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AUTOMATIC BLOOD PRESSURE RECORDER

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Fig. 1.

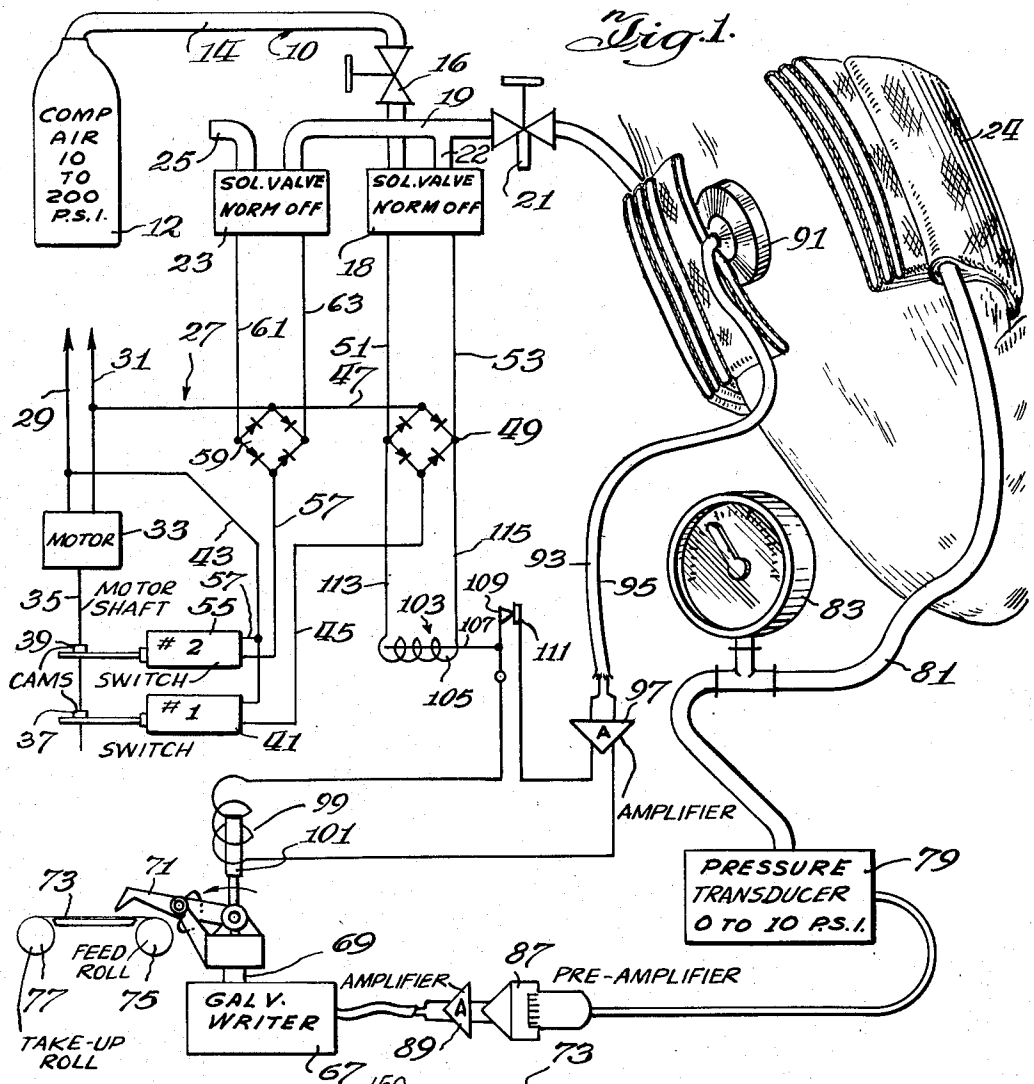
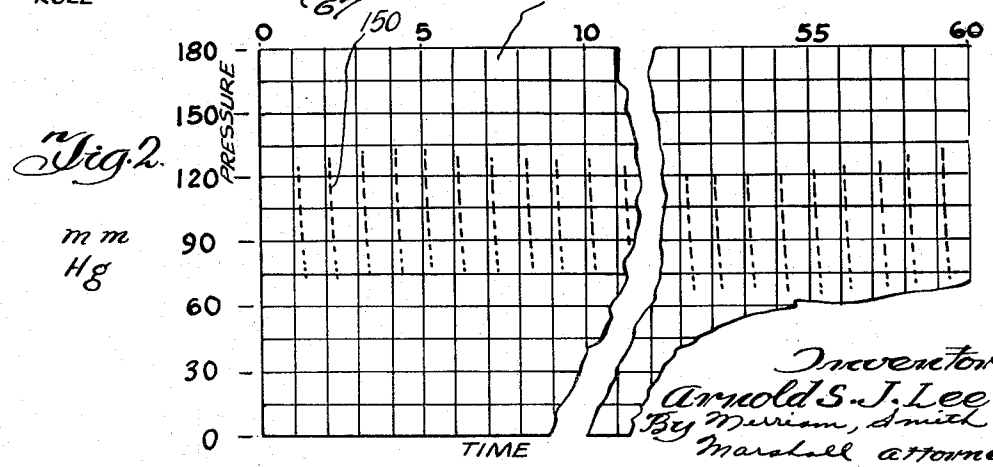


