

Nov. 17, 1964

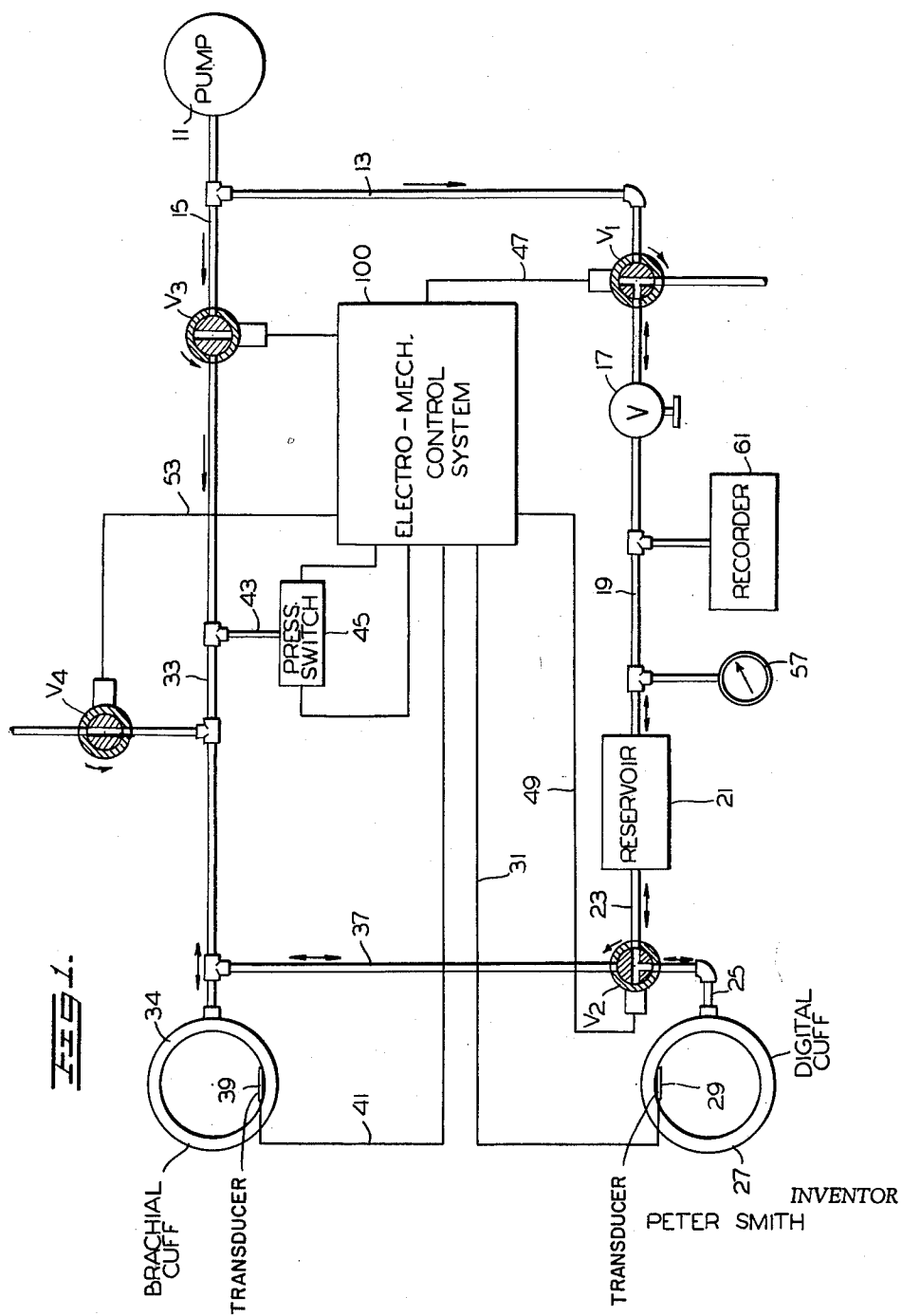
P. SMITH

3,157,177

SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

Filed Feb. 7, 1963

5 Sheets-Sheet 1



Nov. 17, 1964

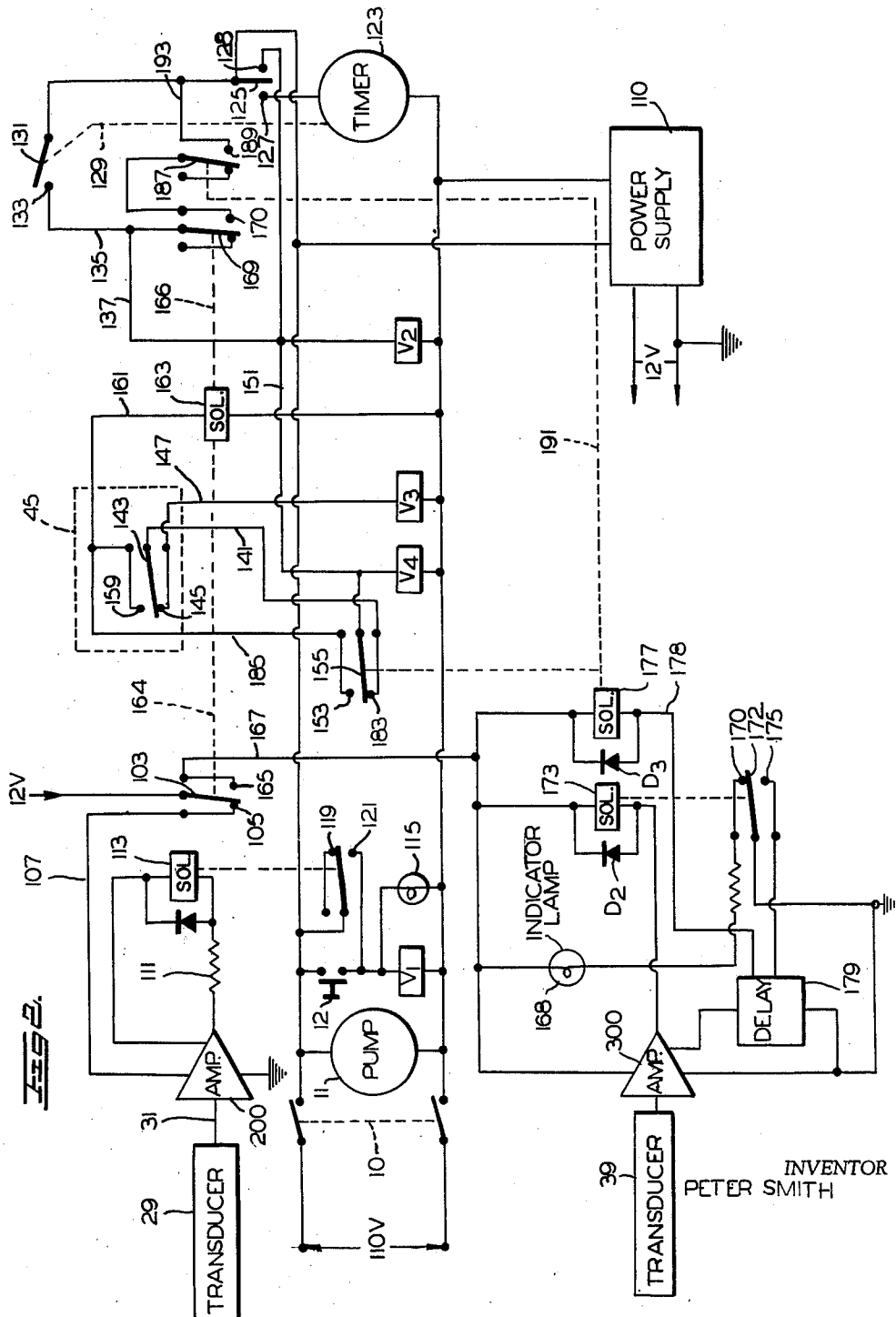
P. SMITH

