

[54] **COMPRESSION
OPHTHALMODYNAMOMETER**

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abandoned.

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128/2.05 N

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[58] **Field of Search**.. 128/2 R, 2 T, 2.05 N, 2.05 R,
128/2.05 P, 2.05 G, 2.05 D; 73/80

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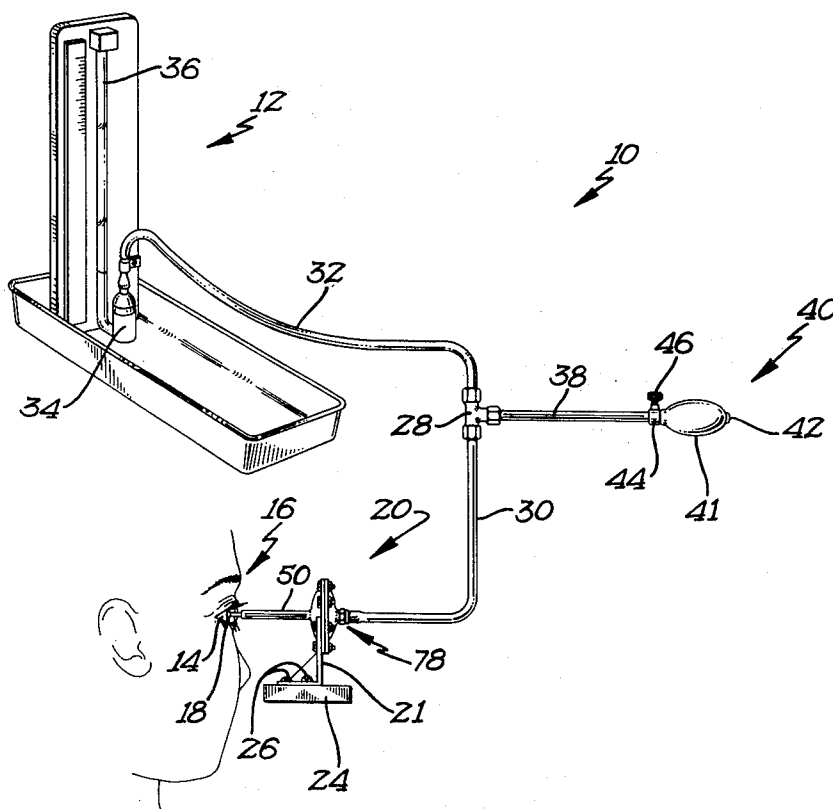
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[57] **ABSTRACT**

A compression ophthalmodynamometer for measuring blood pressure in the human eye in conjunction with a mercury manometer is disclosed. The instrument includes a handheld rubber compressor bulb having one-way valves for providing air under pressure, an air-pressure-to-proportional-contact-force transducer, and tubes which simultaneously conduct the air under pressure to both the manometer and the transducer. The manometer gives an indication of the pressure of the air while, simultaneously, the transducer applies a force proportional to the pressure of the air to the surface of the eye through a foot-plate contact with the surface of the eye. One embodiment of the transducer includes a hollow body separated into halves by a diaphragm. An air pressure chamber is defined within the hollow body between one surface of the diaphragm and the portion of the transducer housing which is adjacent the input to the transducer from the bulb. A rod extends between the second surface of the diaphragm and the foot-plate in contact with the eye to convey air pressure created forces from the diaphragm to the foot-plate and thus to the surface of the eye.