Fig. 2.



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AUTOMATIC BLOOD PRESSURE RECORDER

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This invention relates to blood pressure recording apparatus and more particularly to apparatus for recording blood pressure pulses as a series of dashes, each representing a blood pressure pulse.

Heretofore, devices have been known which are capable of reproducing in graphic fashion blood pressure pulses as they occur. These devices commonly recorded blood pressure pulses in the form of continuous waves which were difficult to interpret.

This invention is primarily directed to an automatic blood pressure recording system by means of which successive readings may automatically be taken without need for direct participation by a physician and in which blood pressure pulses are recorded in the form of a series of spaced dashes, from the systolic to the diastolic readings, which are single-valued functions of pressure. In the present instance, the spaced dashes form a graph of successive blood pressure cycles, the ordinate of which represents pressure and the abscissa of which represents time. In particular, this invention is directed to a system in which blood pressure pulses are recorded as a plurality of series of successive dashes substantially at right angles to the direction of travel of the recording medium. The term "dashes" is used in its usual descriptive sense to refer to traces or recorded lines of finite length.

FIGURE 1 is a schematic diagram of an automatic blood pressure recording system made in accordance with the present invention; and

FIGURE 2 is a graphic representation of the visible recording medium.

Referring now to the drawing, the automatic blood pressure recording system of the present invention is illustrated generally by reference numeral 10 and includes a source 12 of gas under pressure, such as compressed air or the like, a conduit 14, a regulating valve 16 for controlling the pressure of gas from the source 12, a normally closed solenoid valve 18, and a conduit 22 connecting the valve 18 to a manifold 19 in communication with a conventional blood pressure recording cuff 24.

According to the present invention, the cuff 24 is successively inflated by opening the valve 18 to afford free fluid communication between the gas source 12 and the cuff. At the termination of the inflation interval, gas is bled from the cuff 24 through a leak control or bleed valve 21. As the cuff is deflated, blood pressure pulses occurring during this deflation interval are recorded in a manner hereafter described. After completion of the deflation interval, the cuff is completely evacuated by opening of a normally closed solenoid valve 23 for exhausting the gas through a port 25 in a manner hereafter apparent.

The valves 18 and 23 are selectively actuated by means of a control circuit generally indicated by reference numeral 27 which includes power leads 29 and 31 connected to a synchronous motor 33 for rotation of a shaft 35 upon which are mounted cams 37 and 39. Opening of valve 18 is effected by energization of microswitch 41 by rotation of the cam 37. Microswitch 41 is connected to power lead 29 by means of a conductor 43 and to power lead 31 by means of conductors 45, 47 and rectifier bridge 49 which in turn is connected to the solenoid of the valve 18 by means of conductors 51 and 53.