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SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

Filed Feb. 7, 1963

5 Sheets-Sheet 2



Nov. 17, 1964

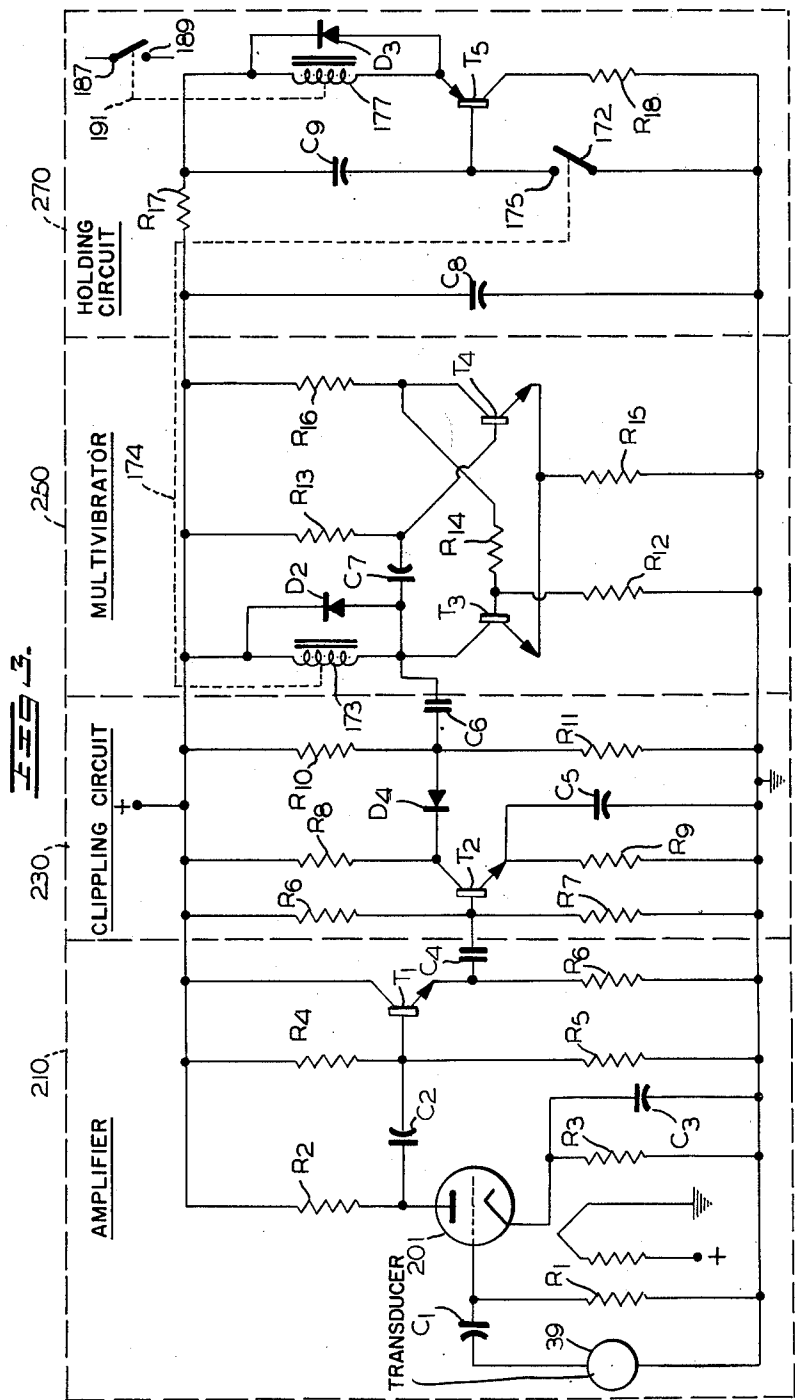
P. SMITH

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SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

