A. T. KEYT.

Sphygmometer

No. 203,548. Patented May 14, 1878.

FIG. 1.

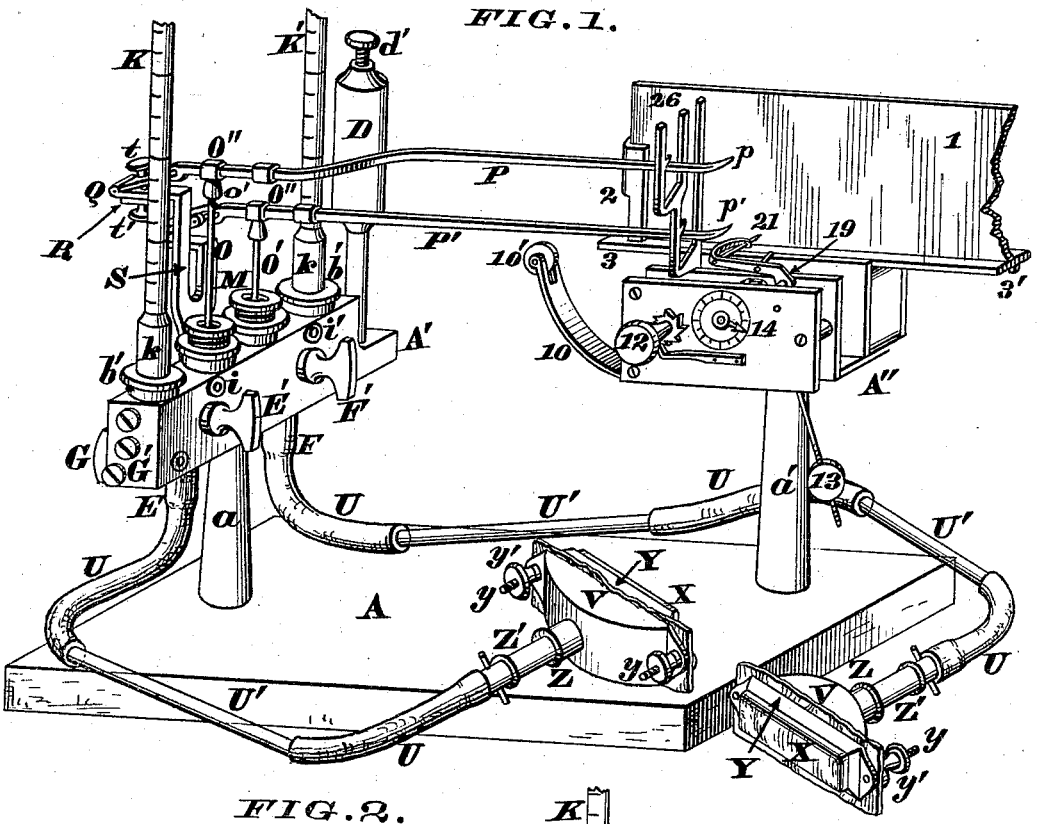


FIG. 2.

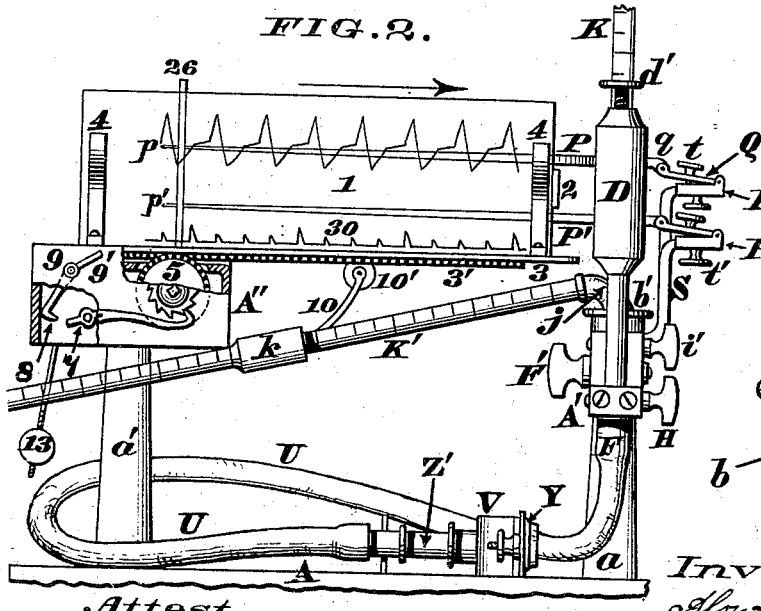
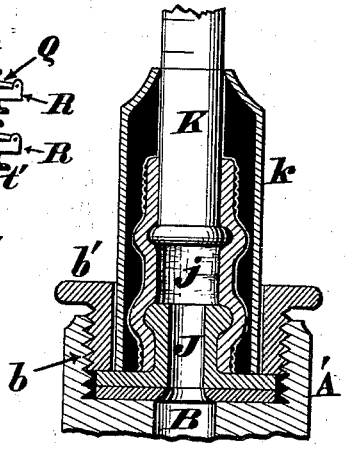


FIG. 3.



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Alonzo T. Keyt
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A. T. KEYT.