Cam 39 is so phased as to afford a suitable time interval before opening of the valve 23. This opening is effected by means of microswitch 55 having a conductor

57 connected to the conductor 43 and a conductor 57 connected to the conductor 47 through rectifier bridge 59. Conductors 61 and 63 connect the rectifier bridge 59 with the solenoid of the valve 23.

In the illustrated embodiment of the present invention, blood pressure pulse beats are recorded as a plurality of series of dashes 150 from the systolic to the diastolic readings. To this end, there is provided a galvanometer writer 67 having an oscillatable shaft 69 upon which is pivotally mounted a stylus 71. The stylus 71 is preferably of the heated type for selective recording of blood pressure pulses on a continuous record 73, of heat sensitive paper or the like, which is initially wound about roll 75 and is progressively wound, at a very low rate of speed, by any suitable means on a roll 77. Oscillation of the shaft 69, for movement of the stylus 71, is effected in response to pressure conditions within the cuff 24 in a manner which will now be described. For this purpose a strain gauge or pressure transducer 79 is disposed in fluid communication with the cuff 24 by means of conduit 81. A manometer 83 may be disposed in the conduit 81, if desired.

As the cuff 24 progressively deflates, and the output of the strain gauge 79 decreases, the end of the stylus 71 is moved across the moving record 73 from top to bottom, as viewed in FIGURE 2; that is, from the systolic to the diastolic. The strain gauge output, within a predetermined decreasing range, may be suitably amplified for operation of the galvanometer 67 by means of pre-amplifier 87 and amplifier 89.

As the end of the stylus 71 swings across the moving record 73 in close proximity to the record, impressions are made by intermittent pivoting of the stylus about its axis in response to blood pressure impulses. For this purpose a microphone 91, which is preferably of the low frequency sensitive crystal type built into a stethoscope head, is arranged under the cuff 24 to convert the pulse beats into electrical impulses. The microphone is connected by means of conductors 93 and 95 to an amplifier 97, the output of which actuates a solenoid 99 which has an armature 101 movable upwardly, as viewed in FIGURE 1, to pivot the stylus 71 about its axis and effect momentary contact of the stylus point with the moving record.

Energization of the stylus circuit while the end of the stylus is swinging towards the end of its arc at the systolic end is prevented by means of a disarming relay 103 which includes a solenoid 105 having an armature 107 connected to a pivotally mounted contact 109 which may selectively engage a stationary contact 111. The solenoid 105 is connected to the rectifier bridge 49 by means of conductors 113 and 115. As the valve 18 is actuated for inflating the cuff 24, the energization of its circuit also energizes the solenoid 105 to pivot the contact 109 to the left, as viewed in FIGURE 1, to break the stylus circuit. As previously explained, de-energization of the stylus circuit prevents recording as the cuff 24 inflates. It will be apparent that as the stylus 71 moves downwardly, as viewed in FIGURE 2, recording commences at a level when the pulse would normally be first heard by the physician. Then pulses are recorded approximately one every second until the diastolic level is reached. To obtain this result, the amplifier 97 is preferably of the transistor type with high input impedance and a low frequency response. Preferably the output is in the order of one watt. The pressure regulating valve 16 is preferably between the range of 0–8 p.s.i. The strain gauge or transducer 79 is desirably connected to a suitable strain gauge coupler of the preamplifier 87.