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5 Sheets-Sheet 3



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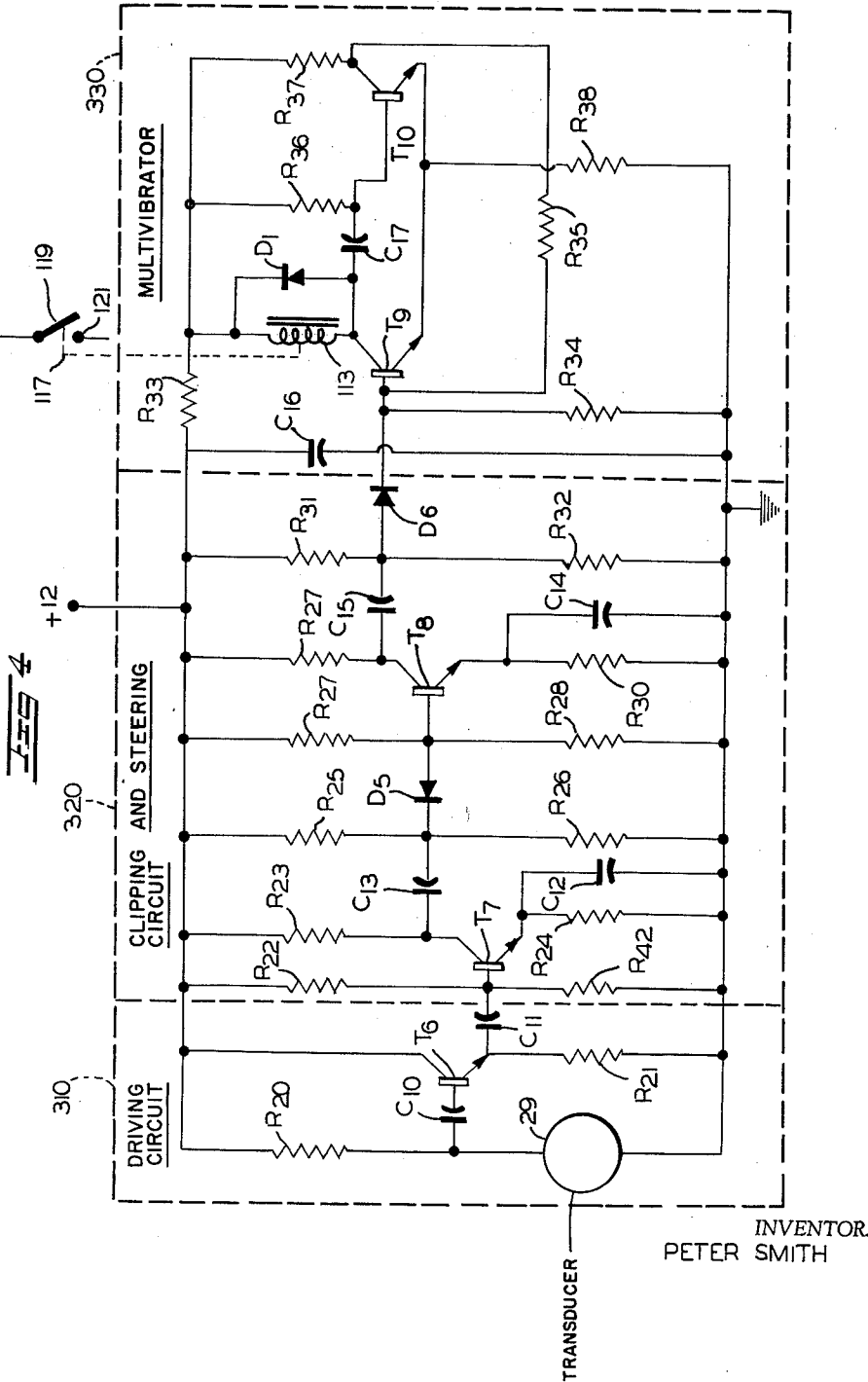
P. SMITH

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SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

Filed Feb. 7, 1963

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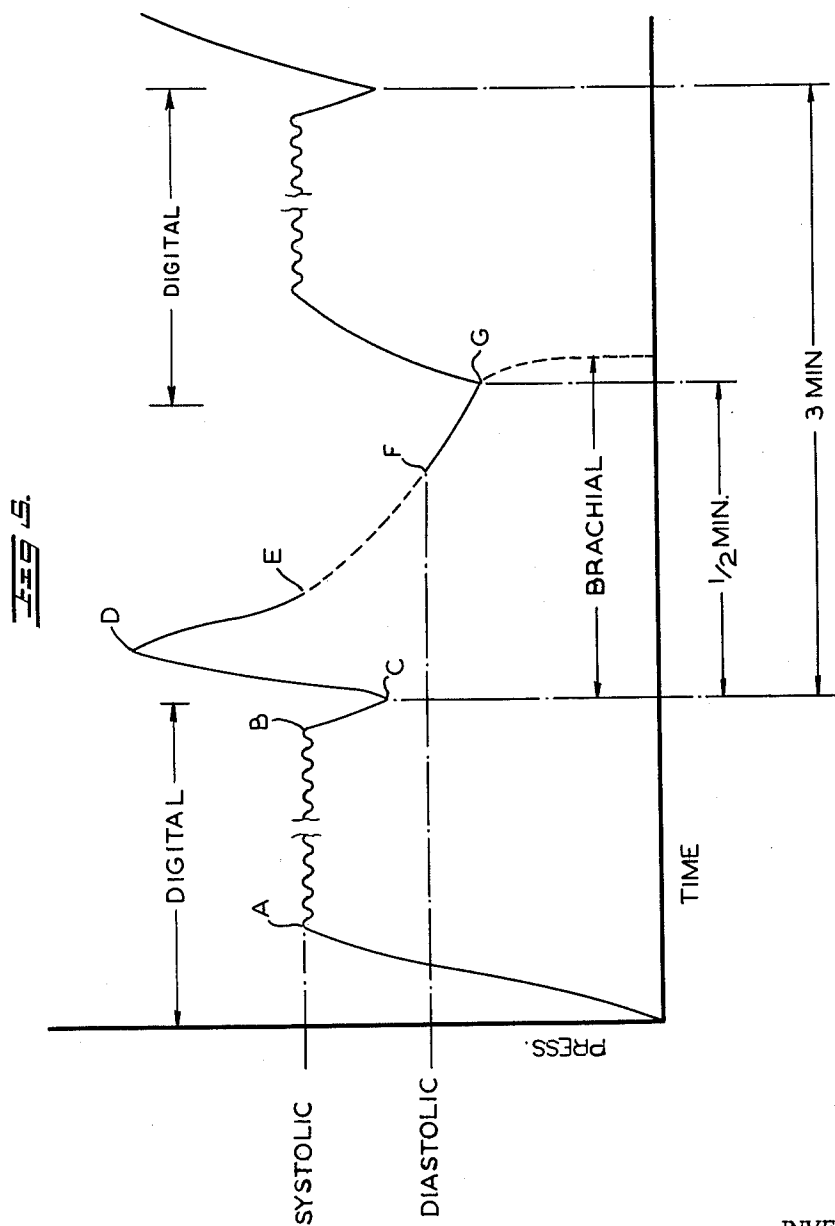
P. SMITH

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SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

Filed Feb. 7, 1963

5 Sheets-Sheet 5



INVENTOR
PETER SMITH

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3,157,177 SYSTOLIC DIASTOLIC BLOOD PRESSURE FOLLOWER

Peter Smith, Glendola, N.J., assignor to Dynamics Corporation of America, New York, N.Y., a corporation of New York

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14 Claims. (Cl. 128-2.05)

This invention relates generally to a system for continuously indicating blood pressures in a patient and more specifically to a pneumatic pressure system controlled by an electromechanical system for obtaining continuous readings of systolic and diastolic blood pressures.

