has been adjusted to the proper value by the correction coefficient adjusting means 16, from the detection signal from the first infrared sensor 10.

The adjusting device 23 comprises a switch 24 for designating the start of correction amount adjustment for the radiation clinical thermometer 1, a timer 25 for monitoring the lapse of a predetermined period of time after the switch 24 is turned on, an adjustment mode notification means 26 for notifying the radiation clinical thermometer 1 that an adjustment mode is being set, a first memory 30 for storing the digital output from the temperature difference correction means 18 which is output through the A-D converter 19, a second memory 31 for storing the digital output from the temperature difference correction means 18 which is output through the A-D converter 19 upon checking the lapse of the predetermined period of time by the timer 25, a comparison means 29 for comparing the value stored in the first memory 30 with the value stored in the second memory 31, a correction coefficient generation means 28 for outputting a new correction coefficient to the correction coefficient adjusting means 16 on the basis of the comparison result obtained by the comparison means 29, and a storage instructing means 27 for instructing the correction coefficient adjusting means 16 to store the

currently set correction coefficient on the basis of the comparison result obtained by the comparison means 29.

In correction amount adjustment, the temperature of the blackbody 33 upon storing the output in the first memory 30 may differ from that upon storing the output in the second memory 31. For this reason, every time correction amount adjustment is performed, the temperature of the blackbody 33 is measured by the water thermometer 32, and the measured water temperature, i.e., the temperature of the blackbody 33, is stored in the first and second memories 30 and 31. The comparison means 29 then compares the value stored in the first memory 30 with the value stored in the second memory 31, considering the water temperature as well.

Fig. 4 is a circuit diagram of the temperature difference correction means 18 in Fig. 3.

The correction coefficient adjusting means 16 and the subtraction means 17 shown in Fig. 3 are realized by an addition circuit 35 in Fig. 4. The correction coefficient adjusting means 16 is realized by a variable resistor whose resistance can be externally changed.

In this embodiment, the temperature difference correction means 18 including the subtraction means 17 is realized by the addition circuit 35. However, since the polarity of the second infrared sensor 11, whose output is input to the addition circuit 35, is opposite that of the first infrared sensor 10, the addition circuit 35 substantially operates to subtract the output from the

second infrared sensor 11 from the output from the first infrared sensor 10. In addition, the initial-stage amplification means 14 and 15 are respectively connected to the outputs of the first and second infrared sensors 10 and 11. However, these means may not be required depending on the degrees of sensor outputs and the performance of the addition circuit 35.

Fig. 5 is a circuit diagram of the addition circuit 35 including the correction coefficient adjusting means 16 in Fig. 4.

As the correction coefficient adjusting means 16, a well-known R-2R ladder resistor type C-A converter may be used, as shown in Fig. 5.

Reference numeral 36 denotes a register in which a correction coefficient is set in accordance with an instruction from the correction coefficient generation means 28; 37, a memory for storing the correction coefficient set in the register 36 in accordance with an instruction from the storage instructing means 27; and 38, a selector for selecting the correction coefficient output from the register 36 upon reception of an adjustment mode notification from the adjustment mode notification means 26, selecting the correction coefficient stored in the memory 37 when receiving no adjustment mode notification from the adjustment mode notification means 26, and ON/OFF-controlling the respective switches connected to the resistors on the basis of the selected correction

coefficient. With this ON/OFF control, the synthetic resistance of the R-2R ladder resistor type C-A converter changes.

Fig. 6 shows the outer appearance of each device in Fig. 3.

The blackbody 33 comprises a heater 46 for heating water 48 filling a thermostatic chamber 44 having a recess (to be referred to as a "blackbody cavity" hereinafter) in which the probe 2 is to be inserted, and an agitator 47 for making the temperature of the water 48 uniform.

Fig. 6 shows a cutaway view of the main body 4 of the radiation clinical thermometer 1 to allow the board on which a battery 42, an IC 43, and the like are mounted to be seen. The radiation clinical thermometer 1 is connected to the adjusting device 23 through a board connector 41 and vertically moved by an elevator 40 connected to the adjusting device 23, so that the probe 2 is inserted into a probe holding member 45 having a high thermal conductivity and kept at almost the same temperature as the water temperature, and fixed in the blackbody cavity. For example, a display section 39 of the adjusting device 23 displays a correction coefficient, a procedure for adjusting the radiation clinical thermometer 1, an adjustment end mark, or the like.

Fig. 7 is a flow chart for explaining the steps in adjusting the correction amount for the radiation clinical thermometer 1 by using the device shown in Fig. 3.

First of all, the radiation clinical thermometer 1 is left to stand in the surroundings so as to keep the first infrared sensor 10, the optical waveguide means 13, and the temperature difference detection means 54 in an isothermal state at almost room temperature (first temperature difference condition) (F-1). The radiation clinical thermometer 1 is then set on the elevator 40 and connected to the adjusting device 23 through the board connector 41. The adjusting device 23 outputs a signal from the adjustment mode notification means 26 to the selector 38 of the correction coefficient adjusting means 16 to instruct the radiation clinical thermometer 1 to operate in the adjustment mode. In the adjustment mode, the selector 38 selects the correction coefficient from the register 36, and a resistance is determined on the basis of this correction coefficient (F-2). Note that in the initial state in which the board connector 41 is connected to the radiation clinical thermometer 1, a predetermined correction coefficient from the correction coefficient generation means 28 is initially set in the register 36 of the correction coefficient adjusting means 16.

When the switch 24 of the adjusting device 23 is turned on, the elevator 40 lowers the radiation clinical thermometer 1 to insert the probe 2 into the probe holding member 45 so as to receive thermal radiations from the blackbody 33 (F-3).

When the probe 2 is fixed to the probe holding member 45, the adjusting device 23 stores, in the first memory 30, the temperature data (first temperature data) output from the A-D converter 19 of the radiation clinical thermometer 1 (F-4). That is, since the optical waveguide 9 and the second infrared sensor 11 are kept in the isothermal state without any temperature difference therebetween, the output from the second infrared sensor 11 becomes zero, and the output from the correction coefficient adjusting means 16 becomes zero regardless of the value of the initially set correction coefficient. With this operation, the first memory 30 stores the measurement result on the temperature of the blackbody 33 in the state in which there is no temperature difference between the optical waveguide means 13 and the first infrared sensor 10 (the first temperature condition).

When the timer 25 operates, and 10 seconds have elapsed (F-5), the temperature data (second temperature data) output from the A-D converter 19 is stored in the second memory 31 (F-6). In this case, since the probe holding member 45 is kept at almost the same temperature as the water temperature, when 10 seconds have elapsed, the temperature of the optical waveguide means 13 near the probe 2 rises. In contrast to this, the first infrared sensor 10 is still kept at almost room temperature because it is spaced apart from the probe holding member 45. For this reason, a temperature difference occurs between the optical

waveguide means 13 and the first infrared sensor 10 (second temperature difference condition). Similarly, a temperature difference occurs between the optical waveguide 9 and the second infrared sensor 11. The second infrared sensor 11 therefore generates an output corresponding to this temperature difference. On the basis of the initially set correction coefficient, the correction coefficient adjusting means 16 generates an output obtained by correcting the output from the second infrared sensor 11. The subtraction means 17 subtracts the corrected output from the second infrared sensor 11 from the output from the first infrared sensor 10. Since the A-D converter 19 converts the output from the subtraction means 17 into a digital value, and outputs the resultant temperature data (second temperature data), the adjusting device 23 stores the second temperature data in the second memory 31.

The comparison means 29 compares the first temperature data stored in the first memory 30 with the second temperature data stored in the second memory 31 (F-7). If the comparison result indicates incoincidence (F-8), the correction coefficient generation means 28 outputs a new correction coefficient to the register 36 of the correction coefficient adjusting means 16 to change the correction coefficient output from the register 36 (F-9). The above processing is then performed again, starting from the sampling of the second temperature data (F-6). That is, the comparison result indicating incoincidence means that

the second temperature data stored under the second temperature difference condition differs from the first temperature data stored under the first temperature difference condition in which there is no temperature difference between the first infrared sensor 10 and the optical waveguide means 13. That the first and second temperature data, which should be equal to each other, differ from each other indicates that the correction amount for the second infrared sensor 11 is not correct. Therefore, until a correct correction amount is determined, the correction coefficient is changed to find the resistance of, the correction coefficient adjusting means 16, which makes the temperature of the blackbody 33, measured by the radiation clinical thermometer 1, uniform even if the temperature difference condition changes.

If it is determined in step (F-8) that the comparison result indicates incoincidence, the storage instructing means 27 outputs a signal to the memory 37 of the correction coefficient adjusting means 16 to record, on the memory 37, the correction coefficient currently set in the register 36 (F-10). The radiation clinical thermometer 1 is then raised by the elevator 40 and removed from the board connector 41 (F-11). When the radiation clinical thermometer 1 is disconnected from the adjusting device 23 in this manner, no signal indicating the adjustment mode is output to the selector 38 of the correction coefficient adjusting means 16. As a result, the selector 38 selects

the correction coefficient from the memory 37, and a resistance is determined on the basis of this correction coefficient.

The temperature of the blackbody 33 under the first temperature difference condition may be slightly different from that under the second temperature difference condition. It suffices, therefore, if the actual temperature of the blackbody 33 is measured by the water thermometer 32 and stored in the first and second memories 30 and 31 every time the first and second temperature data are obtained, and the comparison means 29 compares the first and second temperature data with each other, considering the actual temperature. Even if there is no temperature difference between the first infrared sensor 10 and the optical waveguide means 13, the output from the A-D converter 19 changes as the temperature of the blackbody 33 changes. If, therefore, there is a difference between the temperature of the blackbody 33 upon storage of the first temperature data and the temperature of the blackbody 33 upon storage of the second temperature data, the first and second temperature data may be adjusted in accordance with this difference.

In this embodiment, the first temperature difference condition is the condition in which the optical waveguide means 13 and the first infrared sensor 10 are set in an isothermal state. However, the present invention is not limited to this; a predetermined temperature difference may be set.

In this embodiment, under the two types of temperature difference conditions, i.e., the first and second temperature difference conditions, the correction amount is adjusted such that the temperature of the blackbody 33 which is measured by the radiation clinical thermometer 1 is made uniform. However, the present invention is not limited to this; adjustment may be performed such that the temperature of the blackbody 33 which is measured by the radiation clinical thermometer 1 is made uniform under three or more types of temperature difference conditions.

In this embodiment, the adjusting device 23 adjusts the correction amount until the first temperature data becomes equal to the second temperature data. However, the present invention is not limited to this; adjustment may be performed such that the difference between the first and second temperature data falls within a predetermined range (in which the measurement accuracy is not affected).

In this embodiment, the second temperature difference condition is set by causing the probe holding member 45 in the blackbody 33 to hold the probe 2 for a predetermined period of time. However, the present invention is not limited to this; the probe 2 may be heated by a heater block 49 heated by a heater device 50 to set the second temperature difference condition, as shown in Fig. 8.

In this embodiment, the addition circuit 35 incorporates the correction coefficient adjusting means 16,

as shown in Fig. 4. However, the present invention is not limited to this. For example, as shown in Fig. 9, a second initial-stage amplification means 51 may incorporate a correction coefficient adjusting means 34.