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FIG. 4.

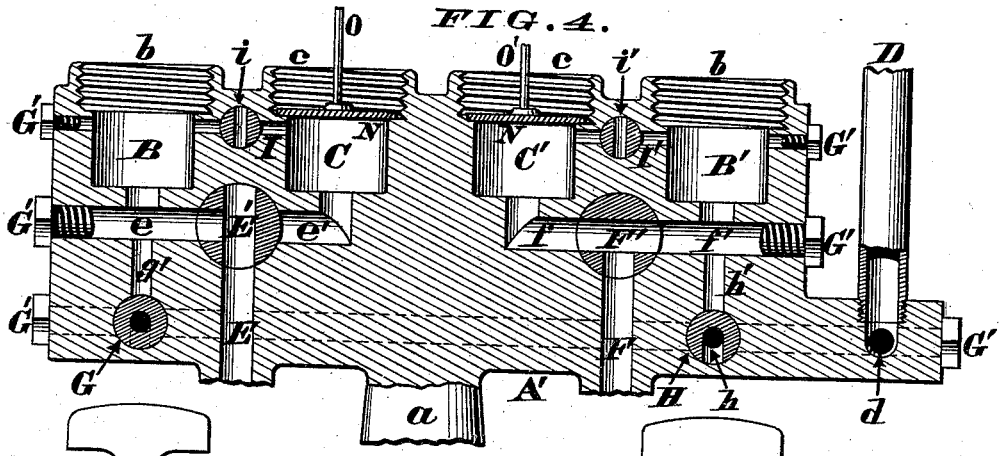


FIG. 5.

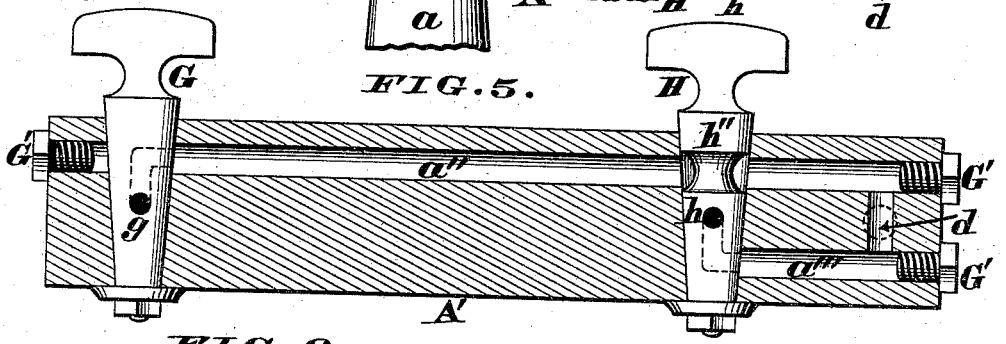


FIG. 6.

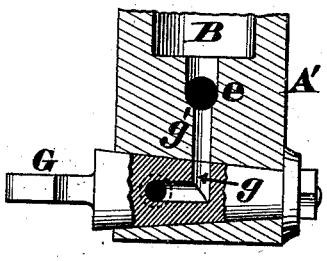


FIG. 7.

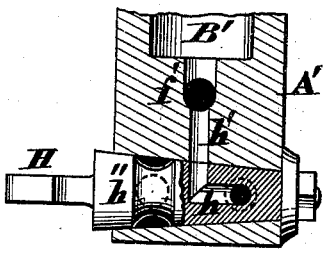


FIG. 8.

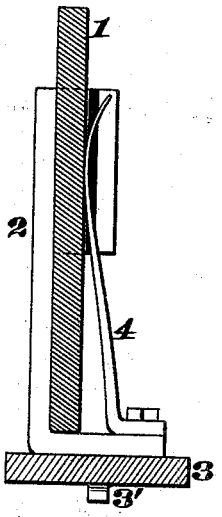


FIG. 9.

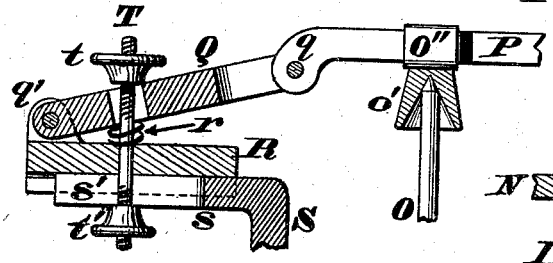
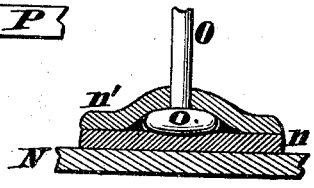


FIG. 10.



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3 Sheets—Sheet 3.

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FIG. 11.

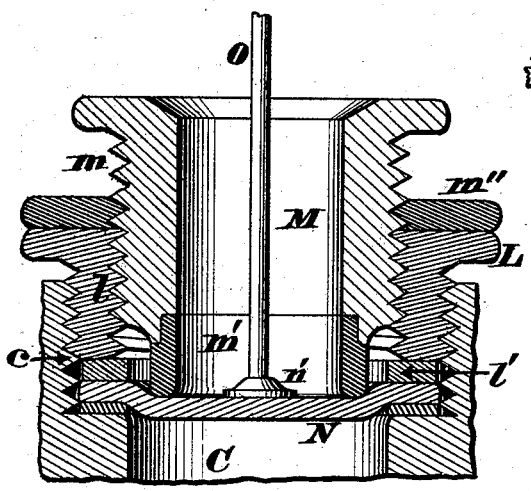


FIG. 12.