Numerous systems are in use today for obtaining both the systolic and diastolic blood pressures of a patient. These systems or methods range all the way from a simple pressure band with a microphone for picking up Korotkow sounds in normal use by doctors to complicated pneumatic and electronic systems for determining the same information.

The copending application Serial No. 58,115, now Patent No. 3,143,111, entitled "Blood Pressure Follower" and assigned to the assignee of the present application illustrates and describes a system for obtaining a continuous reading of the systolic blood pressure of a patient by means of an electrical transducer and associated pressure cuff around the digit of a patient. While this system has proven to be very satisfactory, it still does not provide a means integral with the system for obtaining the diastolic blood pressure reading. One of the inherent difficulties in including a diastolic pressure indicator in the system of the above-mentioned application is the fact that while the systolic pressure can be continuously read over a period of four hours or more without discomfort to the patient, the diastolic reading using a microphone for obtaining the Korotkow sounds cannot be continuously applied in the same manner without discomfort and possibility of harm to the patient.

Accordingly, it is an object of this invention to provide a continuously operating system for obtaining alternate indications of systolic and diastolic blood pressures of a patient.

A further object of this invention is to provide an automatic apparatus which will alternately indicate the diastolic and systolic blood pressure of a patient.

A still further object of this invention is to provide a diastolic systolic blood pressure follower system having an automatic timing device for alternately switching from systolic to diastolic indications in accordance with a predetermined program.

Another object of this invention is to provide a blood pressure follower system for giving a continuous indication of systolic blood pressure with programmed interruptions for indications of diastolic and systolic blood pressure.

Yet another object of this invention is to provide a system for obtaining systolic blood pressure of a patient in two separate arterial positions on the body.

Still another object of this invention is to provide a system for obtaining systolic diastolic blood pressure readings using a pneumatic pressure supply system common to both pressure determinations.

Broadly speaking, the present invention comprises a digital transducer and a brachial transducer with pressure cuffs associated with each transducer and connected to a pneumatic pressure system. Valves are incorporated in the pressure system for switching the pressure from a digital cuff to the brachial cuff at predetermined intervals. An electromechanical system is incorporated in the device for controlling the operation of the valves with the signal input to the electromechanical system being sup-

plied by the digital and brachial transducers. With the cuffs placed about that portion of the body wherein the transducers are placed, the pressure within the cuff is controlled by the signal output or lack of signal output from the individual transducers. Therefore, the pressure in the cuff is directly associated with the arterial blood pressure and the pressure gauge connected to the cuffs will give a direct reading of the arterial blood pressures.

The details of operation of the present invention will appear in the following discussion taken in conjunction with the drawings wherein:

FIG. 1 is a schematic presentation of the pneumatic pressure system together with the lead controls from the electromechanical system to the valves of the pressure system;

FIG. 2 is a schematic presentation of the electromechanical control system;

FIG. 3 is a schematic presentation of the brachial amplifier and associated electronic equipment;

FIG. 4 is a schematic presentation of the digital amplifier and associated electronic equipment; and

FIG. 5 is a pressure-time chart of a typical operation of the device through the digital and brachial pressure determination cycles.

Turning now more specifically to the drawings, in FIG. 1 the solenoid valves are all shown in their inactivated positions with the pneumatic pressure supply means such as pump 11 providing the pneumatic pressure within the conduits 13 and 15. In the position shown in FIG. 1, the system is under operation controlled by the transducer 29 within the digital cuff 27. Transducer 29 may be any of the well-known piezoelectric transducer devices or it may be a photoelectric transducer such as shown in copending application Serial No. 186,431, now Patent No. 3,103,214, assigned to the assignee of the present invention. When the pressure in the cuff is below the digital pressure within the artery over which the transducer 29 is placed, each arterial pulsation causes a signal to be induced in the transducer 29 which is transmitted to the electromechanical control system 100 through lead 31. As will be explained in detail in connection with FIG. 2, the electromechanical control system supplies a control signal in response to the transducer output through lead 47 to actuate solenoid valve V_1 . Actuation of the solenoid valve V_1 allows the pressure in conduit 13 supplied by the pump 11 to pass through valve V_1 and through the manually adjusted throttle valve 17 to the reservoir 21, through conduit 23, solenoid valve V_2 and conduit 25 to the digital cuff 27. When the digital cuff reaches the pressure required to occlude the artery, the pulsations therein will stop and the signal output from the transducer will also stop. Therefore, the solenoid valve V_1 will return to the position shown and the pressure in the cuff will begin to leak to atmosphere through valve V_1 at a rate controlled by the setting of the throttle valve 17. When the signals appear in transducer 29 as a result of pulsations in the artery, the system will actuate valve V_1 and the cuff 27 will be inflated. In actual practice, therefore, the pressure in the cuff hunts slightly about the systolic pressure within the artery and may be read by means of a pressure gauge 57 or recorded by means of a standard recording device 61.

When the electromechanical control system 100 is activated to switch to a brachial operation, solenoid valve V_3 is actuated, connecting conduit 33 to conduit 15 and solenoid valve V_4 is also actuated, closing off the deflate means directly connected to conduit 33. The brachial cuff 34 is rapidly inflated to a point well above that pressure necessary to occlude the artery associated with the brachial transducer 39.

Under this operation, solenoid valve V_2 is also actuated, connecting conduit 37 through conduit 23, reservoir 21,

conduit 19, throttle valve 17 to solenoid valve V_1 to deflate to atmosphere.

When brachial cuff 34 attains the above-mentioned predetermined pressure, the pressure switch 45, connected with conduit 33 through conduit 43, is closed and deactivates the solenoid valve V_3 through the electromechanical control system 100 thus closing the inflate means to the cuff 34 while solenoid valve V_4 remains actuated and prevents any fast deflate of the cuff 34.