As shown in Fig. 3, this embodiment includes the correction coefficient adjusting means 16 for adjusting the correction coefficient for the signal output from the second infrared sensor 11, and the adjusted output from the second infrared sensor 11 is subtracted from the output from the first infrared sensor 10. However, the present invention is not limited to this. For example, as shown in Fig. 10, a correction coefficient adjusting means 83 may be used to adjust the output from the first infrared sensor 10 to a proper ratio, and the adjusted output from the first infrared sensor 10 may subtract from the output from the second infrared sensor 11, thereby detecting infrared radiations from the object without any influences of the temperature of the optical waveguide 8. Fig. 11 is a circuit diagram of a temperature difference correction means 85 in Fig. 10 which corresponds to this arrangement.

In this embodiment, the first and second temperature data are obtained from the outputs from the A-D converter 19. However, the present invention is not limited to this. For example, as indicated by the dotted arrows in Figs. 3 and 10, the outputs from the temperature data calculation means 20 may be obtained as the first and second temperature data.

Although the first and second memories 30 and 31, the comparison means 29, and the like are arranged in the adjusting device 23, these components may be arranged in the radiation clinical thermometer 1.

Fig. 12 is a schematic block diagram showing a radiation clinical thermometer 55 and a device which perform correction amount adjustment for the radiation clinical thermometer according to the second embodiment of the present invention. The same reference numerals in Fig. 12 denote the same parts as in Fig. 3, and a description thereof will be omitted.

In this embodiment, A-D converters 57 and 56 in a temperature difference correction means 61 perform digital conversion on the input stages of a correction coefficient adjusting means 59 and a subtraction means 60. Reference numeral 58 denotes an A-D converter for converting the output from a temperature sensor 12 into digital data.

Fig. 13 is a block diagram showing the correction coefficient adjusting means 59 and the subtraction means 60 in Fig. 12.

The correction coefficient adjusting means 59 comprises a contribution setting means 63 for setting and outputting a contribution on the basis of the signals from an adjustment mode notification means 26, a storage instructing means 27, and a correction coefficient generation means 28, a multiplication circuit 64 for calculating the corrected output from a second infrared

sensor 11 by multiplying the contribution from the contribution setting means 63 and the output from the A-D converter 57 which is recorded on a memory 66, and the memory 66 for storing the corrected output from the second infrared sensor 11 in place of the output from the second infrared sensor 11.

The subtraction means 60 comprises a memory 65 for storing the output from the A-D converter 56, and a subtraction circuit 67 for subtracting the corrected output from the second infrared sensor 11, stored in the memory 66, from the output from a first infrared sensor 10, stored in the memory 65.

In this embodiment, correction amount adjustment is performed as follows. First of all, the contribution setting means 63 sets a contribution on the basis of the correction coefficient from the correction coefficient generation means 28. The multiplication circuit 64 then corrects the output from the second infrared sensor 11 on the basis of the set contribution. The subtraction circuit 67 subtracts the corrected output from the second infrared sensor 11 from the output from the first infrared sensor 10. In this case, adjustment is performed until a contribution that makes the outputs from the subtraction circuit 67, stored in first and second memories 30 and 31, uniform under the first and second temperature difference conditions is determined. Since the manner of setting the temperature

difference conditions is the same as in the first embodiment, a description thereof will be omitted.

This embodiment includes the correction coefficient adjusting means 59 for adjusting the correction coefficient for the signal from the second infrared sensor 11, as shown in Fig. 12. However, the present invention is not limited to this. For example, the embodiment may include a correction coefficient adjusting means for adjusting the correction coefficient for the signal from the first infrared sensor 10.

Fig. 14 is a partially cutaway sectional view of the probe of a radiation clinical thermometer according to the third embodiment of the present invention. The same reference numerals in Fig. 14 denote the same parts as in Fig. 2, and a description thereof will be omitted.

In the first and second embodiments, the temperature difference detection means 54 is constituted by the optical waveguide 9 and the second infrared sensor 11. In this embodiment, a temperature difference detection means is constituted by a second temperature sensor 69 for measuring the temperature of an optical waveguide 70 and a first temperature sensor 72 for measuring the temperature of an infrared sensor 71.

Reference numeral 70 denotes the optical waveguide for efficiently focusing thermal radiations from the eardrum of an object to be measured. This optical waveguide consists of the same material as that for the optical

waveguide 8 in Fig. 2, and has undergone the same inner surface process as that of the waveguide 8. Reference numeral 69 denotes a second temperature sensor for measuring the temperature of the optical waveguide 70; and 71, a sensor for detecting thermal radiations emitted from the object and focused by the optical waveguide 70. This sensor also detects thermal radiations from the optical waveguide 70 itself when there is a temperature difference between the infrared sensor 71 and the optical waveguide 70. Reference numeral 72 denotes a first temperature sensor for measuring the temperature of the infrared sensor 71.

Fig. 15 is a schematic block diagram showing a radiation clinical thermometer 73 and a device which perform correction amount adjustment for the radiation clinical thermometer in Fig. 14. The same reference numerals in Fig. 15 denote the same parts as in Fig. 3, and a description thereof will be omitted.

Referring to Fig. 15, the radiation clinical thermometer 73 comprises an optical waveguide means 74 which are constituted by a filter 7 and the optical waveguide 70 to focus thermal radiations from a blackbody 33, the infrared sensor 71, the temperature difference detection means 75 constituted by the second temperature sensor 69 and the first temperature sensor 72, a temperature calculation means 81 for calculating the temperature of the object on the basis of the outputs from the temperature difference detection means 75, the infrared sensor 71, and the first

temperature sensor 72, and a display means 22 for displaying the temperature as the calculation result obtained by the temperature calculation means 81.

The temperature calculation means 81 comprises a temperature difference correction means 79 for correcting the error based on the difference in temperature between the optical waveguide 70 and the infrared sensor 71, an A-D converter 80 for converting analog data into digital data, and a temperature data calculation means 20 for calculating the temperature data of the object on the basis of the digital output from the temperature difference correction means 79 and the output from the first temperature sensor 72. The temperature difference correction means 79 comprises an initial-stage amplification means 77 for amplifying the detection signal from the infrared sensor 71, a correction coefficient adjusting means 76 for adjusting the correction coefficient to correct the error based on the temperature difference, and a subtraction means 78 for subtracting the detection signal from the temperature difference detection means 75, which is adjusted to a proper value by the correction coefficient adjusting means 76, from the detection signal from the infrared sensor 71.

Fig. 16 is a circuit diagram showing the temperature difference correction means 79 and the temperature difference detection means 75 in Fig. 15.

The correction coefficient adjusting means 76 and the subtraction means 78 are realized by an addition circuit

82 in Fig. 16. Similar to the correction coefficient adjusting means 16 in Fig. 5, as the correction coefficient adjusting means 76, an R-2R ladder resistor type C-A converter may be used. The correction coefficient adjusting means 76 includes a register 36 in which a correction coefficient is set in accordance with an instruction from a correction coefficient generation means 28, a memory 37 for storing the correction coefficient set in the register 36, in accordance with an instruction from the storage instructing means 27, and a selector 38 for selecting the correction coefficient output from the register 36 upon reception of an adjustment mode notification from an adjustment mode notification means 26, selecting the correction coefficient stored in the memory 37 when receiving no adjustment mode notification from the adjustment mode notification means 26, and ON/OFF-controlling the respective switches connected to the resistors on the basis of the selected correction coefficient. With this ON/OFF control, the synthetic resistance of the R-2R ladder resistor type C-A converter changes.

In the temperature difference detection means 75, the first temperature sensor 72 and the second temperature sensor 69 are series-connected, and the two terminals of this series circuit are respectively connected to a (+) power supply and a (-) power supply. These power supplies are set to +2.5 V and -2.5 V, i.e., the same voltage with

respect to the reference voltage. The temperature difference detection means 75 outputs a temperature difference signal Td having undergone voltage division at the first temperature sensor 72 and the second temperature sensor 69. Note that the two temperature sensors 72 and 69 consist of thermistors having similar electrical characteristics.

In this embodiment, correction amount adjustment is performed as follows. First of all, a correction coefficient is set in the register 36 in accordance with an instruction from the correction coefficient generation means 28. The resistance of the correction coefficient adjusting means 76 is then determined on the basis of this correction coefficient. The temperature difference signal Td from the temperature difference detection means 75 becomes a corrected temperature difference signal through the correction coefficient adjusting means 76. The subtraction means 78 subtracts the corrected temperature difference signal from the output from the infrared sensor 71 which is amplified by the initial-stage amplification means 77. In this case, adjustment is performed until a correction coefficient that makes the outputs from the A-D converter 80, stored in first and second memories 30 and 31, equal to each other is determined. Since the manner of setting the temperature difference conditions is the same as in the first embodiment, a description thereof will be omitted.

This embodiment includes the correction coefficient adjusting means 76 for adjusting the correction coefficient for the signal from the temperature difference detection means 75, as shown in Fig. 15. However, the present invention is not limited to this. For example, the embodiment may include a correction coefficient adjusting means for adjusting the correction coefficient for the signal from the infrared sensor 71.

In the present invention, as each infrared sensor, for example, a sensor using a thermopile or a pyroelectric element may be used. In addition, the temperature sensors are not limited to the thermistors, and any elements can be used as long as they have temperature characteristics. For example, diodes may be used.

[Industrial Applicability]

Although the present invention has been disclosed for the radiation clinical thermometers, the invention can be applied to general radiation thermometers.



C L A I M S

1. A radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference,

characterized in that said temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal or the infrared detection signal.

2. A radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference





temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference,

characterized in that said temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal.

3. A radiation clinical thermometer according to claim 2, characterized in that said temperature calculation means comprises temperature difference correction means for subtracting the temperature difference signal from the infrared detection signal, and temperature data calculation means for calculating the temperature data on the basis of an output signal from said temperature difference correction means and the reference temperature signal, said temperature difference correction means including said correction coefficient adjusting means.

4. A radiation clinical thermometer according to claim 3, characterized in that said temperature difference correction means comprises subtraction means for subtracting the temperature difference signal from the infrared



detection signal in an analog manner, and said correction coefficient adjusting means comprises adjusting means for adjusting a contribution of the temperature difference signal with respect to said subtraction means.

5. A radiation clinical thermometer according to claim 4, characterized in that said subtraction means comprises an addition circuit constituted by an operational amplifier for receiving the infrared detection signal and the temperature difference signal, and said correction coefficient adjusting means comprises resistance adjusting means for changing a resistance of a temperature difference signal input resistor.

6. A radiation clinical thermometer according to claim 5, characterized in that said resistance adjusting means comprises a plurality of resistors, switching means for switching and connecting said resistors, and a control circuit for controlling said switching means.

7. A radiation clinical thermometer according to claim 3, characterized in that said temperature difference correction means comprises subtraction means for subtracting the temperature difference signal from the infrared detection signal in a digital manner, and said correction coefficient adjusting means comprises adjusting means for adjusting a contribution of the temperature difference signal with respect to said subtraction means.

8. A radiation clinical thermometer according to claim 7, characterized in that said subtraction means comprises an



infrared detection signal memory and a temperature difference signal memory for storing the infrared detection signal and the temperature difference signal as digital values, respectively, and a digital subtraction circuit for subtracting data in said two memories from each other, and said correction coefficient adjusting means comprises a multiplication circuit for multiplying the value stored in said temperature difference signal memory by the contribution, and contribution setting means for setting the contribution.

9. A radiation clinical thermometer according to claim 3, characterized in that said optical waveguide means comprises a first optical waveguide portion having an open distal end, said infrared sensor comprises a first infrared sensor arranged at a proximal end of said first optical waveguide portion, and said temperature difference detection means comprises a second optical waveguide portion kept in substantially the same temperature state as that for said first optical waveguide portion and having a sealed distal end, and a second infrared sensor arranged at a proximal end of said second optical waveguide portion.

