

[54] **BLOOD PRESSURE CUFF AND BLADDER
AND APPARATUS EMBODYING THE SAME**

[75] Inventor: **Theodore Aronson**, Fort
Lauderdale, Fla.

[73] Assignee: **Para-Medical Instrument
Corporation**, Fort Lauderdale, Fla.

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1972, abandoned.

[52] U.S. Cl. **128/2.05 C; 128/2.05 G; 128/327**

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[58] Field of Search **128/2.05 A, 2.05 C, 2.05 G,
128/2.05 M, 2.05 Q, 2.05 R, 2.05 S, 2.05 V,
327**

[56] References Cited

UNITED STATES PATENTS

598,343	2/1898	Hill et al.	128/2.05 G
2,076,642	4/1937	Hubbard et al.	128/2.05 G
2,981,251	4/1961	Berman	128/2.05 C
3,229,685	1/1966	Ringkamp et al.	128/2.05 A
3,315,662	4/1967	Buffington	128/2.05 G

3,557,779	1/1971	Weinstein	128/2.05 Q
3,633,567	1/1972	Sarnoff	128/2.05 C

FOREIGN PATENTS OR APPLICATIONS

290,046	11/1931	Italy	128/327
1,130,963	6/1962	Germany	128/2.05 G

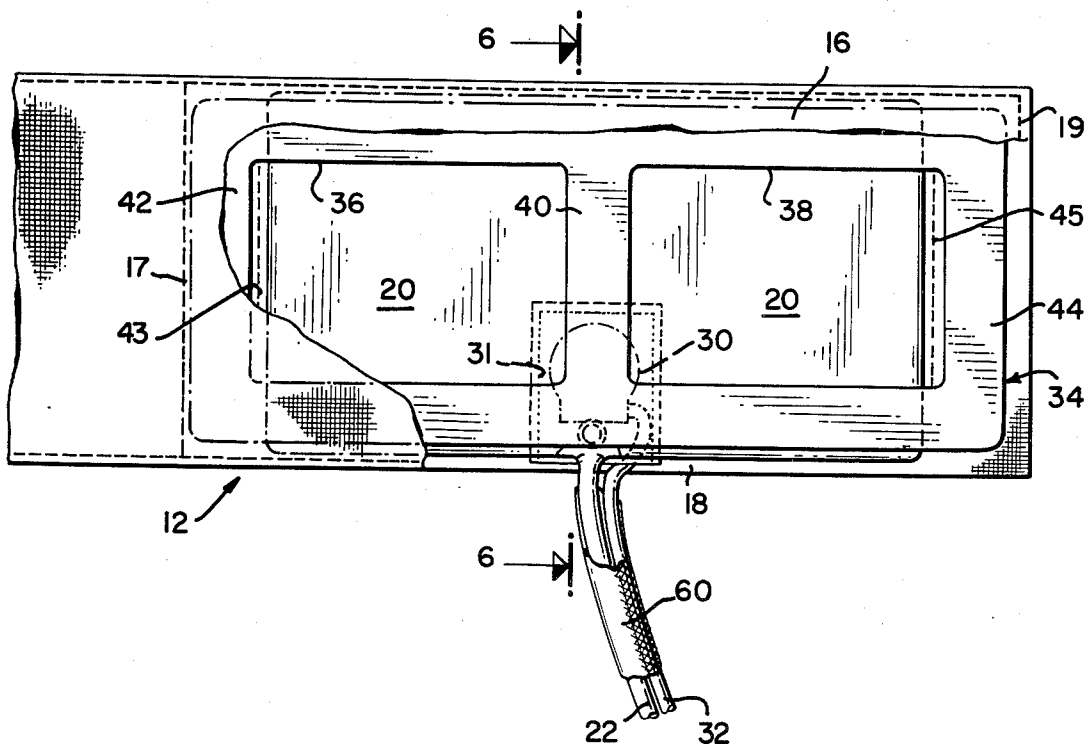
Primary Examiner—William E. Kamm

[57]

ABSTRACT

A blood-pressure cuff comprises an elongated non-elastic cover having an inflatable portion in which is disposed an inflatable bladder. Means extends from the inflatable portion for fastening the cover when the inner surface of the inflatable portion is applied to a limb of the user preparatory to inflation of the bladder. An integral, prestressed resilient clip of spiral shape is freely disposed in the inflatable portion of the cover between the bladder and outer cover surface to impart its spiral shape to both the inflatable portion of the cover and the bladder therein. The inflatable bladder may have a plurality of contiguous chambers each in fluid communication with adjoining chambers and a single fluid inlet adapted to have fluid under pressure supplied to the chambers for inflating the chambers.