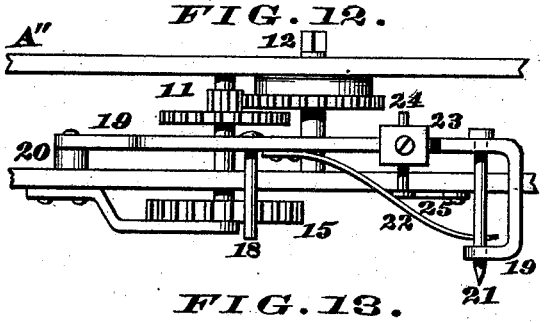


FIG. 13.

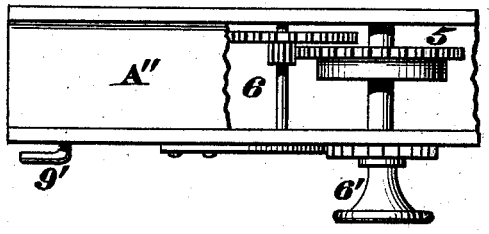


FIG. 15.

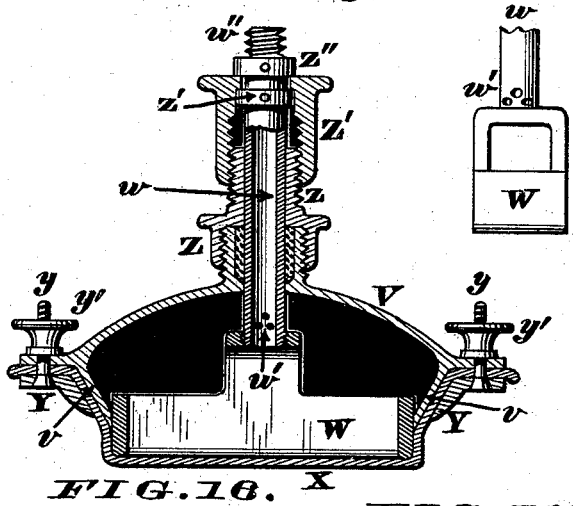


FIG. 14.

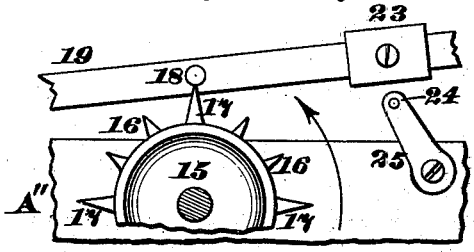


FIG. 18.

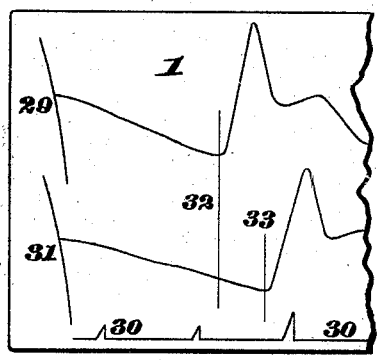


FIG. 16.

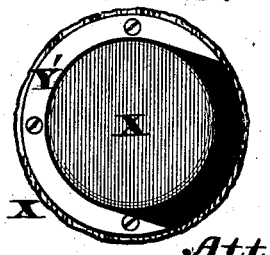
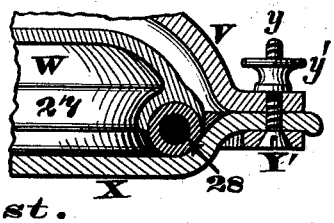


FIG. 17.



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UNITED STATES PATENT OFFICE.

ALONZO T. KEYT, OF CINCINNATI, OHIO.

IMPROVEMENT IN SPHYGMOMETERS.

Specification forming part of Letters Patent No. **203,548**, dated May 14, 1878; application filed March 23, 1878.

To all whom it may concern:

Be it known that I, ALONZO T. KEYT, of Cincinnati, Hamilton county, Ohio, have invented a Combined Sphygmometer, Sphygmograph, Cardiometer, Cardiograph, Stethometer, and Stethograph with Chronograph Attachment, of which the following is a specification:

The earliest sphygmometer of which I have any record is the one invented and used by Dr. Hirrison, of France, which instrument comprised a fluid-receptacle, an index-tube for exposing the pulsations, and an elastic membrane for communicating motion from the pulse to the fluid. For a further description of this sphygmometer see a work translated from the French by Dr. E. S. Blundell, in 1835, entitled "The Sphygmometer, an instrument which renders the action of the arteries apparent to the eye, by Dr. Julius Hirrison." An instrument constructed on the same principle as the above was used by Dr. Scott Allison, of England, in 1856, a full description of which instrument, under the name of "Sphygmoscope," is given in "The Lancet," American edition, Vol. II, 1856, page 527, and Vol. I, 1857, page 240. Drawings of the same are seen in "Beale's Microscope in Medicine," third edition, page 292; also in the "Scientific American," June 13, 1857, page 318. This instrument was also provided, when required, with a flexible tube or hose, to connect the glass tube or indicator of the device with the fluid-receptacle.