In operation, the cuff 24 is placed in position over the brachial artery in the upper arm and the microphone 91 is positioned beneath it. The valve 16 is then opened

and the energy source energized. As the shaft **35** rotates, the cam **37** closes microswitch **41** to open valve **18** to permit the flow of gas, such as compressed air or the like, from the reservoir **12** to the cuff **24** by way of conduit **14**, valve **16**, valve **18**, conduit **19** and bleed valve **21**. The bleed valve **21** is adjusted to bleed air to atmosphere at a rate sufficient to deflate the cuff **24** within a period of about 15 seconds. After additional rotation of the shaft **35**, and after air has been progressively bled to atmosphere through valve **21**, microswitch **55** is closed by cam **39** to open the valve **23** to permit complete exhaustion of the cuff **24** to atmosphere through the exhaust port **25**. As the cuff **24** deflates, the end of the stylus **71** is moving in an arcuate path from top to bottom in FIGURE 2. While the pressure in cuff **24** still exceeds approximately 120 mm. Hg, blood circulation in the brachial artery is cut off and no pulse beats are transmitted. As the air progressively bleeds out through the valve **21**, no record is made until a pulse beat is detected by the microphone **91**. The first pulse beat recorded represents the systolic blood pressure and each successive dash **150** represents a pressure pulse beat. The last recorded pulse beat represents the diastolic blood pressure reading. After this point, the pressure of the pulse beats is insufficient to energize the stylus circuit.

The automatic blood-pressure recording system of the present invention exhibits important advantages over automatic recording devices heretofore known. For instance, the visible record is extremely simple since there is recorded not only the systolic and the diastolic blood pressure readings for each deflation cycle of the cuff, but the characteristics of each pulse beat in a cycle are recorded as a series of dashes substantially at right angles to the direction of travel of the recording medium. The strength and interval of each pulse beat are readily visible to the physician. The stylus circuit operation is a single value function of the pressure in the cuff. Preferably the inflation of the cuff is accomplished in one or two seconds and deflation in about 15 seconds.

The system of the present invention basically involves the presentation of blood pressure data in the form of a series of dashes, from the systolic to the diastolic readings, the dashes of one cycle being substantially parallel to the dashes of the preceding cycles. The record may be reproduced in any suitable way, such as by the use of a cathode ray oscilloscope, optical beam recorder, or the like. For the sake of simplicity, applicant has illustrated recording by means of a hot stylus on a heat sensitive medium.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. An automatic blood pressure recording system comprising a source of gas under pressure, an inflatable cuff, control means for selectively inflating said cuff with gas from said source, a bleed valve for progressively deflating said cuff, said control means being further operative to completely deflate said cuff after a predetermined amount of gas has been exhausted through said bleed valve, a recording galvanometer having an oscillatable recording stylus arranged to oscillate into and away from contact with the surface of a recording medium, a timing motor, means including said motor for conjointly controlling said cuff-inflating means and the periodic recording of said galvanometer, means for detecting pressure pulse beats as the pressure in said cuff decreases, means for converting said pulse beats into electrical impulses, and means controlled by said converting means and including said recording galvanometer to effect recording of a series of dashes, each representing one of said pressure pulse beats, on said recording medium.

2. An automatic blood pressure recording system comprising a source of gas under pressure, an inflatable cuff, means providing fluid communication between said gas pressure source and said cuff, means for controlling the flow of gas to said cuff to effect alternate inflation and deflation thereof, a bleed valve for progressive deflation of said cuff, said control means comprising a first solenoid valve operable upon actuation to afford inflating of said cuff, a second solenoid valve operable upon actuation to exhaust gas in said cuff to atmosphere, a synchronous motor having a shaft, a pair of cams disposed on said shaft in phased relation, a microswitch operatively associated with each of said cams, each of said microswitches being electrically connected to each of said solenoid valves and being alternately energizable by said cams for alternate energization of said solenoid valves, a recording galvanometer having a stylus oscillatable in response to pressure in said cuff and intermittently progressively recording medium disposed in limited spaced relation to said stylus, means for detecting pressure pulse beats as the gas in said cuff is progressively exhausted through said bleed valve, means for converting said pulse beats into electrical impulses, means for amplifying said electrical impulses, solenoid means operable in response to said amplified impulses for selectively urging said stylus into recording engagement with said recording medium in response to each amplified electrical impulse, and means for de-energizing said solenoid means when said first solenoid valve is de-energized.

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