21 Claims, 15 Drawing Figures



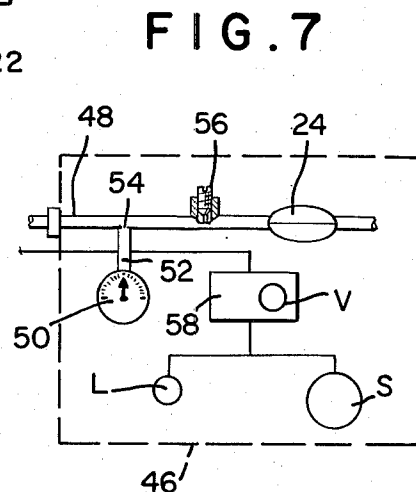
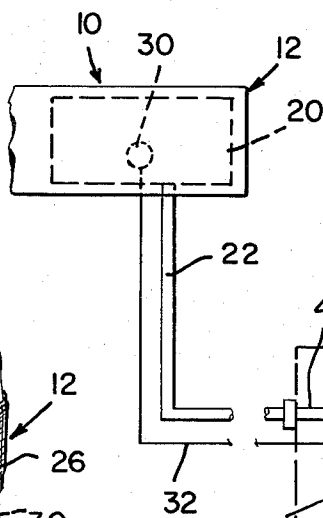
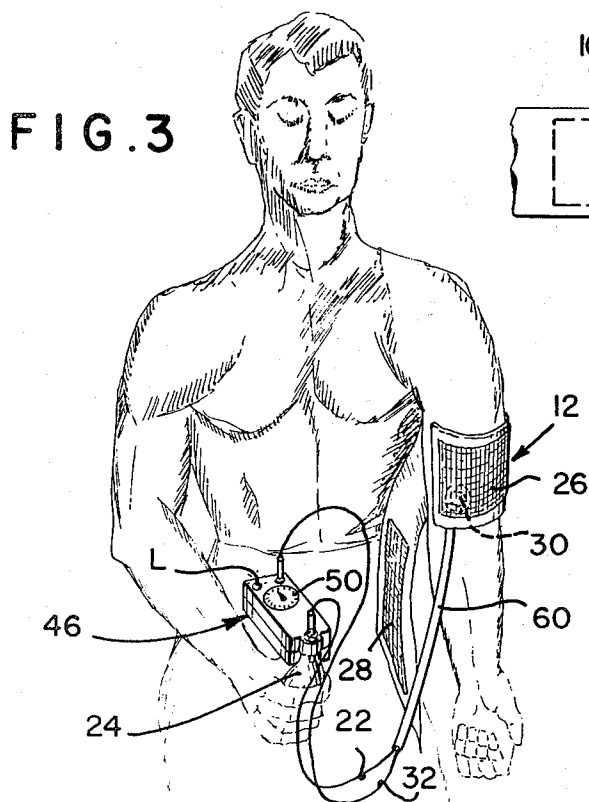
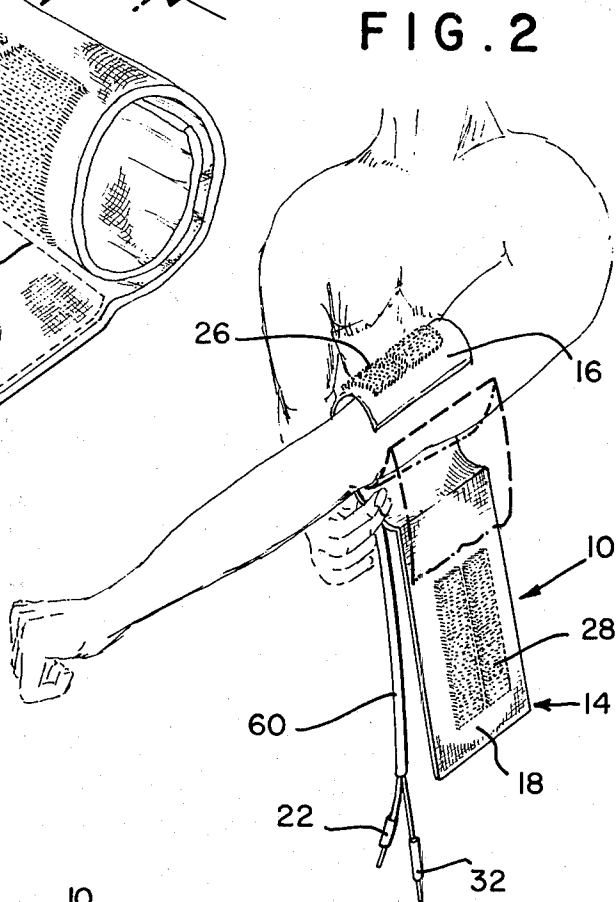
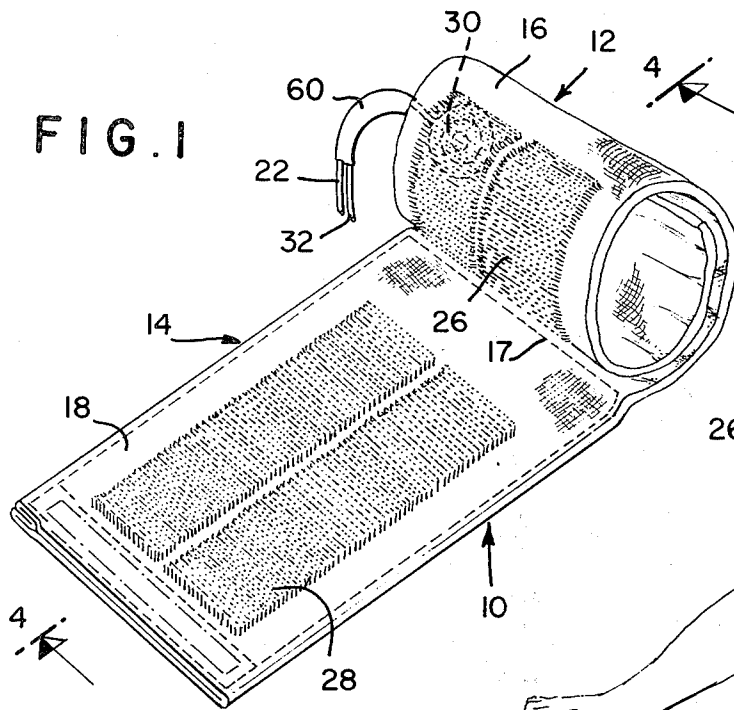