Conceding, then, that these features of the sphygmometer are old and well known to the medical profession, my invention consists, first, in combining in a single structure an instrument capable of simultaneously tracing on a suitable tablet, or medium of any kind, the action of two distinct members or bodies, as the heart and an artery, or two arteries, by which arrangement the slightest variations between such pulsations can be detected at a glance.

The second part of my invention consists in combining with this duplex tracing-instrument a chronograph attachment, that indicates upon the aforesaid tablet or medium certain predetermined intervals of time, such as fractions of seconds, &c., in order that the variations between the tracings of any two pulsation-records may be measured with the utmost precision.

The third part of my invention comprises a novel construction of that portion of the instrument which is applied directly to the pulsating body, the object of this improvement being to adapt the elastic membrane to the surface over different pulsating organs, and to adjust said membrane to the proper tension. This portion of the instrument I have designated as the "pulse-base."

The fourth part of my invention consists in imparting motion from said pulse-base to the tracing-lever by means of a delicate diaphragm whose under surface receives the impulses of the transmitting-fluid. This diaphragm is preferably disk-shaped, and is securely confined at its margin in a suitable cup or chamber, into which chamber the transmitting-fluid can be diverted when desired.

The fifth part of my invention consists in a combination of devices for increasing or diminishing the tension of this elastic diaphragm.

The sixth part of my invention comprises a novel combination of slide, leaf, spring, and temper-screw for the delicate adjustment of the pivoted end of the tracing-lever.

The seventh part of my invention comprises a novel method of coupling the index-tube to the stand of the instrument, which coupling devices are constructed so as to maintain the tube perfectly erect when in use, while at the same time allowing said tube to be turned or bent down to a horizontal position when the instrument is out of service.

The eighth part of my invention consists in providing the aforesaid stand with a series of chambers, channels, and stop-cocks, which cocks are so constructed and arranged as to permit the transmitting-fluid to traverse the index-tube or set the tracing-levers in motion.

The ninth part of my invention consists in providing said stand with another series of channels and stop-cocks, for the purpose of charging the chambers with a proper quantity of transmitting-fluid, which fluid flows by gravitation simply from an elevated reservoir fitted to said stand.

The tenth part of my invention consists in coupling the pulse-base to the appropriate

channel of the stand by means of a hose composed of alternate sections of rubber and glass, or other flexible and transparent materials. Such a hose can be handled with perfect facility, while the transparent sections enable the operator to detect the presence of any air-bubbles in the transmitting-fluid, which bubbles would impair the efficiency of the instrument and cause it to give false records.

The eleventh part of my invention comprises a novel combination of clock-work and carriage, wherewith the tablet is advanced at a regular speed, so as to insure a uniform action of the tracing-levers against said tablet.

The twelfth part of my invention consists in providing this carriage with suitable standards and springs, that maintain the tablet in a proper position to be acted on by said tracing lever or levers.

In addition to these leading features of my invention, I have devised various details of construction, which details will be hereinafter fully described.

In the annexed drawings, Figure 1 is a perspective view of my combined instrument ready for use, the upper ends of the index-tubes being broken away and a portion only of the tablet being shown. Fig. 2 is a side elevation of the instrument, the nearest index-tube being bent down, and the tablet represented as having nearly completed its course. Fig. 3 is an enlarged axial section through the coupling devices of one of the index-tubes. Fig. 4 is a vertical longitudinal section through the stand that supports the tracing-levers, index-tubes, &c. Fig. 5 is a horizontal section through said stand, taken in the plane of the channels that communicate with the reservoir, the reservoir-cocks being shown open. Figs. 6 and 7 are vertical sections through said reservoir-cocks and their communicating channels. Fig. 8 is an enlarged vertical section, showing the tablet secured to the carriage. Fig. 9 represents the adjusting devices at the pivoted end of one of the tracing-levers. Fig. 10 shows the method of attaching the needle to the flexible diaphragm that operates the tracing-lever. Fig. 11 is an enlarged vertical section through said diaphragm and its attachments. Fig. 12 is a plan of the chronograph or time-marker. Fig. 13 is a plan of the clock-work that drives the tablet-carriage. Fig. 14 is an elevation of the time-marking wheel of the chronograph. Fig. 15 is a vertical section of the pulse-base. Figs. 16 and 17 represent modifications of said base; and Fig. 18 represents a portion of a tablet having two tracings and the time-line marked on it.

A represents a table or bed-plate, having two pillars, *a a'*, that support, respectively, the stand A′ and the housing A″, said stand being furnished with four distinct chambers or cups, B B′ and C C′, of which chambers the two outer ones, B B′, communicate with the graduated index-tubes of the instrument, while the two inner cups, C C′, have fitted within them the devices that impart motion to the tracing-levers. Furthermore, this stand A′ is traversed longitudinally and near its bottom with two parallel channels, *a″* and *a‴*, that communicate, by means of the branch *d*, with an elevated reservoir, D, having at its upper end a screw-threaded tap or a stopper, *d′*, whose removal permits the ready filling of said reservoir with alcohol or any other fluid that will transmit the beats of the pulse to the various indicating devices of the instrument.