Cuff 34 then slowly deflates through conduit 37, solenoid valve V_2 , the various conduits and throttle valve 17, through solenoid valve V_1 to atmosphere. The brachial transducer may be a piezoelectric microphone device for picking up Korotkow sounds such as that shown in the application Serial No. 256,965, filed February 7, 1963, now Patent No. 3,148,677, entitled "Brachial Transducer" and assigned to the assignee of the present invention. As the pressure cuff 34 diminishes, the first Korotkow sound will be heard at the systolic pressure and will provide an indication within the electromechanical control system as will be explained in detail as the description proceeds. As the pressure further decreases, the Korotkow sounds continue until the point at which the last sound occurs, indicating the diastolic blood pressure. Means are provided within the electromechanical control system for holding the valves in the position for brachial detection for a short period after the last Korotkow sound occurs. After this delay time, the electromechanical system deactivates solenoid valve V_4 and solenoid valve V_2 allowing a rapid deflate of the brachial cuff 34 through solenoid valve V_4 and returning the system to the digital operation.

Turning now to FIG. 2 which schematically illustrates the electromechanical control system, closing of the manual switch 10 supplies 110 volt power to the system including the pneumatic pressure pump 11 in the power supply 110 which converts the 110 volt power to a 12 volt power supply for providing the B+ voltage to the various electronic control devices.

The control switch 125 is a three position switch movable from the open position shown in the drawing to either the contact 127 for automatic timing operation or the contact 128 for the test position.

Assuming now that the switch 125 is moved to contact 127 for the automatic operation of the timer 123 at the start of the cycle the system is operating on the systolic transducer operation using transducer 29. Arterial pulses in the digit induce a signal in transducer 29 which is transmitted through lead 31 to the amplifier 200. The B+ voltage is supplied through the 12 volt line, switch arm 103, contact 105 and lead 107 to the amplifier 200. The pulses from the transducer 29 are therefore amplified and activate relay 113 through resistor 111 and the associated diode D_1 .

Each time the relay 113 is activated, which is the equivalent of a pulse, it operates the switch arm 119 moving this arm to contact 121. Every time that switch arm 119 contacts 121 the 120 volt supply is delivered to the solenoid valve V_1 thus supplying pressure to the cuff 27 as illustrated in FIG. 1. Additionally, current is supplied to the light 115 which is in parallel with the solenoid valve and this light acts as a pulse indicator visible to the operator of the unit. When the pressure cuff reaches the pressure which is equivalent to the arterial pressure, the artery is occluded and there are no further signals from the transducer 29. In this state, the switch arm 119 is not activated and the digital cuff is allowed to gradually deflate through the throttle valve indicated in FIG. 1 until pulses reappear in the artery. This operation gives a continuous indication on the pressure gauge 57 of the systolic blood pressure of the patient.

At the set predetermined intervals of the timer 123, actuation of the timing switch arm 131 occurs whereby the switch arm is moved into contact with contact 133. This switch provides 120 volt power through leads 135,

137, and 151 to solenoid valve V_2 which transfers the pressure system to the brachial cuff and to solenoid valve V_4 which closes off the fast deflate from the brachial cuff.

Simultaneously 120 volt power is applied through switch arm 153, contact 183, lead 141, switch arm 143, contact 145 and lead 147 to solenoid valve V_3 for rapidly inflating the brachial cuff 34. The brachial cuff continues to inflate well above the systolic blood pressure until pressure switch 45 is activated moving switch arm 143 to contact 159. Thus, the pressure switch removes the current from the solenoid valve V_3 and cuts off the rapid inflate for the brachial cuff 34. At the same time, power is supplied through contact 159 and lead 185 to contact 153.

Actuation of pressure switch 45 further supplies power through lead 151 to relay 163, actuating the relay for moving switch arm 159 to contact 170 for reasons which will become obvious as the description proceeds. Additionally, activation of relay 163 moves switch arm 103 by means of linkage 164 to contact 165 removing the B+ supply from the digital amplifier and applying this B+ supply to the brachial amplifier through lead 167.

The brachial cuff 34 now begins to gradually deflate through conduit 37, solenoid valve V_2 , the reservoir, throttle valve 17 and solenoid valve V_1 . As soon as the pressure in the brachial cuff 34 reaches the digital blood pressure within the artery, transducer 39 picks up Korotkow sounds, inducing a signal which is fed to amplifier 300. The amplified signals are sent to the relay 173 and associated diode D_2 so that the relay intermittently actuates a switch arm 172 in accordance with each Korotkow sound detected by the transducer 39.

In its normally inactivated position, switch arm 172 is positioned on contact 170 which connects the 12 volt supply through the indicator lamp 168 to ground. However, every time the switch arm 172 is moved to contact 175 through the actuation of relay 173, the circuit to the indicator lamp is opened, thus giving a visual indication of the starting and ending points of the sounds.

Activation of relay 173 also energizes delay circuit 179 which in turn energizes relay 177 via lead 173. This holding circuit is so designed that the relay 177 will be held in an activated position after the first pulse from transducer 39 and will hold the relay activated until a predetermined interval, such as 2-3 seconds, after the last Korotkow sound.

Activation of relay 177 closes switch arm 187 to contact 189, thus completing the circuit from the 120 volt supply through lead 193, contact 189, switch arm 187, contact 170, switch arm 169, leads 137 and 151 to solenoid valve V_2 and V_4 . Therefore, the closing of switch arm 169 by relay 163 and switch arm 187 by relay 177 bypasses the timer circuit so that the time of the brachial operation is independent of the timer 123 once the operation is initiated.

Relay 177 also moves switch arm 155 to contact 153 thereby supplying 120 volt power by means of leads 185 and 161 to relay 163. Therefore, as long as relay 177 is activated, relay 163 will maintain the B+ supply to the brachial amplifier and maintain switch arm 169 on contact 170 providing independent operation of the brachial amplifier regardless of the position of the pressure switch.

When the indicator lamp 168 stops blinking, it is an indication that relay 173 is no longer being activated and therefore there are no further Korotkow sounds. This point on the pressure gauge indicates the diastolic pressure within the artery and can be read by observing the commencement of a steady light in indicator lamp 168 and pressure gauge 57.

A short interval after the last Korotkow sound has activated relay 173, such as 2-3 seconds, the delay circuit 179 will allow the relay 177 to be inactivated thus opening the switch arm 187 and returning it to the open con-

tact. Additionally, switch arm 155 returns to contact 183. Since the timer switch is now in its open position, the circuit from the 120 volt supply has been broken and solenoid valve V_2 returns to its inactivated position and solenoid V_4 also returns to its inactivated open position. The opening of solenoid valve V_4 provides a direct deflate to atmosphere from the brachial cuff 34, allowing a rapid deflation of this cuff while the solenoid valve V_2 is returned to its position connecting the pneumatic conduit 23 to the digital cuff 27. Inactivation of relay 177 also removes the power supply from relay 163 which not only returns switch arm 169 to its open position, but also returns switch arm 103 to contact 105, reconnecting the B+ supply to the digital amplifier. The digital indicating circuit resumes its operation with inflation of the digital cuff and the cycle repeats itself.