FIG. 4

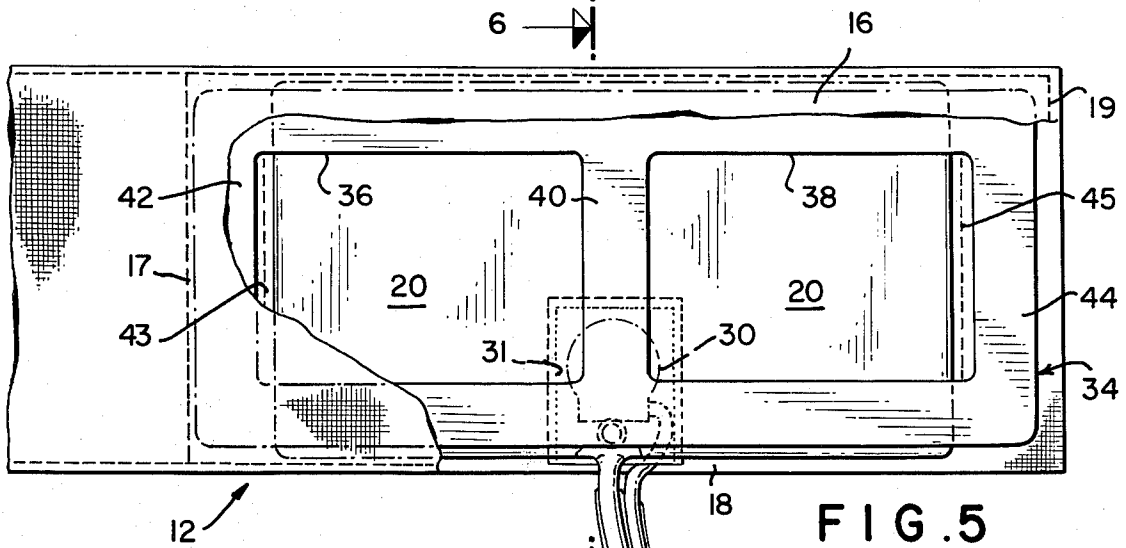
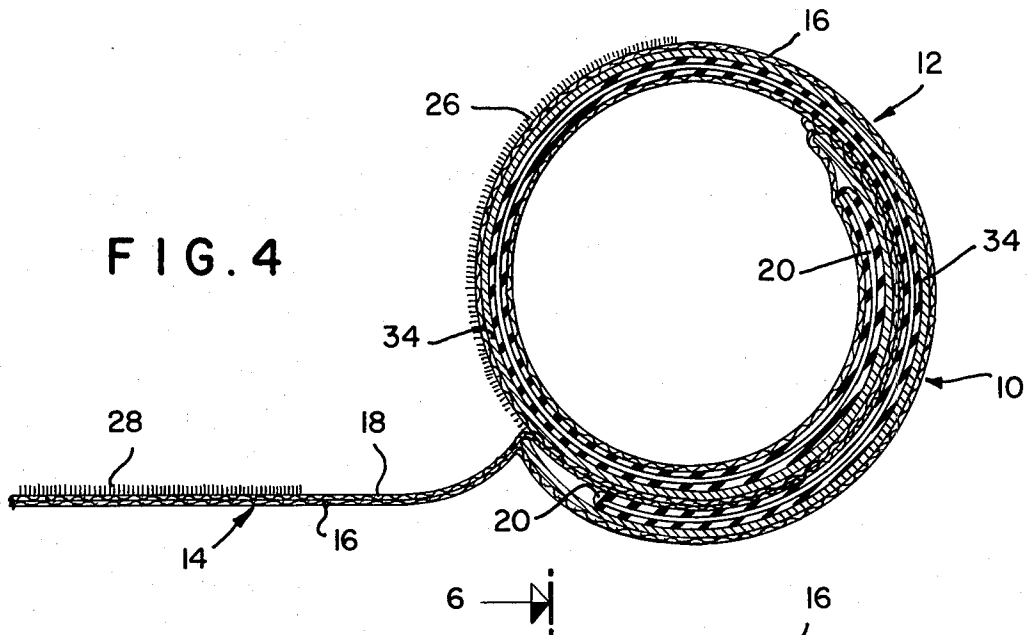