E is a vertical channel, communicating by branches *e e′* with chambers B and C. E′ is a three-way cock, wherewith either of these channels *e* or *e′* can be caused to communicate with the inlet E; or said cock may be so rotated as to close this inlet E.

F is another vertical inlet, whose horizontal branches *f f′* communicate with chambers B′ and C′. F′ is the three-way cock of said inlets F *f f′*.

The longitudinal channel *a″* has a reservoir-cock, G, whose port *g* communicates with channel *e* by the passage *g′*. The other longitudinal channel, *a‴*, has a reservoir-cock, H, whose port *h* communicates with channel *f′* by passage *h′*. This cock H is provided with a circumferential groove, *h″*, to permit the ready flow of fluid along channel *a″* as soon as the other cock, G, is opened.

G′ are taps or plugs, whose removal permits the various channels of the stand to be cleaned of any sediment.

Communicating with the upper portions of chambers B and C is a passage, I, controlled with a cock, *i*. The other chambers, B′ and C′, are provided with a precisely similar arrangement of passage, I′, and controlling-cock, *i′*. The object of these passages and cocks is to permit the escape of air from the inner chambers C C′ to the outer ones, B B′, when the instrument is first charged with alcohol.

Chamber B has a female thread, *b*, to receive the external thread of a gland, *b′*, that is screwed down firmly against the annular flange of a short nipple, J, to whose upper or beaded end a flexible coupling, *j*, is secured. This short tube *j* connects with the lower and beaded end of a glass tube, K, thereby affording a yielding coupling, that will allow said index-tube to be bent down to a horizontal position as soon as the thimble *k* is withdrawn from the bore of gland *b′*. This index-tube is graduated in any suitable manner. The other outer chamber, B′, has a precisely similar provision of gland, nipple, flexible coupling, and thimble, and a graduated index-tube, K′.

The inner chamber C has a female thread, *c*, to receive the external thread of a gland, L, which latter has an internal thread, *l*, that engages with the male thread *m* of a follower, M, whose lower end is shod with an annulus, *m′*, of hard rubber; or this shoe may be composed of any other material that will not adhere to the diaphragm.

Engaging with the thread *m* of this follower is a lock ring or nut, *m″*, that is capable

of being set so as to prevent the adjusting device M descending too far into chamber C. Gland L bears against a ring, l', which grasps the margin of a disk-shaped diaphragm, N, composed of thin rubber or any other sensitive material, whose tension can be regulated by causing the follower M m' to press upon said diaphragm with any desired force. After the proper tension of this diaphragm has been obtained the lock-ring m'' can be set accordingly, so as to insure the same pressure at all times when the instrument is to be used; but when not in use the follower M is elevated, so as to relieve said diaphragm of any tension whatever, and thus preserve its elasticity. Secured to the center of this diaphragm by two small disks, n and n', is the head o of a finely-pointed needle, O, said needle being passed through the upper disk n', after which act said disks are cemented to each other and then cemented to the device N. (See Fig. 10.) The other inner chamber, C′, is furnished with a similar arrangement of gland, follower, lock-ring, and diaphragm, and a needle, O′. The pointed end of needle O enters a conical socket, o', of a sliding clip, O″, which clip is applied to a lever, P, whose free end is bent and pointed at p, to serve as a tracer. The other needle, O′, enters a similar socket of a sliding clip applied to lever P′, whose free end is bent, so as to act as a tracer, as seen at p' in Fig. 1.

The heel of lever P is pivoted at q to a leaf, Q, which latter is hinged at q' to a slide, R, capable of being adjusted upon the horizontal limb s of a forked bracket, S, whose lower end is attached to the stand A′. Traversing the leaf Q, slide R, and slot s' of limb s is a stem, T, threaded at both ends, and carrying an upper nut, t, and a lower nut, t'. r is a spring interposed between leaf Q and slide R, which slide is first adjusted, and then secured with nut t' in such a position as to dispose needle O exactly in line with the axis of chamber C. Nut t is then adjusted so as to secure the proper level of tracing-point p. The other lever, P′, is furnished with a precisely similar arrangement of adjustable leaf, slide, &c.

Communicating with the inlet E of stand A′ is a hose composed of flexible sections U and transparent sections U′, which latter are made of glass or other suitable inelastic material. The other end of this composite hose or coupling is attached to the pulse-base, whose construction is clearly shown in Fig. 15. In this illustration, V represents a box or other fluid-receptacle, having a sloping margin, v, whose rectangular opening is traversed by a follower, W, screwed to a tubular stem, w, whose lower end is perforated at w' to permit the escape of air from said box when it is filled with alcohol. Spanning this opening, and fitting snugly against the sloping margin v, is a thin membrane, X, of india-rubber or other suitable elastic material, said rubber being clamped to the box with a frame, Y, whose screw-threaded pins y pass through lugs of the receptacle V, and are secured with thumb-nuts y'. The tubular stem w traverses a stuffing-box, whose gland Z is prolonged upwardly, and has a male thread, z, for engagement of the interiorly-threaded coupling Z′, the upper end of which latter is confined between two collars, z' z'', secured to said stem. The outer extremity of this stem is threaded at w'' for engagement with the coupling of hose U U′.