10. A radiation clinical thermometer according to claim 3, characterized in that said optical waveguide means comprises an optical waveguide member having an open distal end, said infrared sensor comprises a thermopile arranged at a proximal end of said optical waveguide member, and said temperature difference detection means comprises a first



temperature sensor for measuring a temperature of said optical waveguide member and a second temperature sensor for measuring a temperature of said thermopile.

11. A radiation clinical thermometer according to claim 9, characterized in that said temperature difference correction means comprises subtraction means for subtracting the infrared detection signal output from said first infrared sensor and the temperature difference signal output from said second infrared sensor from each other in an analog manner, and said correction coefficient adjusting means comprises adjusting means for adjusting a contribution of the temperature difference signal with respect to said subtraction means.

12. A radiation clinical thermometer according to claim 11, characterized in that said subtraction means comprises an addition circuit constituted by an operational amplifier for receiving the infrared detection signal and the temperature difference, and said correction coefficient adjusting means comprises resistance adjusting means for changing a resistance of a temperature difference signal input resistor.

13. A radiation clinical thermometer according to claim 12, characterized in that said resistance adjusting means comprises a plurality of resistors, switching means for switching and connecting said resistors, and a control circuit for controlling said switching means.



14. A radiation clinical thermometer according to claim 9, characterized in that said temperature difference correction means comprises first initial-stage amplification means for amplifying the infrared detection signal output from said first thermopile, second initial-stage amplification means for amplifying the temperature difference signal output from said second thermopile, and subtraction means for subtracting, in an analog manner, the temperature difference signal output from said second initial-stage amplification means from the infrared detection signal output from said first initial-stage amplification means, and said correction coefficient adjusting means comprises an amplification factor adjusting means for said second initial-stage amplification means.

15. A radiation clinical thermometer according to claim 2, characterized in that said correction coefficient adjusting means is adjusted on the basis of a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means and a second output data signal output under a second temperature difference condition for said infrared sensor and said optical waveguide means.

16. A radiation clinical thermometer according to claim 15, characterized in that the first temperature difference condition is a condition in which a temperature of said infrared sensor is substantially equal to a temperature of said optical waveguide means, and the second temperature





difference condition is a condition in which the temperature of said infrared sensor differs from the temperature of said optical waveguide means.

17. A radiation clinical thermometer according to claim 15, characterized in that the second temperature difference condition is set by heating said optical waveguide means.

18. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference, characterized by comprising

the step of arranging temperature difference correction means for adjusting a contribution of the temperature difference signal or the infrared detection signal based on a temperature difference between said infrared sensor and said optical waveguide means, and



arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature difference condition for said infrared sensor and said optical waveguide means, the step of comparing the first and second output data and outputting comparison data, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the first output data signal coincides with the second output data signal.

19. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature



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data signal by correcting an error based on the temperature difference, characterized by comprising

the step of arranging temperature measuring means for measuring a temperature of a blackbody, and temperature difference correction means for adjusting a contribution of the temperature difference signal or the infrared detection signal based on a temperature difference between said infrared sensor and said optical waveguide means, and arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature difference condition for said infrared sensor and said optical waveguide means, the step of measuring a measurement temperature difference between a measurement temperature of the blackbody under the first temperature difference condition and a measurement temperature of the blackbody under the second temperature difference condition, the step of outputting a temperature difference between the first output data signal and the second output data signal, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the temperature difference coincides with the measurement temperature difference.





20. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference, characterized by comprising

the step of arranging temperature difference correction means for adjusting a contribution of the temperature difference signal based on a temperature difference between said infrared sensor and said optical waveguide means, and arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature





difference condition for said infrared sensor and said optical waveguide means, the step of comparing the first and second output data and outputting comparison data, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the first output data signal coincides with the second output data signal.

21. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference, characterized by comprising

the step of arranging temperature measuring means for measuring a temperature of a blackbody, and temperature difference correction means for adjusting a contribution of the temperature difference signal based on a temperature



difference between said infrared sensor and said optical waveguide means, and arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature difference condition for said infrared sensor and said optical waveguide means, the step of measuring a measurement temperature difference between a measurement temperature of the blackbody under the first temperature difference condition and a measurement temperature of the blackbody under the second temperature difference condition, the step of outputting a temperature difference between the first output data signal and the second output data signal, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the temperature difference coincides with the measurement temperature difference.

22. A temperature error correction method for a radiation clinical thermometer according to claim 20 or 21, characterized in that the first temperature difference condition is a condition in which a temperature of said infrared sensor is substantially equal to a temperature of said optical waveguide means, and the second temperature difference condition is a condition in which the temperature



of said infrared sensor differs from the temperature of said optical waveguide means.

23. A temperature error correction method for a radiation clinical thermometer according to claim 20 or 21, characterized in that the second temperature difference condition is set by heating said optical waveguide means.

24. A temperature error correction method for a radiation clinical thermometer according to claim 20 or 21, characterized in that said temperature correction means comprises an addition circuit constituted by an operational amplifier for receiving the infrared detection signal and the temperature difference signal, the step of adjusting said temperature difference correction means comprises adjusting a resistance of a temperature difference signal input resistor of said operational amplifier.

25. A temperature error correction method for a radiation clinical thermometer according to claim 24, characterized in that the first and second output data signals are output signals from said operational amplifier constituting said addition circuit.

26. A temperature error correction method for a radiation clinical thermometer according to claim 20 or 21, characterized in that the first and second output data signals are temperature data signals.



A B S T R A C T

It is an object of the present invention to provide a radiation clinical thermometer which can improve the accuracy of a body temperature as a measurement result.

In order to achieve this object, according to the present invention, there is provided a radiation clinical thermometer including an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to the infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between the infrared sensor and the optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error based on the temperature difference, wherein the temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal.

According to the present invention, since the temperature calculation means includes the correction

coefficient adjusting means for adjusting the correction coefficient for the temperature difference signal from the temperature difference detection means for detecting the temperature difference between the infrared sensor and the optical waveguide means, a radiation clinical thermometer can be provided, which can calculate temperature data upon properly adjusting the error amount based on the temperature difference between the infrared sensor and the optical waveguide means, and improves the measurement accuracy.

FIG. 1

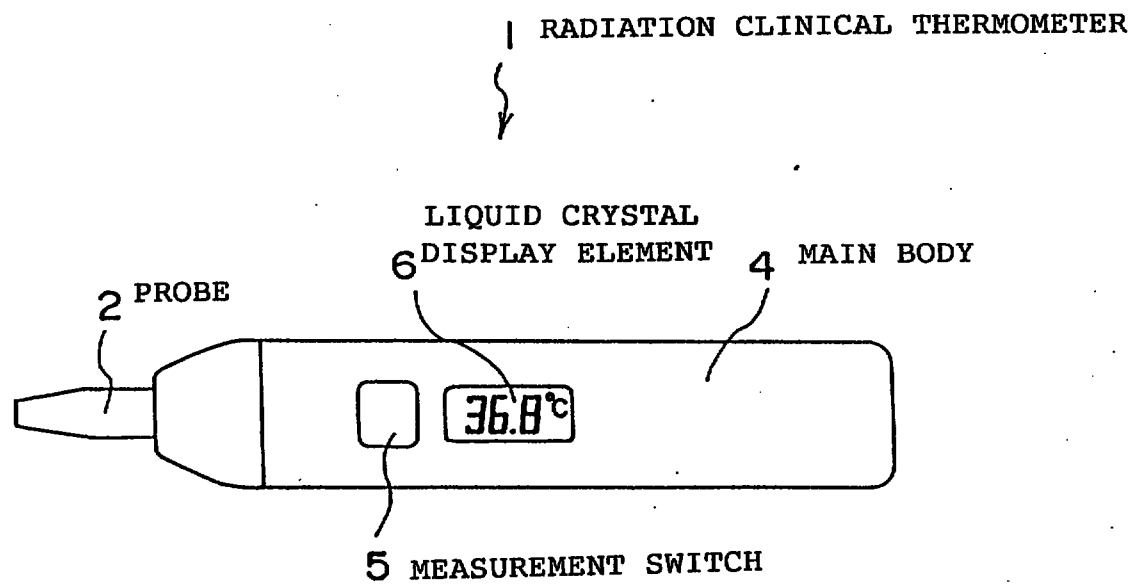


FIG. 2.