FIG. 3 is a detailed schematic of the brachial amplifier and delay circuit. The purpose of this circuit is to amplify signals from the brachial transducer 39, which is primarily used to sense the diastolic blood pressure and additionally further gives a systolic indication, and to activate relays 173 and 177. The circuit consists of amplifier 210 with the associated resistors R_1 , R_2 and R_3 and coupling capacitors C_1 and C_2 , triode 201, and transistor T_1 coupled by means of capacitor C_4 to a clipping circuit 230 including transistor T_2 and the clipping circuit comprising R_8 , R_{10} , R_{11} and diode D_4 . The purpose of the clipping circuit is to remove extraneous noise signals.

Clipping circuit 230 is coupled by means of capacitor C_6 to the one-shot multivibrator circuit 250 consisting of transistors T_3 and T_4 . The one-shot multivibrator 250 supplies the activating pulse to the relay 173.

The holding circuit 270 consists of capacitors C_8 , C_9 , resistor R_{17} and transistor T_5 . Switch arm 172 is activated by relay 173 through linkage 174. When switch arm 172 is closed, capacitor C_9 is charged to a point that maintains the transistor T_5 in a conductive state for a period of time such as 2 or 3 seconds after each closing of switch 172. Therefore, unless the switch 172 is open for a period exceeding the time interval set by the parameters of R_{18} and C_9 , relay 177 will remain activated. This operation, as discussed above in connection with FIG. 2, causes the relay to hold switch 187 in closed position by means of linkage 191. This amplifying, clipping and holding circuit is the subject matter of a separate application entitled Pulse Actuated Control Circuit, Serial No. 256,931, filed February 7, 1963, in the name of the present inventor. For specific details of the circuitry, reference is hereby made to that application.

In FIG. 4, stage 310 of the digital amplifier is a combination emitter follower and driving circuit. The transistor T_6 is energized by setting the D.C. current there-through. The blood flow through the finger is transformed to an electrical signal by the transducer 29 and fed into T_6 . The emitter follower configuration of transistor T_6 exists to isolate the transducer which is a high impedance, low power device from the digital circuitry which is of low impedance. The emitter follower amplifies the signal, power wise, while slightly decreasing the signal voltage amplitude level. The signal appears across a lower impedance than that at the input to T_6 . Hence, more power is available. The increase in power available is necessary so that the following circuitry will not unduly load down or decrease the original signal level.

Stage 320 consists of transistor T_7 , transistor T_8 , the clipping circuit consisting of the resistors R_{25} , R_{26} , R_{27} , R_{28} and diode D_5 , and the diode steering circuit consisting of R_{31} and D_6 . The first transistor T_7 converts and amplifies the signal input. The output of this amplifier is delivered to the clipping circuit consisting of the two voltage dividers and diode D_5 . The anode and cathode of the diode are biased so that the diode will not conduct until the signal has reached a predetermined level. Therefore, the diode will look like an open circuit to

signal voltages below this level and will look like a short circuit to signals above this level.

The signal appearing at the base of T_8 is amplified and inverted and delivered to the diode steering circuit. This diode steering circuit serves to further clip any noise induced by the transducer and also steers only positive portions of the input signal to stage 330.

Stage 330 consists of a one-shot multivibrator circuit where transistor T_9 is normally biased in the off position. Therefore, the signal appearing at base of T_9 can only be positive to turn T_9 on and thus activate the relay coil 113.

The operation of the one-shot multivibrator is as follows: The collector of transistor T_9 is normally at 12 volts D.C. with respect to ground. The base of transistor T_9 is of slightly lower voltage than the emitter, thus retaining the transistor in an off state under D.C. conditions. T_{10} , however, is biased normally on, so that its collector is normally at about 2 volts D.C. with respect to ground. Therefore, under steady state condition, relay 173 will have no voltage across it and thus will be de-energized.

With the application of the signal voltage at the base of transistor T_9 , current will flow from collector to the emitter and the voltage at the collector will drop in amplitude. This changing voltage will be coupled over the base of transistor T_{10} appearing as a negative going signal at that base. Since the voltage at the emitter is fixed with respect to ground for both transistors T_9 and T_{10} , the base of T_{10} is driven below the emitter voltage thus turning transistor T_{10} off as less and less current to the emitter flows. The voltage at the collector of transistor T_{10} thus increases toward B+ as T_{10} approaches its off condition. Part of this increasing voltage is coupled over to the base of transistor T_9 through the RC circuit thus driving T_9 further on towards saturation and T_{10} towards cutoff. Finally, capacitor C_{17} cannot be charged negatively any further and the maximum possible negative voltage appears at the base of transistor T_{10} . At this time, capacitor C_{17} begins to discharge through resistor R_{36} and the low collector to emitter saturation resistance of the now "on" transistor T_9 to the ground. As capacitor C_{17} discharges, the voltage at the base of transistor T_{10} becomes less negative until T_{10} becomes again conductive. Part of the negative going voltage at the collector transistor T_{10} is coupled over to the base of transistor T_9 , and T_9 is again biased towards cutoff.

The one-shot multivibrator 330 serves to deliver a pulse of constant amplitude and width to relay 113 for every pulse of blood pressure sensed by the digital transducer. In this manner positive action of relay 113 is assured even when transducer input signals have irregular wave shapes and varying amplitudes. Diode D_1 across relay 113 serves to conduct any negative going transient due to the action of the coil of the relay to ground.

Operation

Turning to FIG. 5, a graphical representation of the operating system representing time and pressures is indicated therein. When the system is initially actuated by the closing of switch 100, the pressure in the digital cuff builds up to point A at which time it then comes under the control of the output of the digital transducer. As indicated, the pressure within the digital cuff will vary about the systolic pressure between A and B. When signals are detected from the digital transducer, the pressure within the cuff has dropped to a pressure below that within the artery and pulsations are occurring within the artery. When the pressure builds up to a point which is sufficient to occlude the artery, no signals will appear from the digital transducer.

After a period of time, indicated at point B on the graph, the timer actuates switch 131 which immediately stops the inflation input to the digital cuff and transfers

the pneumatic pressure to the brachial cuff through valve V_3 while closing valve V_4 .