It is evident that by properly rotating the coupling Z′ the follower W will advance or recede within box V, and thereby impart a greater or less tension to the membrane X. By protruding the follower through the opening of box V this membrane will be brought somewhat below the general level of devices V and Y, and thus insure a more intimate contact of said membrane with the pulsating body.

The pulse-base and its attached hose, that communicates with the other inlet, F, of the stand A′, being precisely similar to the devices previously alluded to, require no further description.

All of the appliances described thus far are necessary for transmitting the pulsations to the index-tubes and tracing-levers; but, in order that the tracers may effect a permanent record of such pulsations, I provide my instrument with a tablet and driving mechanism, whose construction is as follows: The tablet 1, which is preferably a strip of smoked glass, is maintained against the vertical standards 2 of carriage 3 by springs 4, which arrangement allows strips of various widths and thickness being applied to said carriage. Furthermore, this arrangement maintains the prepared side of the tablet in the same plane, no matter what difference may exist in the thickness of the glass, and consequently the tracers p p' will bear with uniform pressure against any plate that may be applied to the carriage 3. This carriage is confined to a horizontal path by suitable guides in the housing A″, and said carriage has on its under side a longitudinal rack, 3′, that engages with one of the wheels 5 of any suitable clock-train, 6, which may be wound up with knob or handle 6′. Adapted to engage with the fly 7 of this train is a detent, 8, of rock-shaft 9, which latter has an external crank or handle, 9′. (See Figs. 2 and 13.) Projecting from the inner end of housing A″ is an arm, 10, that carries a small roller, 10′, said roller being adapted to support the carriage 3 as the latter advances toward the stand A′. This housing A″ is provided with another clock-movement, 11, which is wound up with handle 12, and is regulated by pendulum 13, or by balance and escapement. 14 represents a dial of this clock, said dial being furnished with a hand that revolves once a minute, the object of these devices being to indicate whether the train 11 is keeping correct time or not. Of this train one of the wheels, 15, is armed with teeth 16 of uniform size, and with another set of teeth, 17, that project some distance beyond

the ones 16, as shown in Fig. 14. These projecting teeth 17 are arranged at regular intervals on wheel 15, and are preferably disposed in such a manner as to indicate seconds of time, while the intermediate or smaller teeth 16 indicate fractions of seconds.

In Fig. 2 the time-line 30, near the lower edge of the tablet 1, represents the effect that would be produced by interposing three small teeth between the larger ones; but the arrangement shown in Fig. 14 would cause said time-line to be divided into seconds and thirds of seconds. The aforesaid line 30 is produced by the contact of the various teeth of wheel 15 with the lug 18 of a vertically-vibrating lever, 19, that is pivoted to housing A″ at 20. The free or distal end of this lever carries a point or stylus, 21, that is maintained against the prepared surface of tablet 1 by a delicate hair-spring, 22. 23 is an adjustable weight, that insures the descent of the free end of lever 19, the lever being arrested by a horizontal pin, 24, of arm 25, which arm is capable of being set at any angle by the screw wherewith it is attached to the housing A″.

26 represents guides for the free ends of levers P P′, said guides being provided with inwardly-projecting spurs, that support these levers when not in use. The lower ends of these guides are inclined, so as to deflect the levers away from the tablet, and thereby prevent the tracers *p p′* being caught and bent when carriage 3 advances.

The circular form of pulse-base shown in Figs. 16 and 17 is intended more especially for receiving the movements of respiration, thereby converting the instrument into a stethometer and stethograh. This base may be held in contact with the chest by a suitable band or strap, and in some cases it is to be preferred to the form shown in Figs. 1 and 15 for receiving the pulsations of the heart. The membrane of this circular form of base is secured to receptacle V with an annulus, Y′, and screws *y*, said membrane being adjusted with a dome-shaped follower, W, that is advanced and retracted by an arrangement of devices similar to those shown in Fig 15.

I prefer, however, to provide this follower with an annular crease or gutter, 27, to receive an elastic or compressible ring, 28, in order the better to adapt the base to inequalities of surfaces to which it is applied, and render it more sensitive to the movements beneath it.

The other follower (seen in Fig. 15) may have a similar arrangement of annular gutter and hollow compressible ring-bearing for the membrane.

To render the operation of my instrument perfectly clear, I will first describe its actions as a single sphygmometer and sphygmograph, presuming that the index-tube K is the one that is to be used for observing the movements of the pulse.

The hose-connecting inlet E with the proper pulse-base is first unscrewed from said receptacle V, after which act said receptacle and hose are charged with alcohol. The hose and receptacle are then coupled together, and cock G is opened, so as to allow alcohol to flow from the elevated reservoir D and fill chamber B until the fluid stands on a level with the lower or zero mark of the graduated scale of index-tube K, the cock *i* being closed and the one E′ set as seen in Fig. 4. Base V is now applied so as to bring its membrane X in close contact with the pulse, and the motions of the latter, being readily communicated through this sensitive membrane, impart corresponding fluctuations to the alcohol in index-tube K, the graduated scale of which allows these fluctuations to be observed with the greatest precision.