9 Claims, 2 Drawing Figures



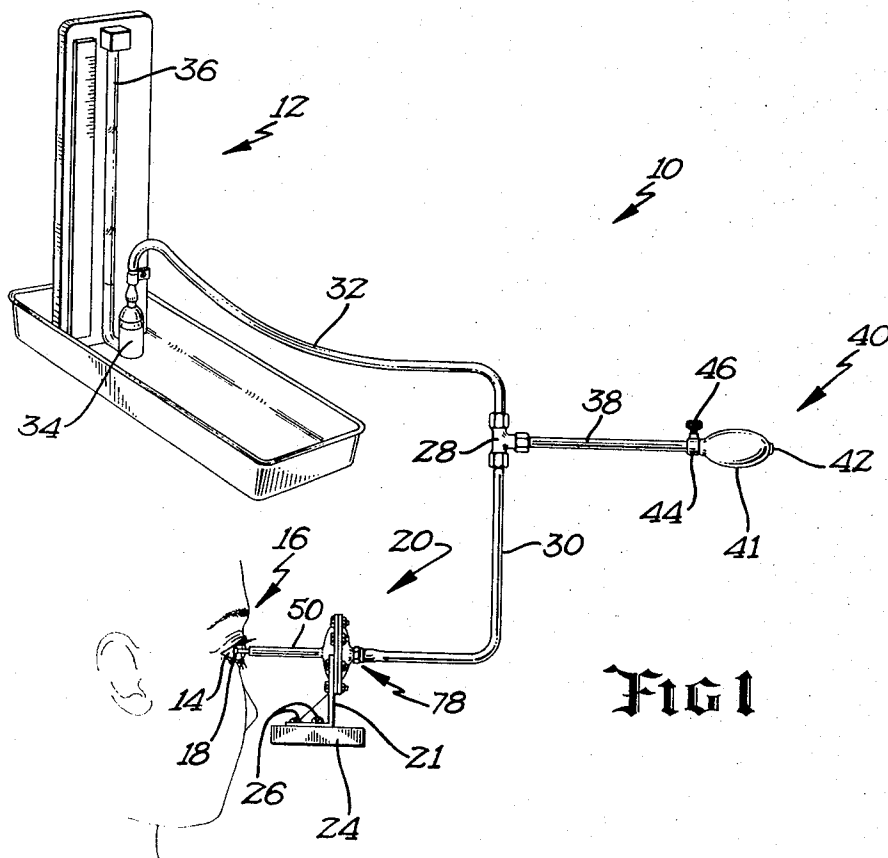


FIG 1

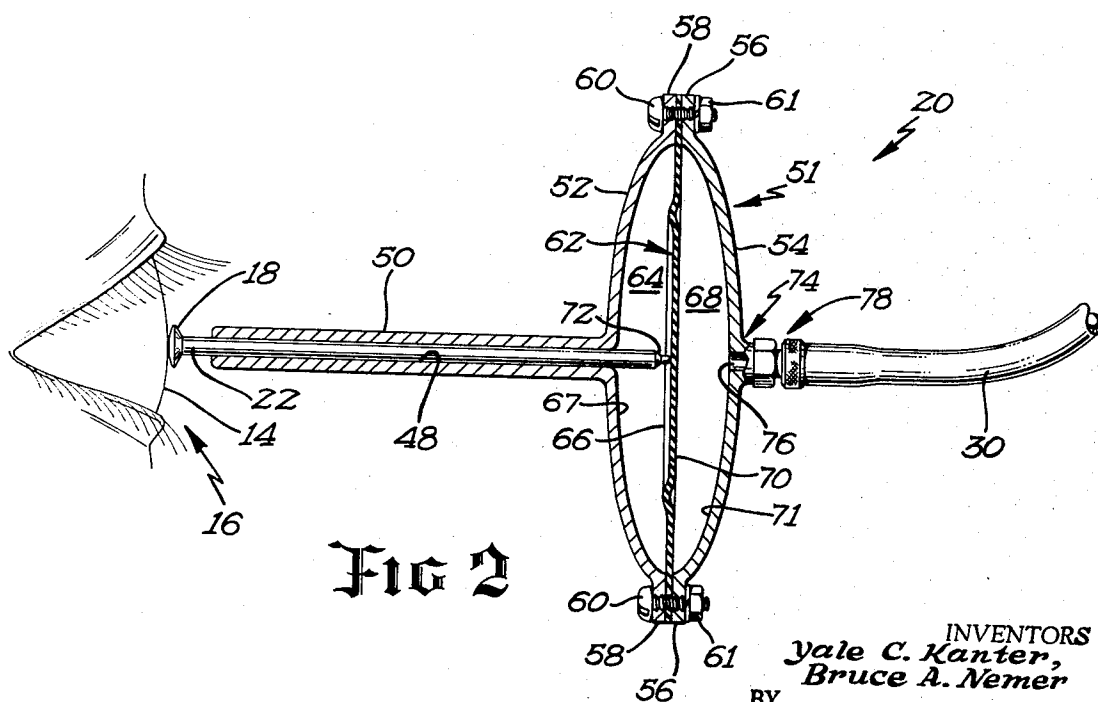


FIG 2

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COMPRESSION OPHTHALMODYNAMOMETER