The start of the inflation period of the brachial cuff is shown at point C and this inflation continues to build up to a peak D well above the brachial systolic pressure. When the pressure point D is reached, pressure switch 45 is actuated closing valve V_3 , thus terminating the fast inflation of the brachial cuff.

As discussed above, the closing of the pressure switch does not affect the fast deflate valve V_4 which is in a position preventing any venting to atmosphere.

The pressure in the brachial cuff now begins to deflate gradually through the conduit 37, valve V_2 , conduits 23 and 19 at a rate controlled by throttle valve 17 and through the valve V_1 to atmosphere. When the pressure is reduced to the point E Korotkow sounds are detected by the brachial transducer and are indicated by the flashing of the indicator lamp 163. Point E, therefore, also represents the systolic blood pressure.

As the pressure continues to fall, Korotkow sounds are detected until the brachial diastolic pressure F is reached. Therefore, by observing the indicator lamp 168 and pressure gauge 57 both the systolic and diastolic blood pressures can be determined at points E and F.

After the last Korotkow sound is detected by the brachial transducer, the delay circuit 179 holds the valves in the same position for a predetermined amount of time indicated between F and G. The point G represents the time at which the valve V_4 is deactuated, rapidly the brachial cuff to atmosphere and the deactivation of valves V_2 connecting the conduit 23 to the digital cuff. The operation then repeats itself.

Although the timer operation may be varied to a certain extent an important consideration is to operate the brachial cuff for as short a period as possible to avoid discomfort to the patient. This inflation period is greatly reduced by means of the fast deflate valve V_4 as indicated in FIG. 5. Very satisfactory operating intervals are indicated on FIG. 5 with the entire cycle consuming approximately three minutes with approximately one half-minute devoted to determination of the brachial pressures with the remaining time giving a continuous measurement of the digital systolic blood pressure.

The above operation also furnishes additional important data. As is well known, a sudden state of shock occurring in a patient causes a constriction of the blood vessels within the patient and this constriction first occurs most noticeably at the extremities of the body such as the digits. Such a constriction naturally causes a fall in the systolic blood pressure at these extremities prior to such indication in those parts of the body closer to the heart.

Therefore, if the systolic pressure by the digital transducer between A and B should suddenly be noticeably less than the systolic pressure indicated by the brachial amplifier at point E, there is an immediate indication that the patient is going or has gone into a state of shock and the necessary preventative measures can be immediately taken.

As will now be evident, the system of the present invention not only provides a desirable continuous systolic blood pressure reading together with intermittent diastolic blood pressure readings, but also it provides the additional information relating to immediate indication of a patient going into a state of shock.

It is to be understood that the above description and related drawings are illustrative of the invention and are not to be considered as limiting the invention in any manner since various components of the system could be replaced by other well-known components. Accordingly, the invention is to be limited only by the scope of the claims.

I claim:

1. A systolic-diastolic blood pressure system comprising

a digital transducer,
a first inflatable cuff surrounding said digital transducer,
a brachial transducer,
a second inflatable cuff surrounding said brachial transducer,
a pneumatic pressure supply,
a first conduit connected between said first cuff and said pneumatic pressure supply,
a first two position solenoid valve in said first conduit, said valve supplying pressure to said first cuff when actuated and venting said first cuff to atmosphere when nonactuated,
a second two-position solenoid valve in said first conduit between said first valve and said first cuff,
a second conduit connected between said second valve and said second cuff, said second valve supplying pneumatic pressure to said second cuff when actuated and to said first cuff when nonactuated,
first electromechanical control means coupled between said first transducer and said first valve for actuating said first valve in response to signal outputs from said first transducer,
second electromechanical control means for actuating said second valve at predetermined intervals,
a third conduit interconnecting said second cuff and said pressure supply,
a third two-position solenoid valve in said third conduit, said third valve inflating said second cuff when in its actuated position,
means coupling said third valve to said second electromechanical control means for control thereof, said second electromechanical control means including a timer for temporarily actuating said second and third valves substantially simultaneously,
a pressure switch means connected in said third conduit and coupled to said second electromechanical control means for deactuating said third valve when the pressure in said second cuff reaches a predetermined amount,
means coupling said second transducer to said second electromechanical control means for maintaining said second valve in its actuated position during the period of signal outputs from said second transducer independent of said timer, said second valve returning to its nonactuated position at the cessation of signals from said second transducer,
means for detecting the pressure in said cuffs, and
means for indicating the signal outputs of said transducers.

2. The apparatus of claim 1 further comprising a
a fourth two-position solenoid valve in said third conduit between said cuff and said third valve, and
means coupling said fourth valve to said second electromechanical control means, said fourth valve being open to atmosphere in its nonactuated position, said timer actuating said fourth valve substantially simultaneously with said second and third valves,
and means coupling said fourth valve to said second transducer through said second electromechanical means for maintaining said fourth valve in its actuated position during the period of signal output from said second transducer independent of said timer.

3. A systolic-diastolic blood pressure system comprising
a digital transducer,
a first inflatable cuff surrounding said digital transducer,
a brachial transducer,
a second inflatable cuff surrounding said brachial transducer,
a pneumatic pressure supply,
conduit means interconnecting said cuffs and said pressure supply,

a first two position solenoid valve in said conduit means, said valve supplying pressure to said first cuff when actuated and venting said first cuff to atmosphere when nonactuated,

a second two-position solenoid valve in said conduit means between said first valve and said first cuff, said second valve supplying pneumatic pressure to said second cuff when actuated and to said first cuff when nonactuated,

electromechanical control means coupled between said first and second transducers and said valves for actuating said valves in response to signal outputs from said transducers,

timer means in said electromechanical control means for actuating said second valve at predetermined intervals,

a third two-position solenoid valve in said conduit means, said third valve inflating said second cuff when in its actuated position,

means coupling said third valve to said electromechanical control means, said timer temporarily actuating said second and third valves substantially simultaneously,

a pressure switch means connected in said conduit means and coupled to said electromechanical control means for deactuating said third valve when the pressure in said second cuff reaches a predetermined amount,

means coupling said second transducer to said electromechanical control means for maintaining said second valve in its actuated position in response to signal outputs from said second transducer independent of said timer, said second valve returning to its nonactuated position at the cessation of signals from said second transducer,

means for detecting the pressure in said cuffs, and means indicating the signal output of said transducers.