The proper pressure of the base on the pulse causes the liquid to rise in the tube and afford the largest sweep or range of oscillation. Thus the various qualities of the pulse are shown to the eye, and the instrument performs the office of a sphygmometer. But, in order to preserve a permanent record of these pulsations, it is necessary to convert the instrument into a sphygmograph, which act is accomplished as follows: Cock E′ is turned in the same direction as the one F′ in Fig. 4, thereby opening communication between chambers B and C and allowing the latter to fill with alcohol, the valve *i* having been previously opened to permit the escape of air from chamber C into the one B, and thence out at the upper open end of tube K. These chambers are allowed to fill until the liquid stands at the zero-mark in tube K, and the valves G and *i* are then shut. The glass 1 is now inserted between the uprights 2 and springs 4 of carriage 3, with the smoked or otherwise prepared surface of said glass or other medium presented to the tracers *p p′*. The clock-movements 6 and 11 are then wound up with their respective winders 6′ and 12, and detent 8 is engaged with the fly 9 of movement 6, so as to prevent the carriage 3 starting until everything is ready. Pulse-base V is then applied lengthwise of an artery, and as soon as the greatest range of oscillation is reached in the index-tube K cock E′ is turned, so as to shut off communication between said base and chamber B and compel the pulsations to exert themselves wholly against diaphragm N of the chamber C. This sensitive diaphragm imparts a corresponding motion to the carefully-adjusted lever P, and consequently its tracer *p* describes an arc of a circle whose center is the pivot *q* of said lever. This arc is seen at 29 in Fig. 18.

These preliminaries having been attended to, pendulum 13 is set in motion, and detent 8 is disengaged from fly 7, so as to liberate the clock-movement 6 and allow wheel 5 of the same to propel carriage 3 and its tablet 1 toward stand A′, as indicated by arrow in Fig. 2, which act is accomplished in a few seconds; but during this brief interval the tracer *p* has inscribed on said tablet a com-

plete and correct record of the nature of the pulsations, as represented by the irregular line near the upper edge of the tablet. As these tracings are familiar to those who have made the sphygmograph a special study, no further description of them is necessary in this specification. During this advance of the carriage the point or stylus 21 has also been at work, and has traced near the lower edge of the tablet a straight or horizontal line, 30, interrupted at regular intervals with a series of slight upward deflections, and another series of still greater upward deflections, which deflections show exactly what relation the pulsations bear to certain periods of time.

It is evident that, by applying the base V to the heart and operating the instrument as just described, it will perform the office of a cardiometer and cardiograph, and, with the base shown in Fig. 16, it shows and records the respiratory movements, and thus becomes a stethometer and stethograph of the most approved character. The other tracing-lever, P′ *p*′, has remained inactive during these operations, because the base communicating with inlet F has not been called into service; but by so doing the utility of the instrument is greatly enhanced, and I will now proceed to describe such a duplex use of the same, presuming that it is desired to make tracings of two distant arteries—as, for example, the carotid artery and the dorsal of the foot. Chambers B′ and C′ and their passages or channels are now charged with alcohol, and the various preliminary operations are attended to, as previously described, after which the pulse-base of inlet E is applied to the carotid, while the pulse-base communicating with the other inlet, F, is held against the dorsal, and the carriage 3 is again started. The two points *p p*′ are thus brought into service, and they trace upon the tablet a pair of irregular lines, of which approximations are shown in Fig. 18, the arc 29 indicating the sweep of tracer *p* before the commencement of the upper one of said lines. The arc 31 represents a similar sweep of the other tracer, *p*′. This tablet has also inscribed upon it the time-line 30. After the tablet has been detached from the carriage two parallel vertical lines, 32 and 33, are drawn upon its prepared surface, of which lines the one, 32, indicates the moment the carotid pulsation commenced, while the other line, 33, represents the instant of pulsation of the dorsal of the foot. Now, as these lines are not the same distance from the respective arcs 29 and 31, it is evident they indicate a loss of time between the pulsation of the carotid and that of the dorsal, which loss of time can be very accurately measured by the line 30. To do this it is simply necessary to lay off the distance from line 32 to line 33 on line 30, and then note what proportion this distance bears to the graduations of said line 30. In the present illustration the distance from line 32 to line 33 is found to be equal to one-half the distance between the deflections or graduations of line 30, and, as these deflections are supposed to indicate fourths of a second, it is therefore apparent that the carotid pulsation commenced one-eighth of a second before the dorsal pulsation began.

To test the accuracy of these indications, it is only necessary to reverse the operations—that is to say, to apply the pulse-base of inlet E to the dorsal and place the pulse-base of the other inlet, F, on the carotid artery.

By applying one pulse-base to the heart and the other to an artery, the instrument performs the duties of a combined sphygmograph and cardiograph, wherewith any difference between the heart-beats and the pulsations of the artery can be observed and recorded with the utmost precision.

While preferring to connect the pulse-bases to the inlets E and F of stand A′ by means of the sectional hose shown at U U′ in Fig. 1, the right is reserved of employing an ordinary tubing for the same purpose, as represented in Fig. 2.