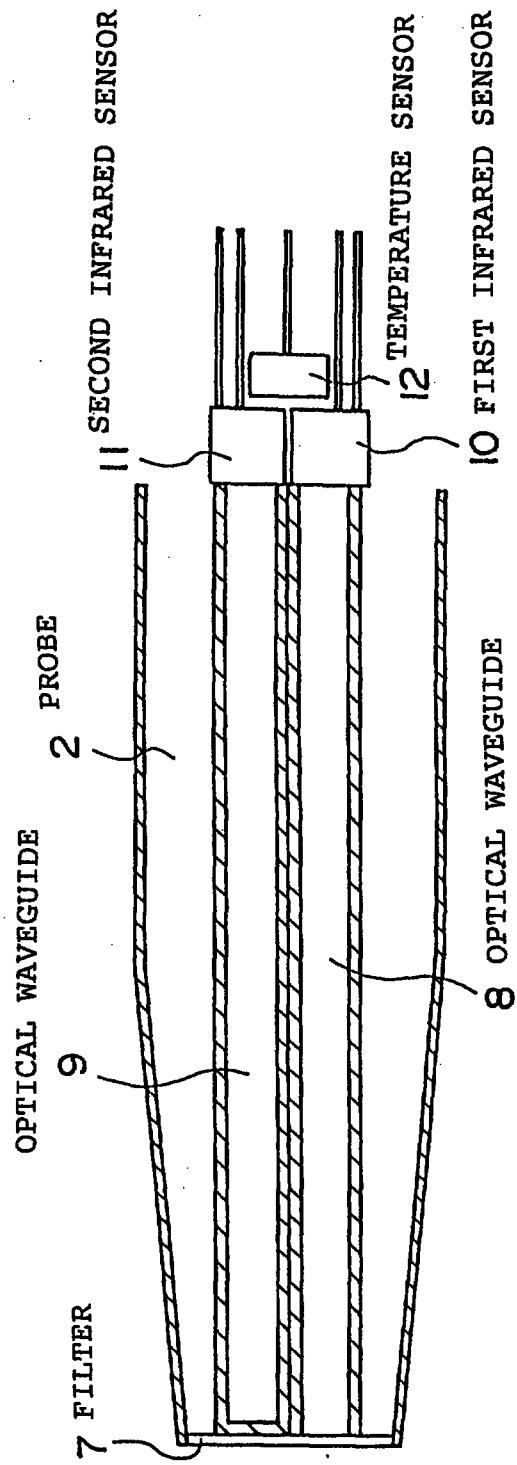
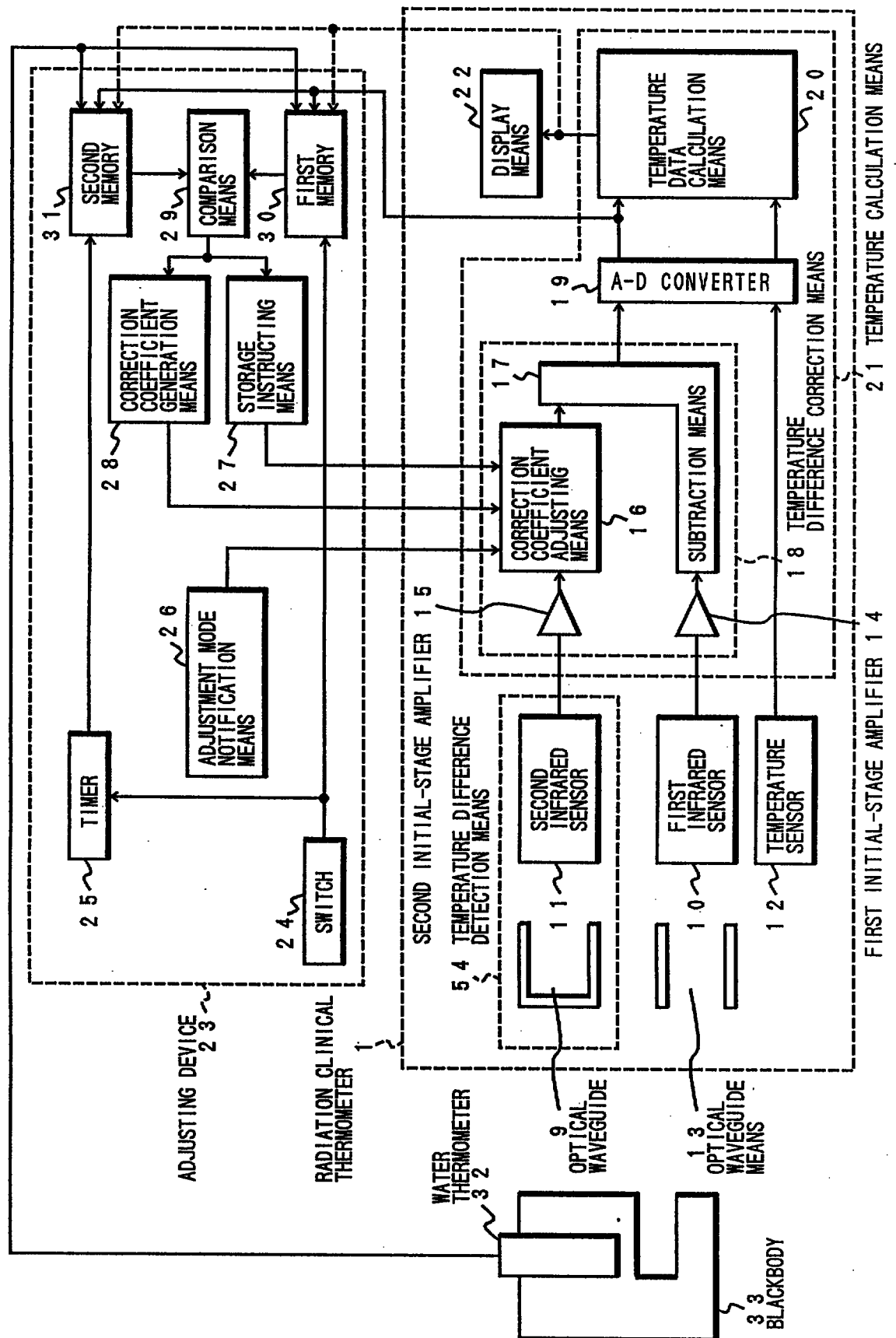