CROSS REFERENCE

This is a continuation of application Ser. No. 147,430 filed May 27, 1971, now abandoned.

BACKGROUND

The present invention relates generally to compression ophthalmodynamometers, which measure blood pressure in the human eye, and more specifically to compression ophthalmodynamometers which operate by air pressure.

The measurement of blood pressure in the eye is useful in the practice of ophthalmology to diagnose various diseases of the human eye. For example, cerebrovascular insufficiency, a transient ischemic cerebral episode, or an impending stroke may be diagnosed with a knowledge of the blood pressure reflected in the eye, and compression ophthalmodynamometers have been found useful in the past to provide such a measure of that blood pressure.

However, users of known compression ophthalmodynamometer devices have encountered difficulty in simultaneously observing blood vessels in the eye to properly determine the blood pressure and observing the readings of blood pressure provided by these known devices.

Further, compression ophthalmodynamometer devices in common use require an operating procedure and provide a measure of blood pressure which are unique in the medical field. Thus, it is presently difficult to compare measures of blood pressure in the human eye, as in the ophthalmic artery, obtained through the use of conventional ophthalmodynamometer devices with conventional measurements of blood pressure in the human body, as in the brachial artery.

SUMMARY

The present invention solves these and other problems of known compression ophthalmodynamometers by providing an instrument which may be easily read by an operator while also observing the condition of the blood vessels within the eye.

Also, the eye blood pressure measuring instrument of the present invention is arranged to use a pressure indicating device, a mercury manometer, which is familiar to all ophthalmologists who would operate instruments according to the present invention. Further, the operating technique of the eye blood pressure measuring instrument of the present invention more closely parallels the technique for obtaining bodily blood pressure, which is well-known to medical personnel, than do the operating techniques of known devices. The use by the present invention of the familiar mercury manometer and the better known operating techniques can provide more uniform and reliable blood pressure measurements. Still further, the measure of blood pressure in the human eye as obtained through the use of the present invention may be better compared to the conventional measures of blood pressure in the human body. All of these results enhance the usefulness of the eye blood pressure measuring instrument of the present invention.

Briefly, the preferred embodiment of the compression ophthalmodynamometer of the present invention

includes an air-pressure-to-proportional-contact-force transducer having an air chamber defined therein with a diaphragm forming one boundary of the air chamber. A rod extends from the diaphragm to a pressure foot which allows the application of a force to the surface of the eye to compress blood vessels within the eye and allow the blood pressure measurement through direct visualization. Pressure to the air chamber within the transducer is controlled by an operator through the use of a hand-held pressure bulb including one-way valves for providing air under pressure between 0 to 300 millimeters of mercury over atmospheric pressure. The air under pressure is simultaneously conducted from the pressure bulb to both the transducer and to a mercury manometer to thus give an indication of the pressure of the air simultaneously with the application of a force to the surface of the eye, which force is directly proportional to that air pressure.

It is thus an object of the present invention to provide a novel ophthalmodynamometer.

It is a further object of the present invention to provide a novel ophthalmodynamometer which may be easily read by an operator while observing the condition of the blood vessels in the eye.

It is a further object of the present invention to provide a novel ophthalmodynamometer which may be advantageously used with a mercury manometer.

It is a further object of the present invention to provide a novel ophthalmodynamometer which has an operating technique closely paralleling the technique for obtaining bodily blood pressure.

It is a further object of the present invention to provide a novel ophthalmodynamometer which provides a measure of blood pressure in the human eye in units of millimeters of mercury.