I also reserve the right of using a suitable retaining device for holding the pulse and respiration bases in place over the organs whose actions are to be observed.

I claim as my invention—

1. A duplex sphygmograph capable of simultaneously tracing the pulsations of any two arteries, &c., on a single tablet, substantially as herein described and set forth.

2. In combination with a duplex sphygmograph capable of simultaneously tracing the pulsations of any two arteries, &c., on a single tablet, a chronograph attachment for indicating the time on said common tablet, substantially as herein described and set forth.

3. In combination with a duplex sphygmograph capable of simultaneously tracing the pulsations of any two arteries, &c., on a single tablet, and a chronograph attachment for indicating the time, a clock-movement for advancing said tablet at an uniform speed, substantially as herein described and set forth.

4. In combination with a duplex sphygmograph, the slide 3, carrying the tablet 1 and the tracers P *p* P′ *p*′, operated by elastic diaphragms N, and needles O O′ of chambers C C′, to which chambers the pulsations are transmitted, substantially as herein described and set forth.

5. In combination with carriage 3, tablet 1, and vibrating tracers P *p* P′ *p*′ of a duplex sphygmograph, the stylus 21, vibrating arm 19, and operating-wheel 15, said wheel being armed with a series of short teeth, 16, and a set of longer teeth, 17, for indicating seconds and subdivisions of seconds on said tablet, substantially as herein described and set forth.

6. In combination with carriage 3, tracers P *p* P′ *p*′, and time-indicator 15 19 21 of a duplex sphygmograph, the rack 3′ and clock-movement 5 6, for advancing said carriage at a uniform speed, substantially as herein described.

7. The elastic diaphragm N, secured within

chamber C by gland L, and having connected to it the needle O, wherewith said diaphragm communicates motion to the tracing-lever P *p*, substantially as herein described.

8. In combination with the elastic diaphragm N, secured within chamber C in the manner specified, the follower M, traversing gland L, and capable of being adjusted to regulate the tension of said diaphragm, substantially as herein described.

9. In combination with diaphragm N and tension-regulator M, the annulus *m'* at the lower end of said regulator, for the purpose herein described.

10. The needle O, whose head *o* is united to diaphragm N with the cemented disks *n n'*, substantially as herein described.

11. The conical socket *o'*, applied to the tracing-lever P *p*, with sliding clip O'', and adapted to receive the point of needle O, which latter communicates with diaphragm N, substantially as herein described.

12. The combination of pivoted tracing-lever P *p q*, hinged leaf Q *q'*, adjusting devices T *t r*, and slide R, substantially as described.

13. The combination of pivoted tracing-lever P *p q*, hinged leaf Q *q'*, slide R, slotted bracket S *s s'*, and adjusting devices T *t t'*, substantially as herein described and set forth.

14. In combination with chamber B *b*, gland *b'*, nipple J, and index-tube K, the flexible coupling *j*, substantially as described.

15. In combination with chamber B *b*, gland *b'*, nipple J, index-tube K, and flexible coupling *j*, the thimble *k*, traversing the bore of said gland, for the purpose set forth.

16. The combination, in a sphygmometer or sphygmograph, of an elevated reservoir, D, for supplying, by gravitation, the various chambers of the instrument with the fluid that transmits the pulsations to the indicating devices, substantially as herein described.

17. The stand A', having channels *a'' a'''*, branch *d*, passages *g' h'*, and cocks G *g* H *h h''*, for supplying chambers B C B' C' and channels *e e' f f'* from reservoir D, as herein described.

18. The combination, in stand A', of chambers B C, inlet E, channels *e e'*, and three-way cock E', said inlet E being adapted to communicate with the pulse-base of the instrument, substantially as herein described.

19. In combination with a sphygmometer or sphygmograph, a coupling for connecting the pulse-base with the indicating devices, which coupling consists of flexible sections U and transparent sections U', as herein described.

20. In combination with pulse-base V, the yielding membrane X, when adapted to be distended below the general level of said base, for the purpose herein described.

21. The combination of pulse-base V *v*, yielding membrane X, and clamping devices Y *y y'*, substantially as herein described.

22. In combination with pulse-base V *v*, membrane X, and clamping devices Y *y y'*, the adjustable follower W, substantially as herein described.

23. In combination with pulse-base V *v*, membrane X, clamp Y *y y'*, and follower W *w w'*, the adjusting devices Z Z' *z z' z''*, substantially as herein described.

24. In combination with pulse-base V *v*, membrane X, and adjustable follower W, the gutter 27 for retaining the compressible and elastic ring 28, that rests against said membrane X, for the purpose specified.

25. The combination, in a sphygmograph, of the carriage 3, having standards 2 and springs 4, which springs enable tablets of various thicknesses being applied to said carriage in such a manner as to insure a uniform action of tracers *p p'* against the prepared surfaces of said tablets, substantially as herein described and set forth.

26. In combination with a sphygmograph, the inclined planes at the lower ends of guides 26, for deflecting tracers *p p'* from the prepared side of the tablet, in the manner herein described, and for the purpose set forth.

In testimony of which invention I hereunto set my hand.

ALONZO T. KEYT.

Witnesses:

JAMES H. LAYMAN,

T. A. BLINN.