FIG. 3



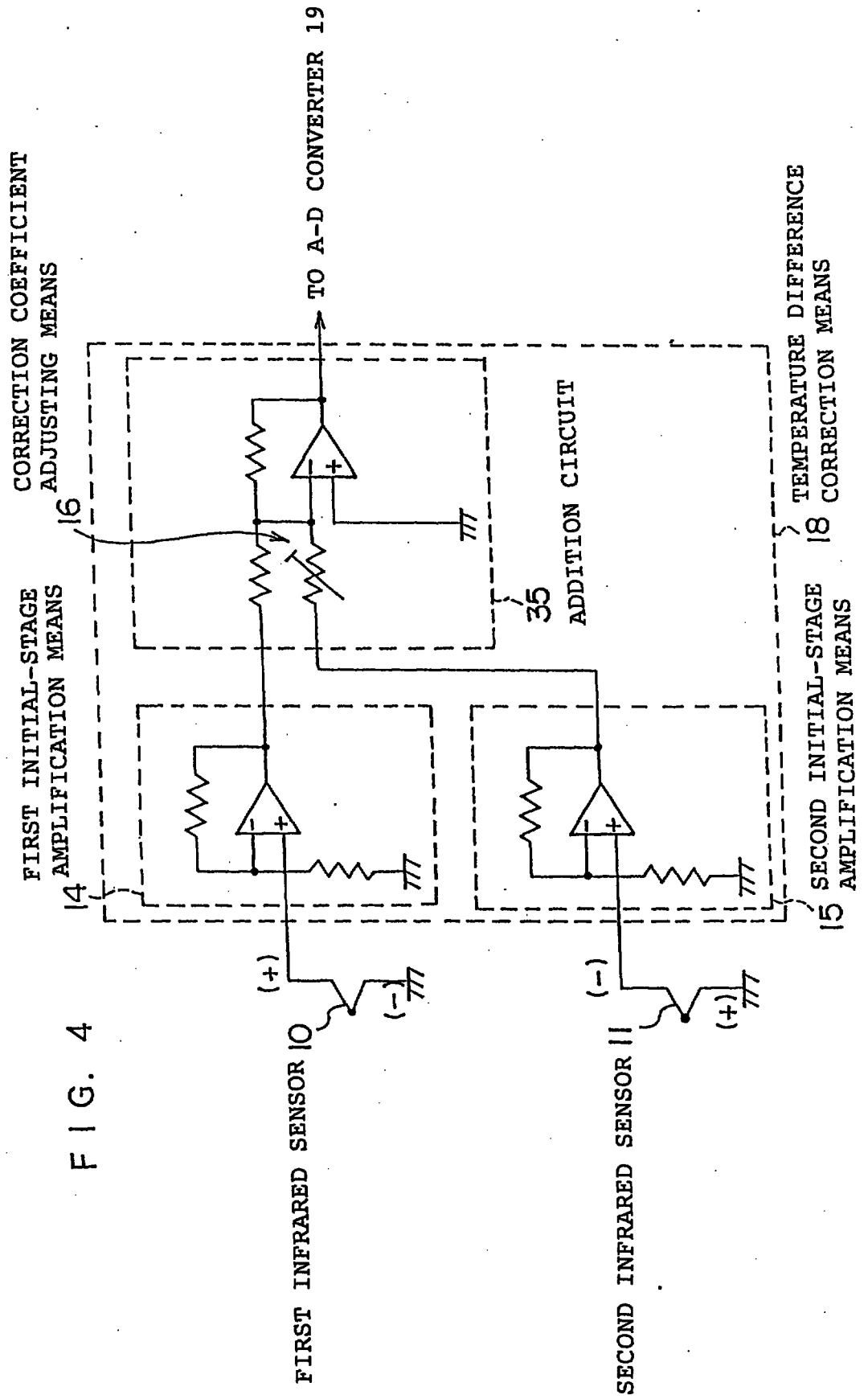


FIG. 5

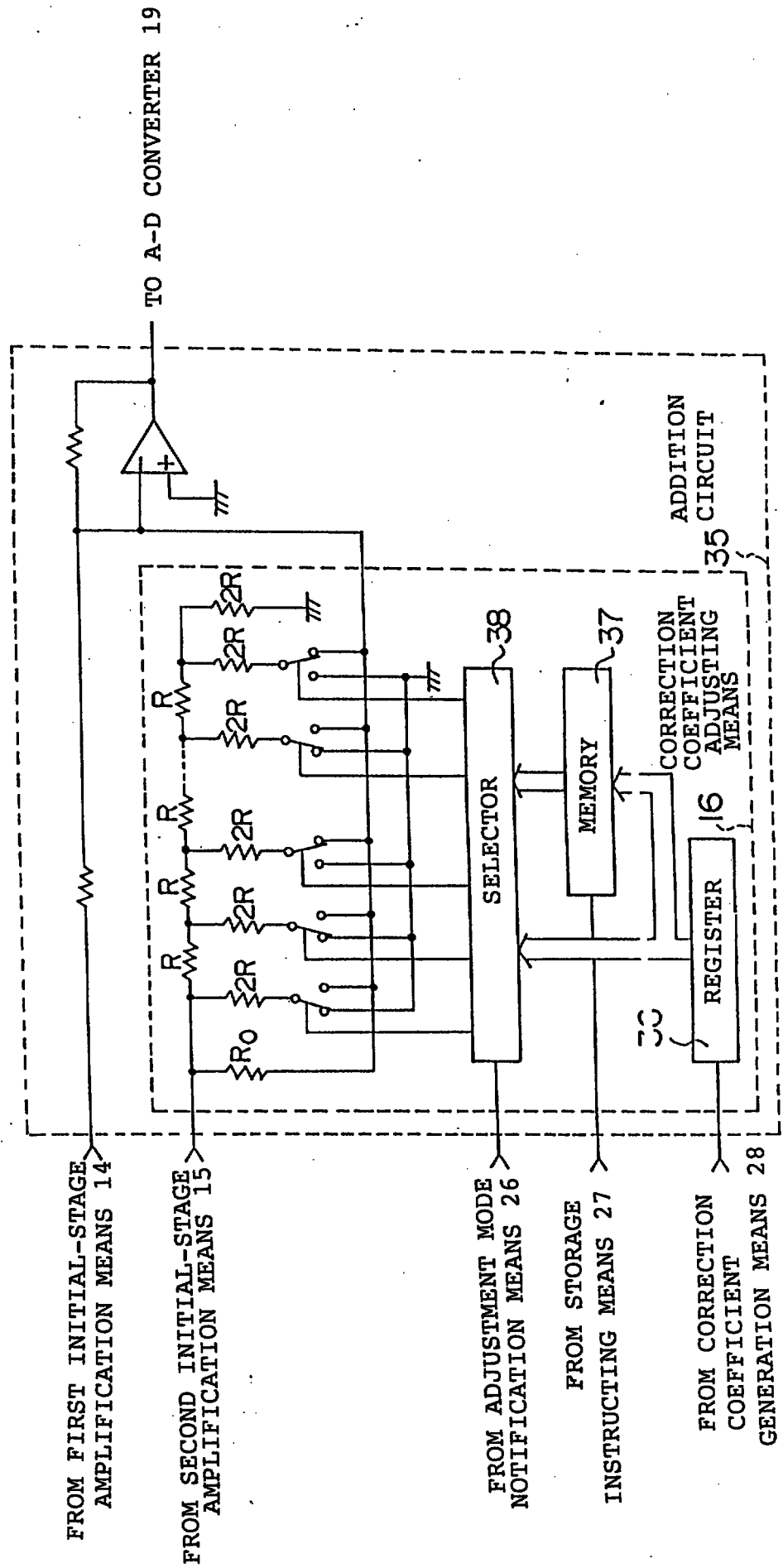


FIG. 6

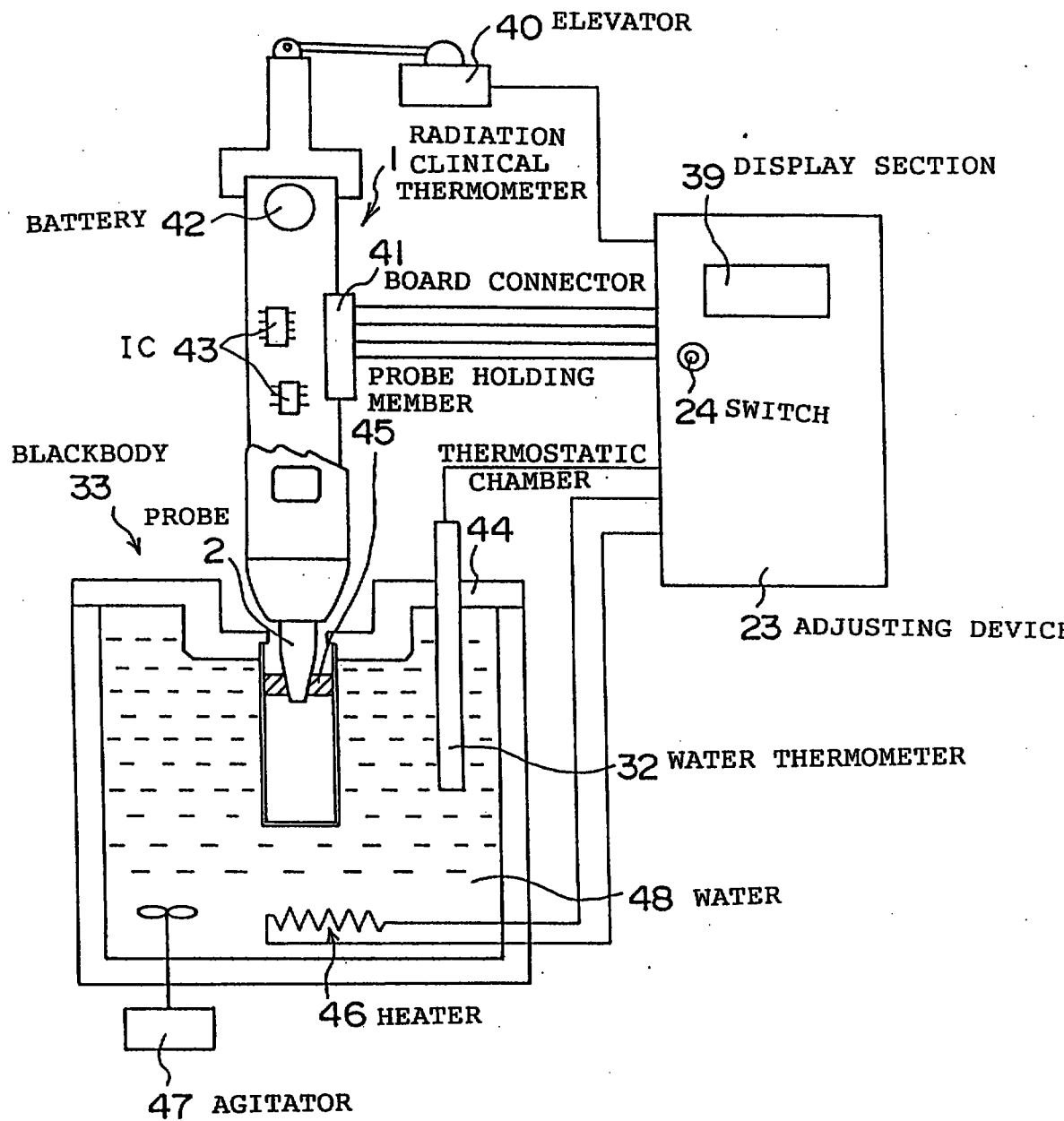


FIG. 7

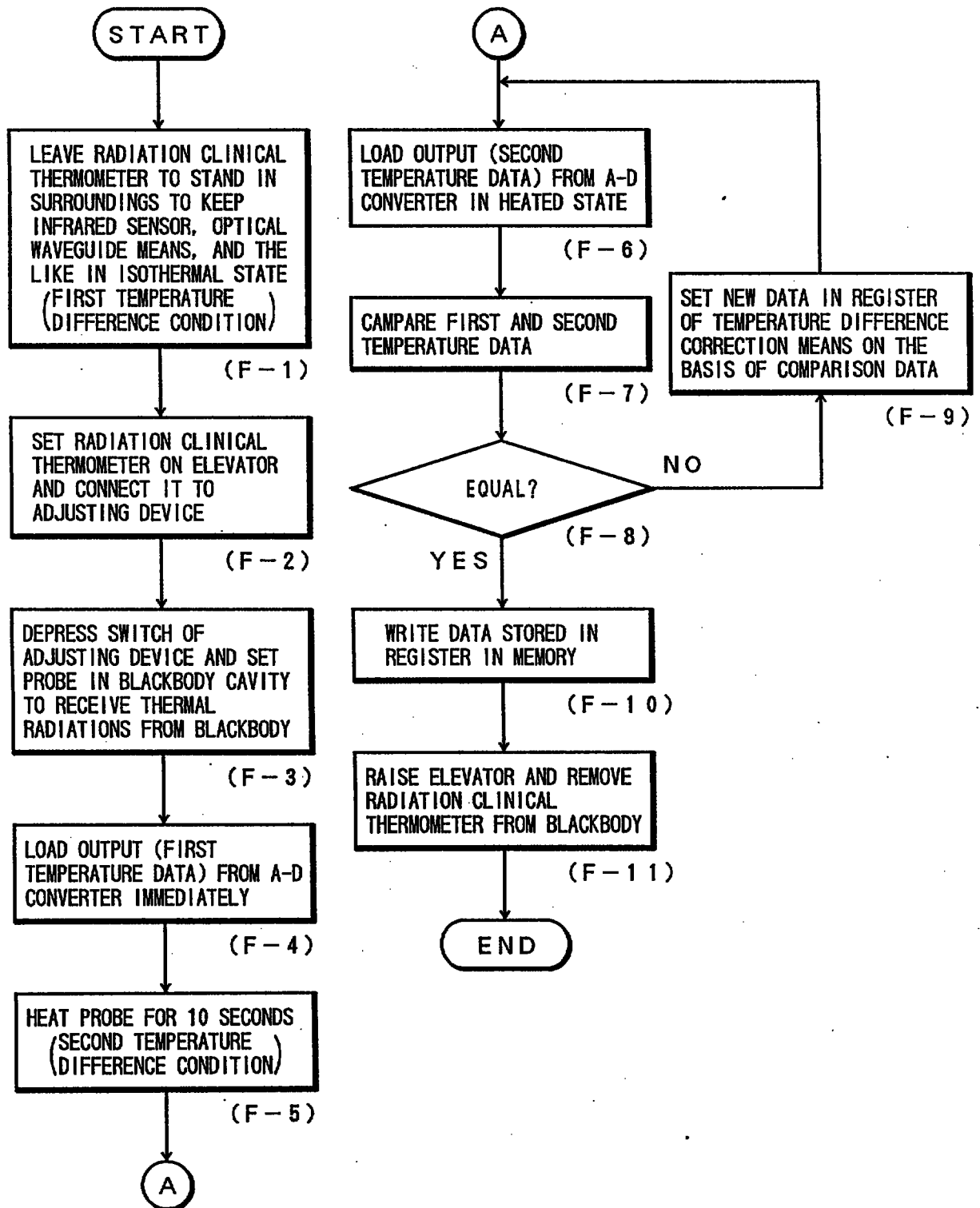
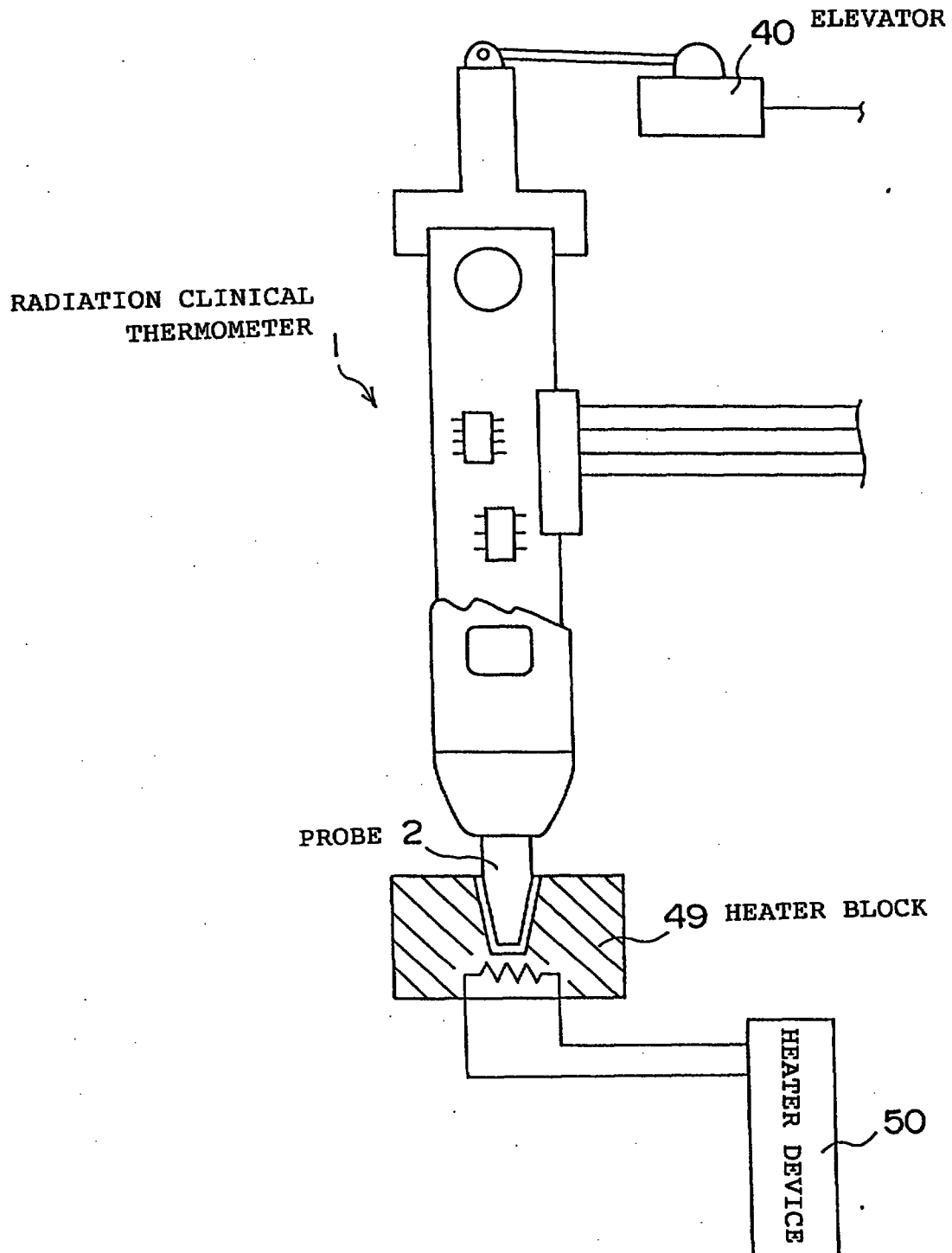