It is a further object of the present invention to provide a novel ophthalmodynamometer which can provide more uniform and reliable blood pressure measurements.

It is a further object of the present invention to provide a novel ophthalmodynamometer which is simple in its construction to thus reduce costs and improve reliability.

These and further objects and advantages of the present invention will become clearer in the light of the following detailed description of an illustrative embodiment of the present invention described in connection with the drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the apparatus of the present invention, in conjunction with a mercury manometer, arranged in a position relative to the eye of a human being to obtain blood pressure readings in the eye of that human.

FIG. 2 shows an enlarged sectional view of a portion of the apparatus of FIG. 1, again in conjunction with a human eye.

DESCRIPTION

FIG. 1 shows an overall view of the compression ophthalmodynamometric apparatus of the present invention, generally designated 10, in conjunction with a mercury manometer generally designated 12. The apparatus 10 is shown in association with the eye 14 of a human being generally designated 16.

In particular, a pressure foot-plate 18 is shown in contact with the surface of eye 14 and arranged to

apply a force to that surface. Pressure foot 18 is connected to an air-pressure-to-proportional-contact-force transducer generally designated 20 by means of a rod 22.

Transducer 20 is shown as including a mounting bracket 21 which is affixed to a base or other mounting surface 24 such as a slit lamp microscope by means of a plurality of screws 26. Base 24 or the mounting surface is arranged such that it may be moved and positioned relative to human 16, and when a desired position is reached, base 24 may be rendered relatively immovable with respect to human 16 by conventional means not shown. The head of human 16 may further be arranged to be held immobile by conventional means not shown. Alternately, base 24 may be supported on the human 16, as by a headband, and in this way rendered relatively immovable with respect to human 16.

Transducer 20 is connected to an air conduction tubing T-section 28 by means of air conducting tubing 30. Further air conduction tubing 32 connects T 28 to a mercury reservoir 34 of manometer 12 having an input arranged to receive air under pressure and cause vertical movement of a column of mercury within a graduated scale 36 in direct relation to the air pressure applied to the input of reservoir 34. Still further air conducting tubing 38 connects T 28 to an air pressure creator, generally designated 40, in the form of a hand-held compressor bulb 41.

Pressure creator 40 includes first one-way valve 42 positioned at one end of bulb 41 for only allowing the entrance of air from the atmosphere into the bulb. Further, a second one-way valve 44 interconnects tube 38 with bulb 41 for allowing the exit of air from the bulb to the tube. A control knob 46 is arranged upon one-way valve 44 to bypass valve 44 and relieve any pressure existing within tube 38 or bulb 41 to the atmosphere.

FIG. 2 shows a more detailed sectional view of transducer 20 in relation to the eye 14 of human 16. In particular, foot-plate 18 is shown as integrally formed with rod 22 which extends within a cylinder 48 formed internally of a tubular housing 50 such as to be freely reciprocally movable in leftward and rightward directions along the central longitudinal axes of tubular housing 50.

Transducer 20 further includes a housing 51 formed of two dish-shaped halves 52 and 54 each including an annular flange, 56 and 58 respectively, formed around their peripheries to allow the joinder of the halves 52 and 54 of housing 51 by means of a plurality of bolts 60 passing through flanges 56 and 58 and threaded into a plurality of nuts 61.

A disc-shaped diaphragm 62 is positioned between the flanges 56 and 58 such that when the dish-shaped halves 52 and 54 of housing 51 are joined around their peripheries with their respective curved portions oppositely directed, a first chamber 64 is defined between a first surface 66 diaphragm 62 and the interior surface 67 of dish-shaped half 52, and a second internal chamber 68 is defined between the second surface 70 of diaphragm 62 and the interior surface 71 of dish-shaped half 54. Thus, second surface 70 of diaphragm 62 forms a boundary of air chamber 68 which boundary is arranged to move in relation to the air pressure within chamber 68. Similarly, surface 66 of diaphragm 62 is arranged to form one boundary of chamber 64.