4. The apparatus of claim 3 further comprising

a fourth valve in said conduit means coupled to said electromechanical control means for venting said second cuff to atmosphere and a pressure switch coupled to said second cuff for controlling said second valve.

5. A systolic-diastolic blood pressure system comprising

a digital transducer,

a first inflatable cuff surrounding said digital transducer,

a brachial transducer,

a second inflatable cuff surrounding said brachial transducer,

a pneumatic pressure supply,

a conduit means interconnecting said cuffs and said pneumatic pressure supply,

a first two-position valve in said conduit means, said valve supplying pressure to said first cuff in one position and venting said first cuff to atmosphere in the other position,

a second two-position valve in said conduit means between said first valve and said first cuff, said second valve supplying pneumatic pressure to said second cuff when in one position and to said first cuff when in the other position,

electromechanical control means coupled between said transducers and said first and second valves for moving said first valve to said one position in response to signal outputs from said first transducer, said electromechanical control means moving said second valve to said one position at predetermined intervals,

a third two-position valve in said third conduit, said third valve inflating said second cuff when in one position and blocking said conduit in the other position,

means coupling said third valve to said electromechanical control means, said electromechanical control means temporarily moving said third valve to said

one position substantially simultaneously with said second valve,

a pressure switch means connected in said conduit and coupled to said electromechanical control means for moving said third valve to said other position when the pressure in said second cuff reaches a predetermined amount,

means coupling said second transducer to said electromechanical control means for maintaining said second valve in said one position in response to signal outputs from said second transducer independent of said timer, said second valve returning to said other position at the cessation of signals from said second transducer,

means for detecting the pressure in said cuffs, and means for indicating the signal output of said transducers.

6. The apparatus of claim 5 further comprising means for venting said second cuff to atmosphere at a predetermined time after the cessation of signals from said second transducer.

7. A systolic-diastolic blood pressure system comprising

a digital transducer,

a first inflatable cuff surrounding said digital transducer,

a brachial transducer,

a second inflatable cuff surrounding said brachial transducer,

means for supplying pneumatic pressure to said cuffs including conduit means interconnecting said cuffs,

a first valve means in said conduit means, said valve controlling the pressure to said first cuff when in one position and venting said first cuff to atmosphere when in the other position,

a second valve means in said conduit means between said first valve and said first cuff, said second valve supplying pneumatic pressure to said second cuff when in one position and to said first cuff when in the other position,

electromechanical control means coupled between said transducers and said valves for actuating said valves in response to signal outputs from said transducers,

a third valve means in said conduit means for inflating said second cuff independently of said first and second valves,

means, including a timer, coupling said third valve to said electromechanical control means for temporarily inflating said second cuff at predetermined intervals,

a pressure switch means connected in said conduit means and coupled to said electromechanical control means for terminating the inflation of said second cuff through said third valve when the pressure in said second cuff reaches a predetermined amount,

means coupling said second transducer to said electromechanical control means for maintaining said second valve in said one position in response to signal outputs from said second transducer independent of said timer, said second valve returning to said other position at the cessation of signals from said second transducer,

means for detecting the pressure in said cuffs, and means for indicating the signal output of said transducer.

8. The apparatus of claim 7 further comprising means for venting said second cuff at a predetermined time after the cessation of signals from said second transducer.

9. A systolic-diastolic blood pressure system comprising

a digital transducer,

a first inflatable cuff surrounding said digital transducer,

a brachial transducer,

a second inflatable cuff surrounding said brachial transducer,

pneumatic pressure means for inflating said cuffs,

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a first valve means for alternately supplying said pressure to said first cuff and venting said first cuff to atmosphere,

a second valve means between said first valve means and said cuffs for alternately supplying said pneumatic pressure to said second cuff and to said first cuff,

electromechanical control means coupled between said transducers and said valve means for actuating said valve means in response to signal outputs from said transducers,

a third valve means for inflating said second cuff independent of said first and second valve means,

means coupling said third valve means to said electromechanical control means, said electromechanical control means including a timer for temporarily actuating said second and third valves substantially simultaneously,

a pressure switch means connected to said second cuff and coupled to said second electromechanical control means for closing said third valve means when the pressure in said second cuff reaches a predetermined amount,

means coupling said second transducer to said electromechanical control means for maintaining said second valve means in the position to supply pressure to said second cuff in response to signal outputs from said second transducer independent of said timer, said second valve means returning to the position to supply pressure to said first cuff at the cessation of signals from said second transducer,

means for detecting the pressure in said cuff, and means for indicating the signal outputs of said transducers.

10. The apparatus of claim 9 further comprising adjustable means between said first valve means and said first cuff for restricting for controlling the rate of inflation of said cuffs.

11. The apparatus of claim 9 further comprising means for deflating said second cuff at a predetermined time interval after the cessation of signals from said second transducer.

12. A systolic-diastolic blood pressure indicating system including a brachial transducer, a digital transducer, and an inflatable cuff surrounding each of said transducers, said system comprising

means for supplying pneumatic pressuer to each of said cuffs,

control means for alternately transferring said pneu-

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matic pressure supply from one of said cuffs to the other of said cuffs,

timer means for actuating said control means at predetermined intervals,

electromechanical means coupled between said digital transducer and said pneumatic supply for inflating said digital cuff in response to signals from said digital transducer when said control means is in the position supplying said pressure to said digital cuff,

a pressure control device coupled to said brachial cuff for terminating the pressure supply to said brachial cuff at a predetermined pressure when said control means is supplying pressure to said brachial cuff,

means for detecting the pressure in each of said cuffs, and means for indicating the signal output of each of said transducers.

13. The apparatus of claim 12 further comprising means coupled to said brachial cuff for venting said brachial cuff to atmosphere at a predetermined time interval after the cessation of signals from said brachial transducer.

14. A system for determining the systolic and diastolic blood pressures of a patient comprising

a digital transducer,

an inflatable cuff surrounding said digital transducer,

a brachial transducer,

an inflatable cuff surrounding said brachial transducer,

a pneumatic pressure supply,

conduit means coupled between said supply and said cuffs,

control valves in said conduits,

electromechanical means coupled between said transducers and said control valves for controlling the pressures in said cuffs in response to signals from said transducers,

timer means coupled to said electromechanical means for transferring the pneumatic pressure from one of said cuffs to the other of said cuffs at predetermined intervals,

means for indicating the pneumatic pressure in said cuffs, and

means for visually indicating the output of said transducers.

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