FIG. 8



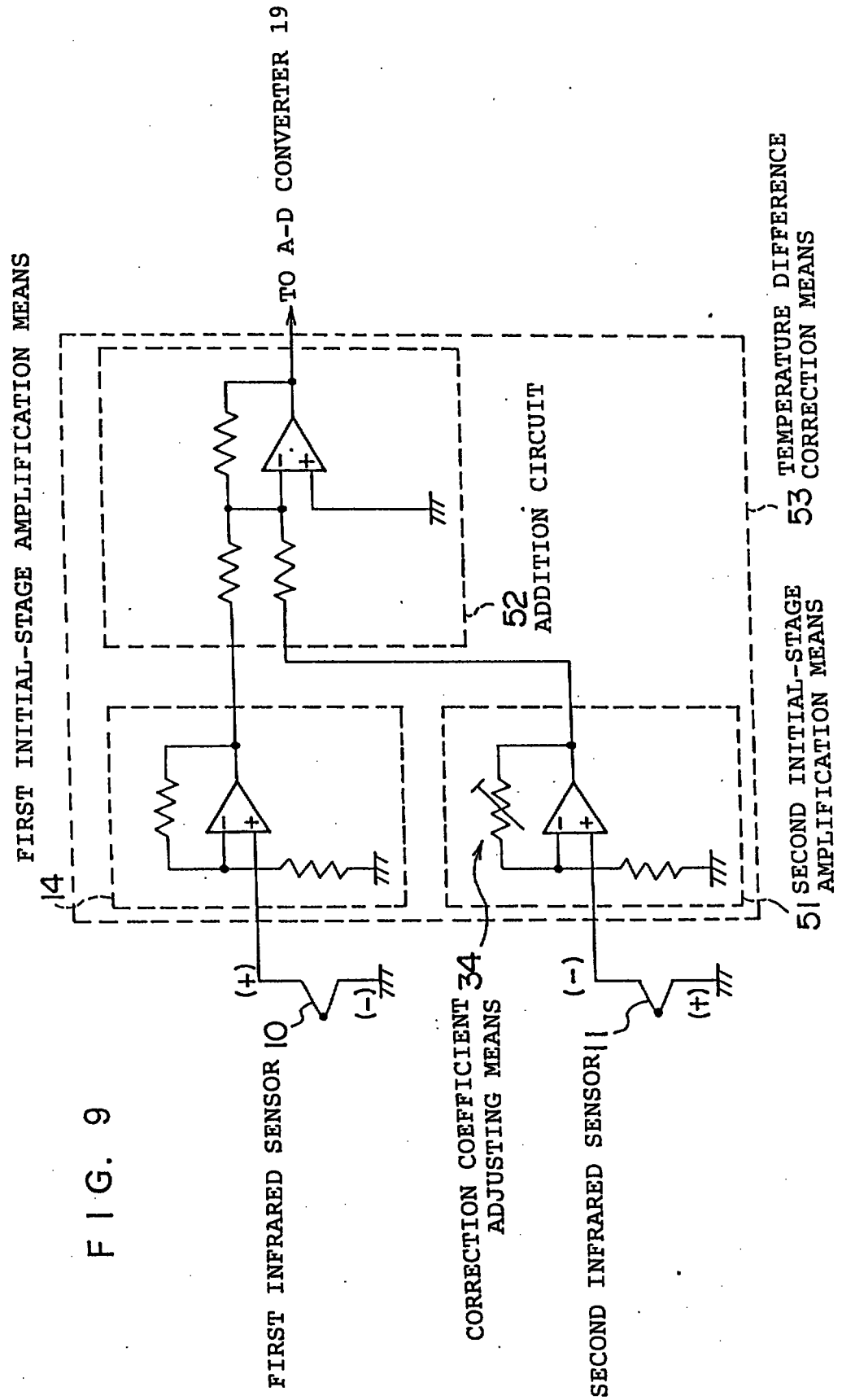
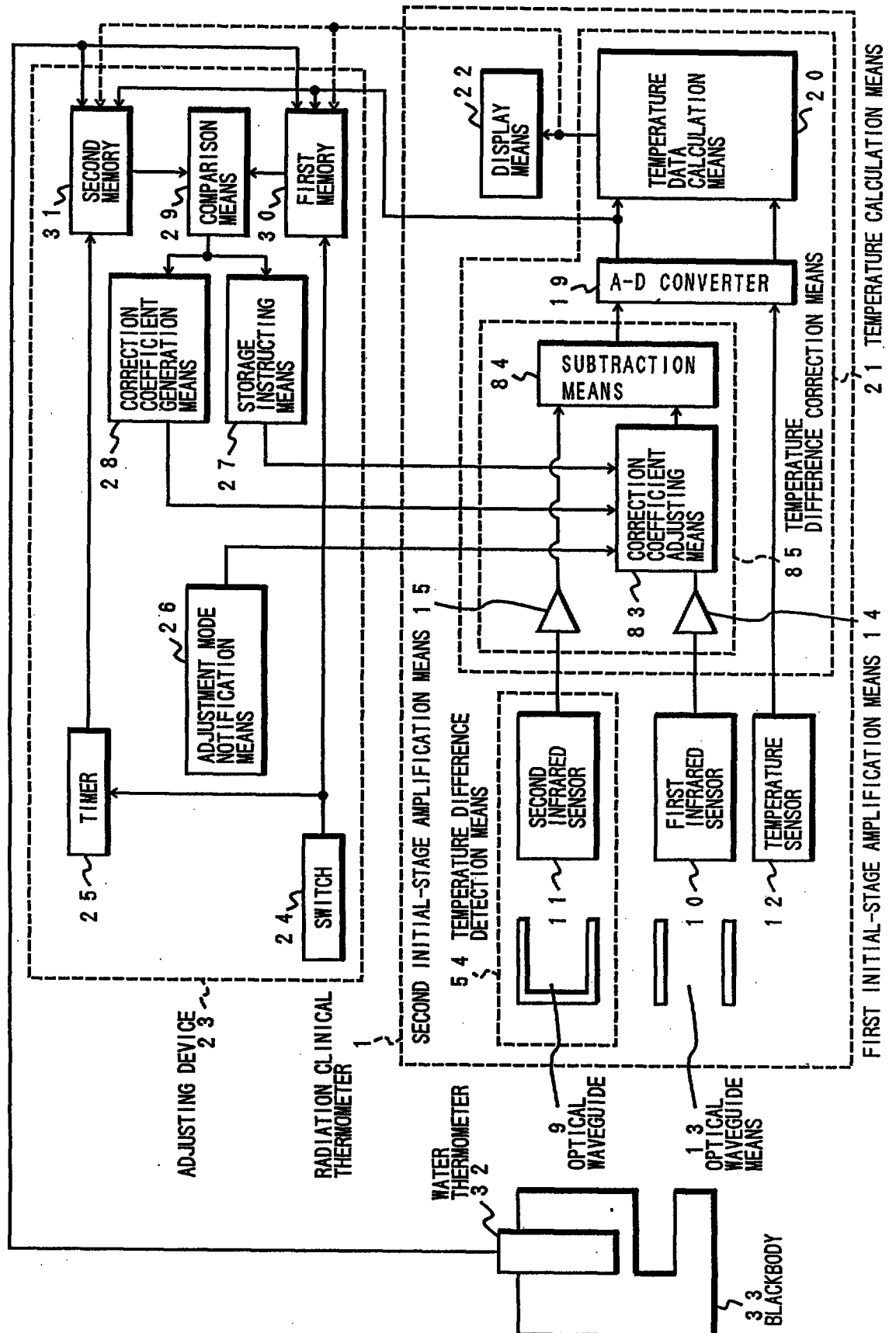