Chamber 68 comprises an air pressure chamber which is arranged to receive air from pressure bulb 41 by means of a transducer input, generally designated 74, which is shown as integrally formed with dish-shaped half 54 of housing 51 to include a cylindrical bore 76. A conventional threaded pressure type fitting 78 then interconnects tubing 30 with transducer input 74 to provide the communication of air between chamber 68 and tubing 30.

Thus, an exchange of air between the pressure bulb 41, the mercury reservoir 34, and chamber 68 of transducer 20 is provided by the interconnection of tubes 30, 32, and 38 by T 28.

Tubular housing 50 is shown as integrally formed with half 52 of housing 51 such that the end 72 of rod 22 opposite pressure foot 18 is positioned within chamber 64 of transducer 20. End 72 is further shown as being of reduced diameter from the diameter of rod 22 for purposes which will be hereinafter explained.

OPERATION

In using the ophthalmodynamometer of the present invention, an ophthalmologist first widely dilates the pupils of both eyes of the human 16. Next, a conventional local anesthetic is applied to both eyes, and allowed sufficient time to become effective.

Next, the human 16 is comfortably seated behind a conventional slit lamp microscope and is instructed to look straight ahead, which will place the eye being tested in the primary position.

The ophthalmologist then uses a conventional Rhyby lens attachment on the slit lamp microscope to obtain direct visualization of the optic nerve head in the eye. The foot-plate 18 of the instrument 10 is placed in apposition with the temporal sclera of the eye, and the microscope adjusted to visualize the optic nerve head. The instrument 10 should be held quite firmly, or preferably be firmly mounted, so that the foot-plate 18 may maintain an horizontal position perpendicular to the eye throughout the examination as an oblique application of foot-plate 18 will result in variation in the pressure. The foot-plate 18 should not be applied too close to the limbus or it will create pressure on the lens and the ciliary body diaphragm which will further allow a variable result. Further, the foot-plate 18 of the instrument 10 should not be applied too far laterally towards the external canthus so that any portion of the foot 18 will at times become entangled in the skin folds of the lateral canthus. Still further, the rod 22 should not be touched during the examination because this will frictionally retard lateral movement of the rod and yield a false reading of variable and unpredictable amount.

The diastolic measurements are first obtained by compressing pressure bulb 40 to force air through one-way valve 44 and cause an increase in the air pressure within tubes 30, 32, and 38 and hence a corresponding increase in the air pressure within both air pressure chamber 68 of transducer 20 and reservoir 34 of manometer 12. This increase in air pressure within chamber 68 immediately causes a distention of surface 70 of diaphragm 62 towards human 16 which in turn causes: an application of force proportional to the air pressure within chamber 68 to end 72 of rod 22 by means of surface 66 of diaphragm 62 in contact with end 72; an application of a corresponding force to pressure foot 18 through rod 22; and an application of force to the outer surface of the eye 14 of human 16. As is well known,

an application of such force to the outer surface of the eye will increase the fluid pressure within the eye which in turn compresses the blood vessels within the eye to allow the measurement of blood pressure in the ophthalmic artery.

The material for diaphragm 62 should not be so pliable as to distend beyond the end 72 of rod 20 and towards human 16, and should not be so firm as to provide pressure non-linearity in the application of force to eye 14. Many such pliant diaphragm materials are conventionally available from suppliers of rubber material.

As the ophthalmologist increases the air pressure within chamber 68, and thus correspondingly increases the force applied to the eye 14 of human 16 by means of pressure foot 18, the first visible arterial pulsation may be observed on the optic nerve head thus indicating that the pressure applied to the eye is above diastolic pressure. The ophthalmologist then slowly rotates knob 46 controlling valve 44 to release a small amount of air from chamber 68 and thus reduce the pressure within chamber 68 to reduce the force applied to the eye 14. With a decrease in pressure, the visible arterial pulsation disappears, and the ophthalmologist recognizes that the pressure applied is below the diastolic measurement. A slight increase in air pressure is then accomplished by a slight compression of bulb 40 to again increase the air pressure within chamber 68 and again increase the force applied to eye 14. This sequence is repeated until a satisfactory indication is received, and the manometer reading is noted. Notice that the notation of the reading is separate and apart from any positioning of pressure foot 18 with respect to eye 14, and thus does not interfere in any way with the positioning of pressure foot 18.

The systolic pressure is then measured by the ophthalmologist by first increasing the air pressure within chamber 68 through very slight successive compressions of pressure bulb 40 to thereby apply an increased force to the eye through pressure foot 18. In this manner, the pressure applied to the eye can be increased under direct visualization and control to a value above the systolic value, which is the preferred method. The control knob 46 on valve 44 is next opened to allow a slow escape of air from chamber 68, and thus a slow decrease in the force applied to eye 14. The systolic blood pressure reading in the eye may then be obtained in the conventional manner by thus slowly decreasing the force applied to the eye until the systolic point is reached, closing valve 44 and slightly increasing the pressure within chamber 68 by slight compressions of bulb 40, slowly releasing the air pressure again, and repeating these steps until a satisfactory reading is obtained.

Blood pressure in the other eye may then be measured by an analogous technique.

The blood pressure measurements thus obtained from human 16 are in units of millimeters of mercury which are the conventional blood pressure measuring units for the remainder of the human body. In fact, the relationship of the diastolic pressure recorded in the eye to the brachial diastolic pressure and the relationship of the systolic pressure measured in the eye to the blood pressure measurement obtained from the arm of the patient are well known. The diastolic pressure in the eye has been noted at approximately one-half of the brachial systolic pressure, and the systolic measurement

from the eye has been noted as approximately two-thirds of those obtained from the arm. Thus, immediately comparative blood pressure readings are obtained.

The reduced diameter tip 72 on rod 22 further allows a more convenient reading of the blood pressure in the eye in that manometer 12 may be calibrated to yield a diastolic pressure measurement equivalent to the brachial measurement or manometer 12 may be calibrated to read a systolic pressure measurement equal to the blood pressure measurement in the arm. This feature of the present invention is due to the fact that the pressure within chamber 68 is measured on manometer 12, and the reduced diameter tip 72 allows a force to be applied to the eye 14 which is a proportion of the air pressure within chamber 68. That is, assuming a fixed pressure within chamber 68, the force applied to eye 14 through pressure foot 18 is equal to that pressure multiplied by the area of contact between end 72 of rod 22 and surface 66 of diaphragm 62. Thus, if the area of contact between end 72 and surface 66 is reduced, the force applied to the eye will be reduced for a fixed pressure within chamber 68.

This feature of the present invention allows the normal diastolic blood pressure measurement of a patient to be, in effect, doubled upon the pressure indicating device, manometer 12. That is, the force applied to the eye may be arranged through the proper selection of the reduced diameter of tip 72 of rod 22 to reflect a one-half proportion of the actual air pressure indicated upon manometer 12, thus allowing manometer 12 to yield an indication directly comparable to the brachial blood pressure. A similar result may be obtained and the systolic measurements of blood pressure in the eye directly compared to those obtained in the arm of the patient.

Still further, end 72 of rod 22 may take the form of a point, and the area of contact be controlled by reinforced disc attached to one or both surfaces of diaphragm 62. The reinforcing disc may then include a depression to accept end 72 of rod 22, and the contact area is the area of the reinforcement. This provides the additional advantage of reinforcing the diaphragm against the constant pressure of the small diameter tip 72 which tends to wear the diaphragm 62 and may ultimately wear through the diaphragm to puncture it.

Thus, the ophthalmodynamometer of the present invention has been shown to allow simultaneous observation of the blood vessels in the eye to properly determine the blood pressure and observation of the readings of blood pressure on a manometer. Further, the present invention has been shown to involve a technique and yield a measure of blood pressure which are highly comparable to conventional techniques and measures of blood pressure obtained in the remainder of the human body.