FIG. 10



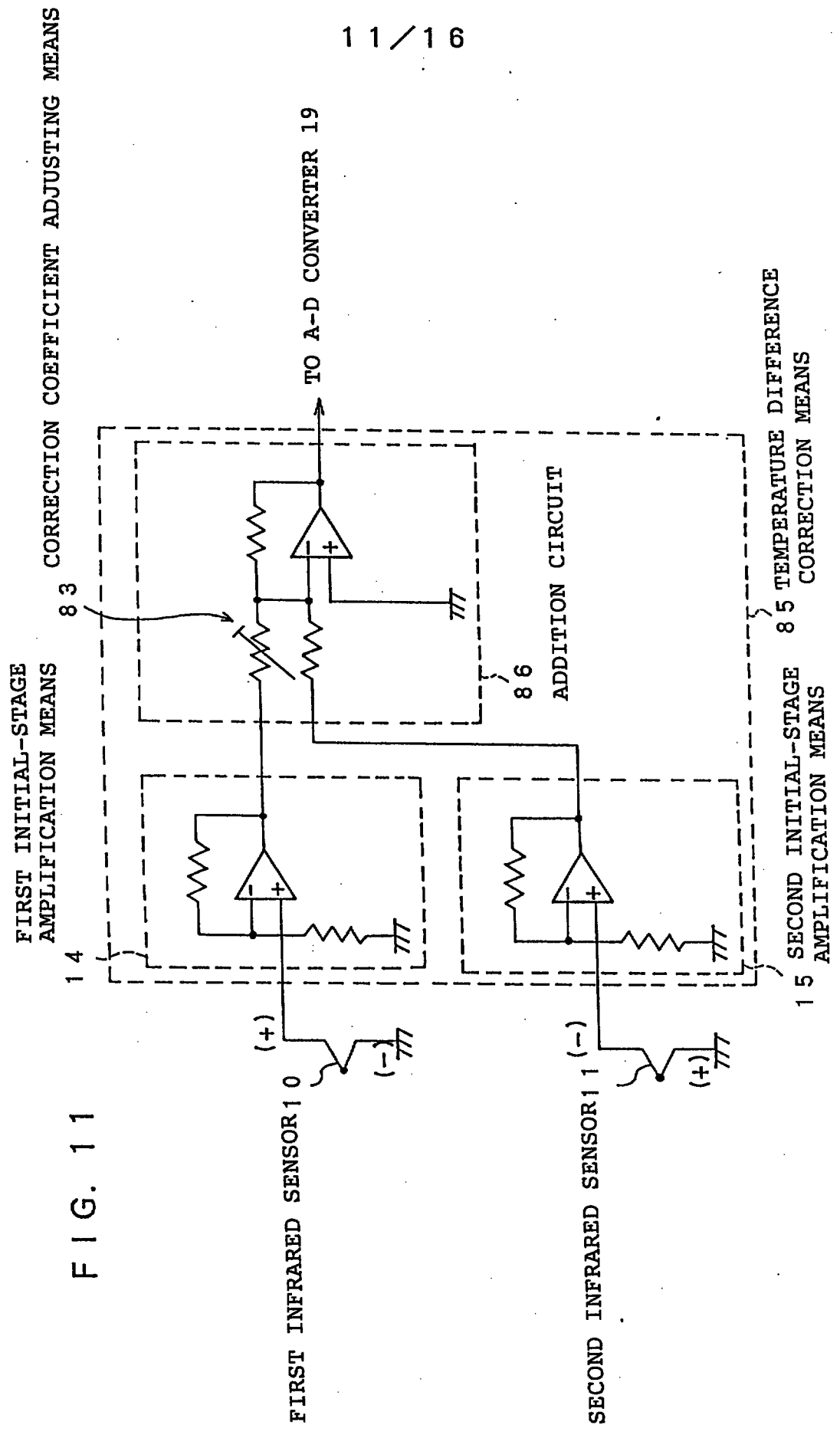


FIG. 11

FIG. 12

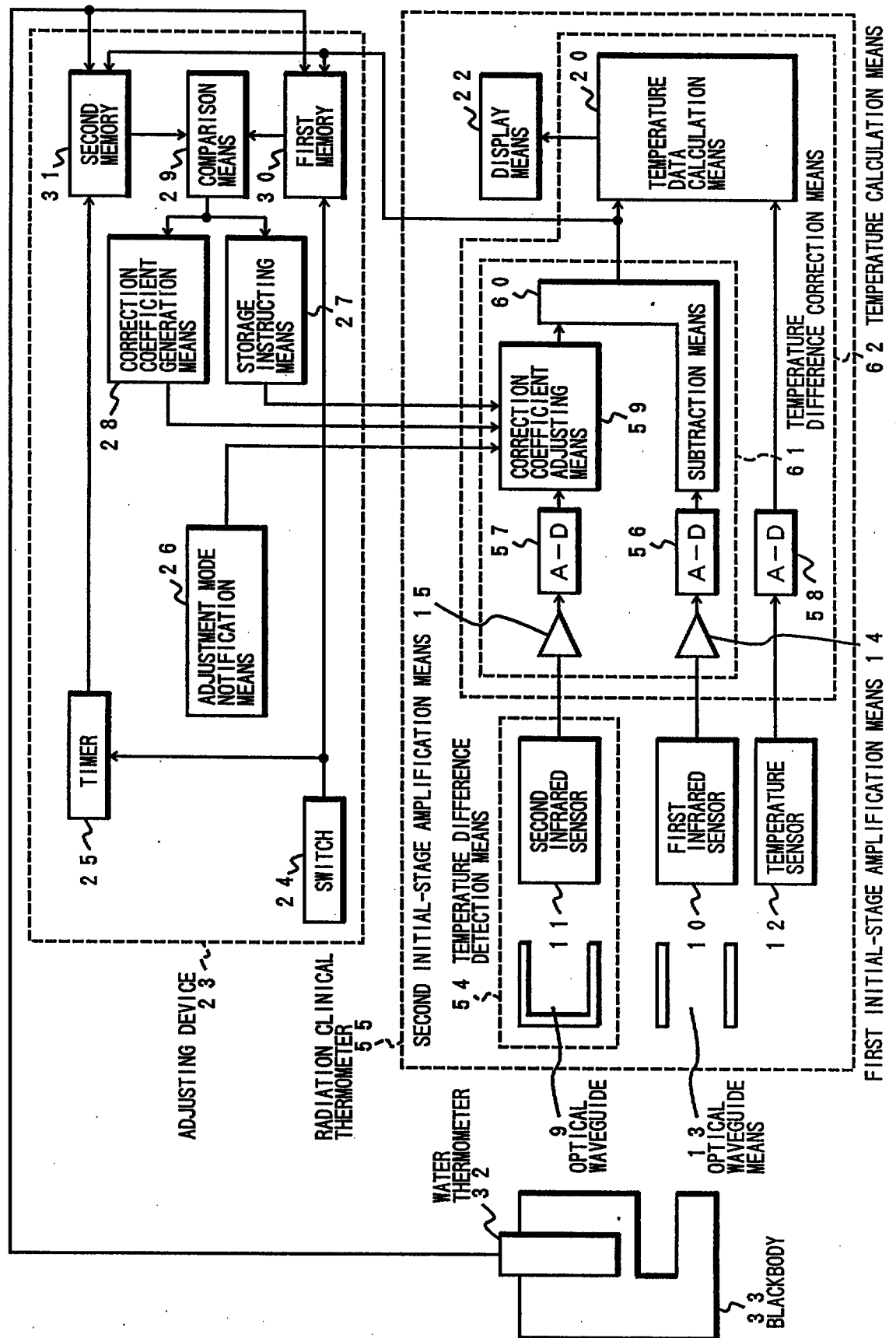


FIG. 13

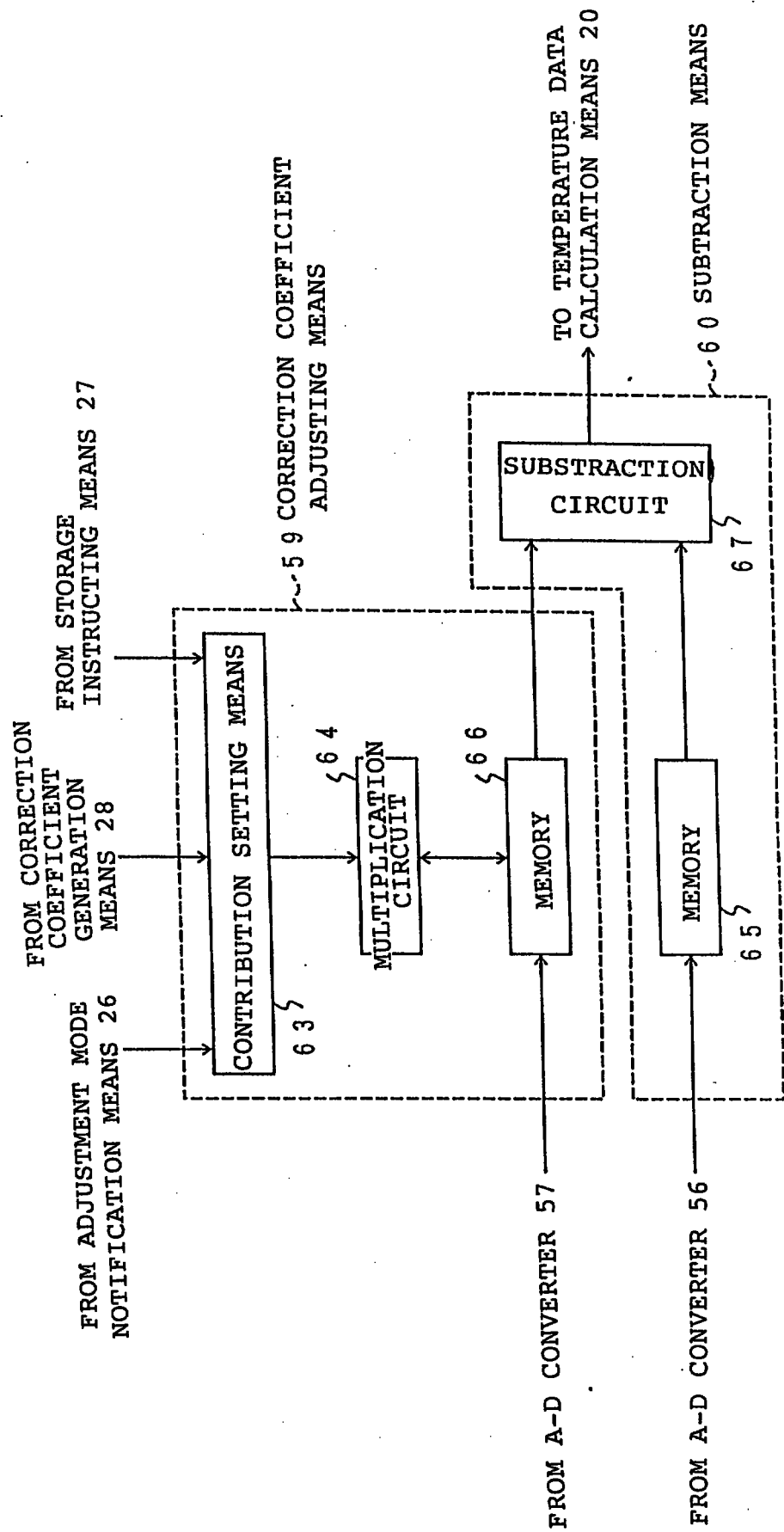


FIG. 14

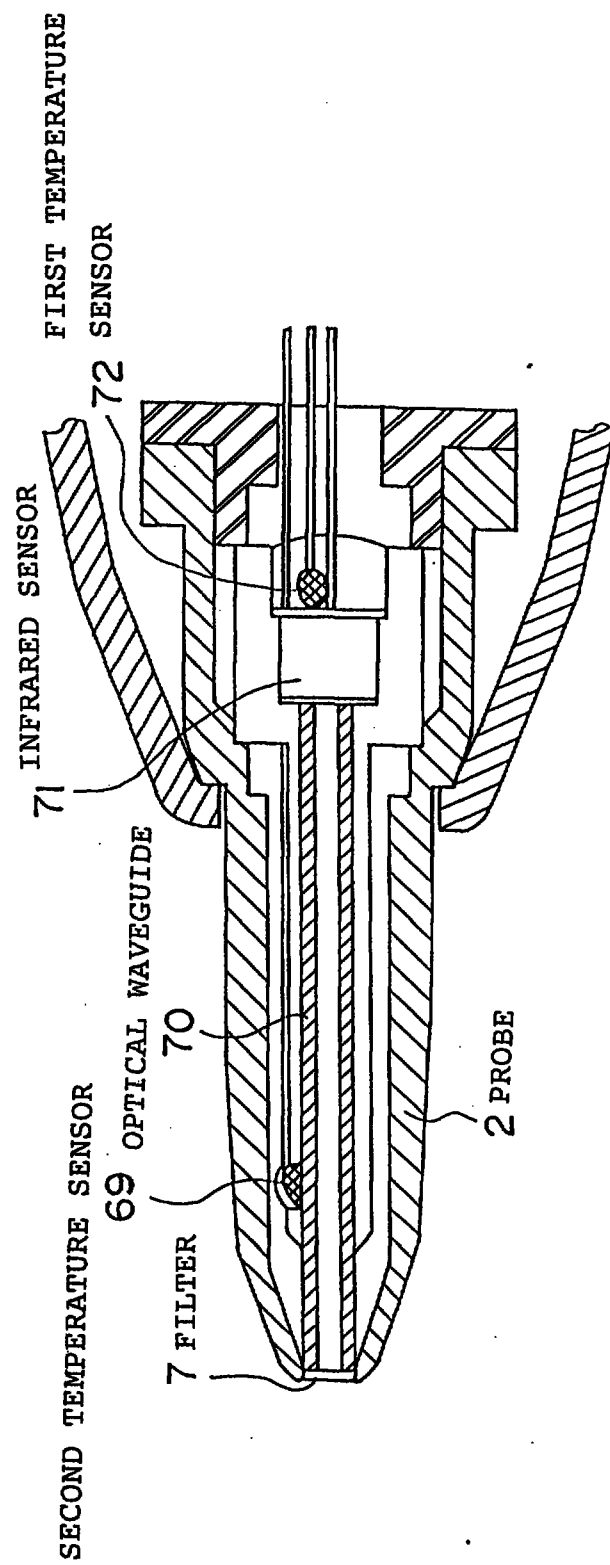
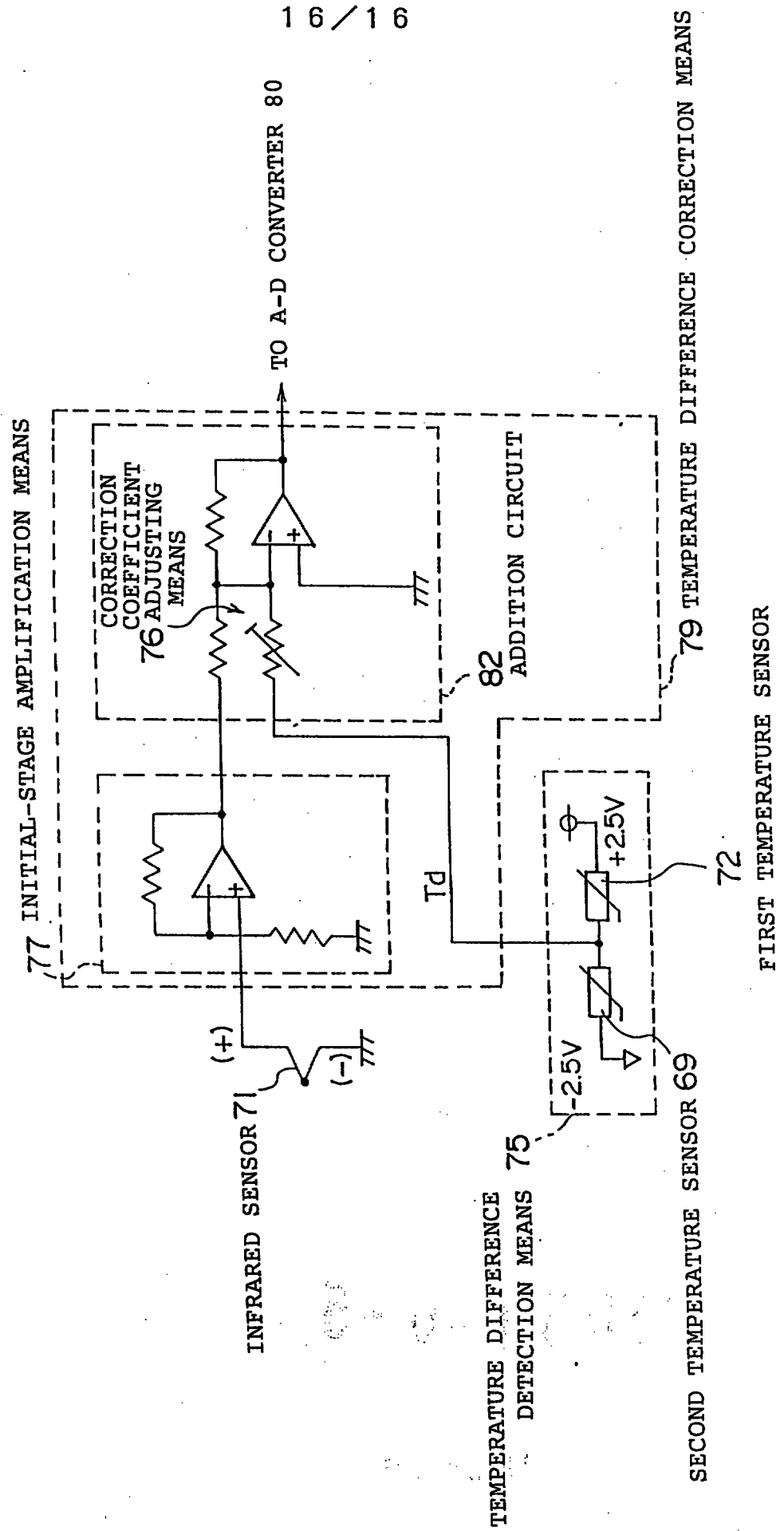


FIG. 16



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measured, optical waveguide means for guiding the thermal radiations from the object to be measured to the infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between the infrared sensor and the optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error caused by the temperature difference, characterized in that the temperature calculation means includes correction coefficient adjusting means for adjusting a correction or the infrared detection signal coefficient for the temperature difference signal.

According to the above arrangement of the present invention, since the temperature calculation means includes the correction coefficient adjusting means for adjusting the correction coefficient for the temperature difference signal from the temperature difference detection sensor for detecting the temperature difference between the infrared sensor and the optical waveguide means, a radiation clinical thermometer can be provided, which can calculate temperature data upon properly adjusting the error amount based on the temperature difference between the infrared sensor and the optical waveguide means, and improves the measurement accuracy.

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C L A I M S

1. A radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error ~~based on~~ ^{caused by} the temperature difference,

characterized in that said temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal or the infrared detection signal.

2. A radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference



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measured, optical waveguide means for guiding the thermal radiations from the object to be measured to the infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between the infrared sensor and the optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error caused by the temperature difference, characterized in that the temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal or the infrared detection signal.

According to the above arrangement of the present invention, since the temperature calculation means includes the correction coefficient adjusting means for adjusting the correction coefficient for the temperature difference signal from the temperature difference detection sensor for detecting the temperature difference between the infrared sensor and the optical waveguide means, a radiation clinical thermometer can be provided, which can calculate temperature data upon properly adjusting the error amount based on the temperature difference between the infrared sensor and the optical waveguide means, and improves the measurement accuracy.

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temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error ~~based on~~ ^{caused by} the temperature difference,

characterized in that said temperature calculation means includes correction coefficient adjusting means for adjusting a correction coefficient for the temperature difference signal.

3. A radiation clinical thermometer according to claim 2, characterized in that said temperature calculation means comprises temperature difference correction means for subtracting the temperature difference signal from the infrared detection signal, and temperature data calculation means for calculating the temperature data on the basis of an output signal from said temperature difference correction means and the reference temperature signal, said temperature difference correction means including said correction coefficient adjusting means.

4. A radiation clinical thermometer according to claim 3, characterized in that said temperature difference correction means comprises subtraction means for subtracting the temperature difference signal from the infrared



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difference condition is a condition in which the temperature of said infrared sensor differs from the temperature of said optical waveguide means.

17. A radiation clinical thermometer according to claim 15, characterized in that the second temperature difference condition is set by heating said optical waveguide means.

18. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error ^{caused by} ~~based on~~ the temperature difference, characterized by comprising

the step of arranging temperature difference correction means for adjusting a contribution of the temperature difference signal or the infrared detection signal ^{caused by} ~~based on~~ a temperature difference between said infrared sensor and said optical waveguide means, and

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caused by
data signal by correcting an error ~~based on~~ the temperature difference, characterized by comprising

the step of arranging temperature measuring means for measuring a temperature of a blackbody, and temperature difference correction means for adjusting a contribution of the temperature difference signal or the infrared detection signal ~~based on~~ ^{caused by} a temperature difference between said infrared sensor and said optical waveguide means, and arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature difference condition for said infrared sensor and said optical waveguide means, the step of measuring a measurement temperature difference between a measurement temperature of the blackbody under the first temperature difference condition and a measurement temperature of the blackbody under the second temperature difference condition, the step of outputting a temperature difference between the first output data signal and the second output data signal, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the temperature difference coincides with the measurement temperature difference.



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20. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error ~~based on~~ ^{caused by} the temperature difference, characterized by comprising

the step of arranging temperature difference correction means for adjusting a contribution of the temperature difference signal ~~based on~~ ^{caused by} a temperature difference between said infrared sensor and said optical waveguide means, and arranging said radiation clinical thermometer so as to receive thermal radiations from a blackbody kept at a constant temperature, the step of detecting a first output data signal output under a first temperature difference condition for said infrared sensor and said optical waveguide means, the step of detecting a second output data signal output under a second temperature

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difference condition for said infrared sensor and said optical waveguide means, the step of comparing the first and second output data and outputting comparison data, and the step of adjusting said correction coefficient adjusting means on the basis of the comparison data such that the first output data signal coincides with the second output data signal.

21. A temperature error correction method for a radiation clinical thermometer comprising an infrared sensor for outputting an infrared detection signal upon reception of thermal radiations from an object to be measured, optical waveguide means for guiding the thermal radiations from the object to be measured to said infrared sensor, a temperature sensor for measuring a reference temperature and outputting a reference temperature signal, temperature difference detection means for detecting a temperature difference between said infrared sensor and said optical waveguide means and outputting a temperature difference signal, and temperature calculation means for receiving the infrared detection signal, the reference temperature signal, and the temperature difference signal and calculating a temperature data signal by correcting an error ^{caused by} ~~based on~~ the temperature difference, characterized by comprising

the step of arranging temperature measuring means for measuring a temperature of a blackbody, and temperature difference correction means for adjusting a contribution of the temperature difference signal ^{caused by} ~~based on~~ a temperature

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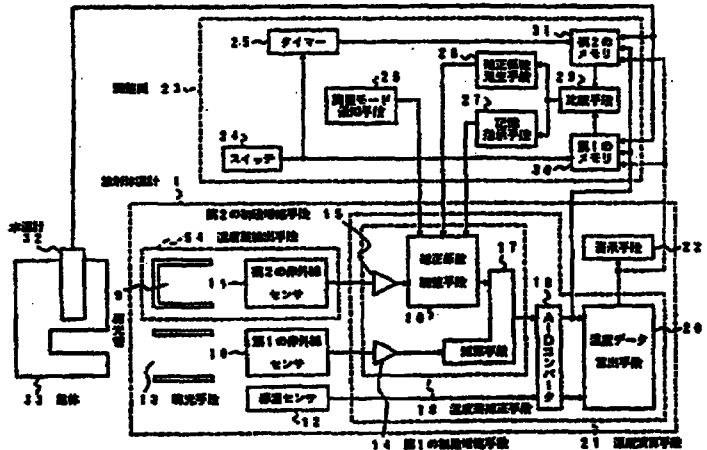
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(54) Title: CLINICAL RADIATION THERMOMETER

(54) 発明の名称 放射体温計



- 1 ... radiation thermometer
- 2 ... light guide pipe
- 3 ... first infrared sensor
- 4 ... second infrared sensor
- 5 ... temperature sensor
- 6 ... light guide wave
- 7 ... first front amplifier
- 8 ... second front amplifier
- 9 ... coefficient adjustment
- 10 ... subtractor
- 11 ... temperature difference correction circuit
- 12 ... A/D converter
- 13 ... temperature data arithmetic circuit
- 14 ... temperature arithmetic circuit
- 15 ... display
- 16 ... regulator
- 17 ... switch
- 18 ... time
- 19 ... adjustment mode indicator
- 20 ... memory indicator
- 21 ... correction coefficient generator
- 22 ... computer
- 23 ... first memory
- 24 ... second memory
- 25 ... water temperature sensor
- 26 ... blank body
- 27 ... temperature difference sensor

(57) Abstract

A clinical radiation thermometer for measuring body temperature with improved accuracy; comprising an infrared sensor for receiving heat radiation from an object and outputting an infrared detection signal; a light guide for guiding heat radiation from the object to the infrared sensor; a temperature sensor for measuring a reference temperature and outputting a reference temperature signal; a difference detector for detecting the temperature difference between the infrared sensor and the light guide and outputting a temperature difference signal; and an arithmetic circuit which, in response to the infrared detection signal, the reference temperature signal and the temperature difference signal, calculates a corrected data signal free of the error due to the temperature difference, wherein the arithmetic circuit is provided with a coefficient adjustment for adjusting a correction coefficient of the temperature difference signal. Since the arithmetic circuit includes the coefficient adjustment for adjusting the correction coefficient of the temperature difference signal from the difference detector for detecting the temperature difference between the infrared sensor and the light guide, the temperature data can be calculated by correctly adjusting the error due to the temperature difference between the infrared sensor and the light guide, and the clinical radiation thermometer has improved measurement accuracy.

(57) 要約

本発明は、体温の測定結果の精度をより向上することができる放射体温計を提供することを目的とする。

本発明はこの目的を達成するために、被測定物体からの熱放射を受けて赤外検出信号を出力する赤外線センサと、被測定物体からの熱放射を赤外線センサへ導くための導光手段と、基準温度を測定して基準温度信号を出力する感温センサと、赤外線センサと導光手段との温度差を検出して温度差信号を出力する温度差検出手段と、赤外検出信号と基準温度信号と温度差信号とを入力し、温度差に基づく誤差を補正した温度データ信号を算出する温度演算手段とを備えた放射体温計において、温度演算手段に、温度差信号の補正係数を調整するための補正係数調整手段を設けた。

本発明によれば、温度演算手段は、赤外線センサと導光手段との温度差を検出する温度差検出センサからの温度差信号の補正係数を調整するための補正係数調整手段を有するので、赤外線センサと導光手段との温度差に基づく誤差量を正しく調整して演算した温度データを算出することができ、測定精度がより向上した放射体温計を提供できる。

情報としての用途のみ

PCTに基づいて公開される国際出願をパンフレット第一頁にPCT加盟国を特定するために使用されるコード

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