It will be realized by those skilled in the art that the invention disclosed therein may also be embodied in specific forms other than the preferred embodiment disclosed without departing from the spirit or general characteristics thereof. Thus, the embodiment described herein is to be considered in all respects illustrative and not restricted. The scope of the invention is indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

What is claimed is:

1. A compression ophthalmodynamometer for measuring blood pressure in the eye of a human, comprising in combination: a mercury manometer including a hollow graduated scale arranged to accommodate a column of mercury and a reservoir arranged to hold a supply of mercury, the reservoir communicating with the hollow of the graduated scale and having an input arranged to accept air under pressure; transducer apparatus including a hollow housing and input means mounted in the hollow housing for providing air to and accepting air from the interior of the hollow housing; a generally vertically arranged diaphragm means including first and second faces, mounted within the hollow housing to define an air chamber between the first face of the diaphragm means and a portion of the interior of the hollow housing, the air chamber being defined adjacent the transducer input such that the transducer input provides air to and receives air from the air chamber; a horizontally arranged rod having a first end and a second enlarged end, with the first end of the rod in direct contact with the second face of the diaphragm means, and with the second enlarged end of the rod extending from said housing and forming a foot-plate and with the second end having a cross-sectional area which is small with respect to the exposed surface area of the eye; means fixed with respect to the transducer housing for horizontally slidably mounting the rod; a pressure bulb including first one way valve means for only allowing the entrance of air from the atmosphere into the bulb and second one way valve means for only allowing the exit of the air from the bulb; a first tube connected to the second one way valve means of the pressure bulb; a second tube connected to the transducer input; a third tube connected to the input of the reservoir; and means for interconnecting the first tube, the second tube, and the third tube for simultaneously providing air under pressure from the bulb to both the manometer and the air chamber.

2. An ophthalmodynamometer for use with an air pressure measuring device for measuring the blood pressure in the eye of a human, comprising in combination: a foot having a cross-sectional area which is small with respect to the exposed surface area of the eye; an air-pressure-to-proportional-contact-force transducer operating in a linear range including an input arranged to receive air under pressure and means for reacting to the air under pressure for applying a contact force which is proportional to the air pressure applied to the reacting means; generally horizontally arranged means, having one end thereof connected to the foot and the other end thereof in direct contact with the reacting

means, for conveying the contact force provided by the reacting means of the transducer to the foot; operator controlled air means for selectively providing air under pressure between at least 0 and 300 millimeters of mercury over atmospheric pressure; means arranged to connect an air pressure measuring device; and means connected to the means arranged to connect to an air pressure measuring device, the air means, and the transducer input for simultaneously conducting the air under pressure from the air means to both the means arranged to connect to a measuring device and the transducer input.

3. The ophthalmodynamometer of claim 2, wherein the transducer includes at least one air pressure chamber receiving air from the transducer input, and wherein the reacting means comprises a diaphragm forming at least a part of the boundary of the air chamber and arranged to move in relation to the air pressure in the air chamber.

4. The ophthalmodynamometer of claim 3, wherein air means comprises a hand-held compressor bulb including the first one way valve means for only allowing the entrance of air from the atmosphere into the bulb and second one way valve means for only allowing the exit of air from the bulb.

5. The ophthalmodynamometer of claim 4, wherein the air means comprises: a first tube extending from the second one way valve means of the bulb; a second tube extending from the means arranged to connect to a measuring device; a third tube extending from the input of the transducer; and means for interconnecting the first tube, the second tube, and the third tube to allow the exchange of air between each of the first tube, second tube, and third tube.

6. The ophthalmodynamometer of claim 5, wherein the conveying means includes a rod horizontally slidably mounted with respect to the transducer, the rod having one end in contact with the diaphragm and the other end attached to the foot.

7. The ophthalmodynamometer of claim 6, wherein the end of the rod in contact with the diaphragm is reduced in diameter from the remaining portions of the rod.

8. The ophthalmodynamometer of claim 2, wherein the conveying means includes a rod horizontally slidably mounted with respect to the transducer, the rod having one end in contact with the means for reacting and the other end attached to the foot.

9. The ophthalmodynamometer of claim 8, wherein the end of the rod adjacent the transducer is reduced in diameter from the remaining portions of the rod.

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