FIG. 5

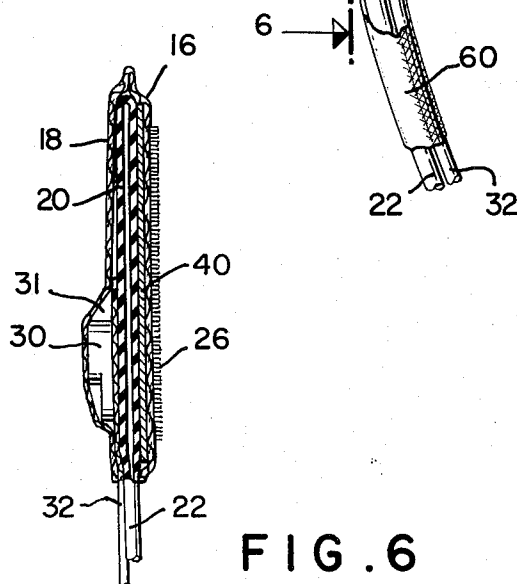


FIG. 6

FIG. 8

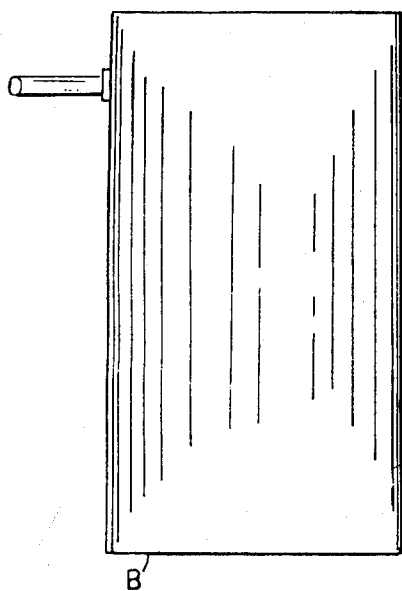


FIG. 9

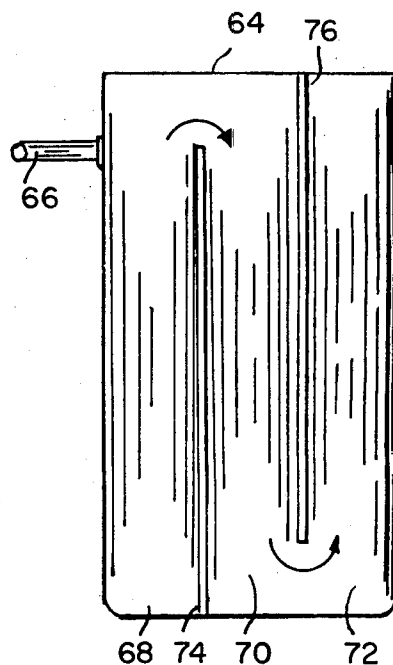
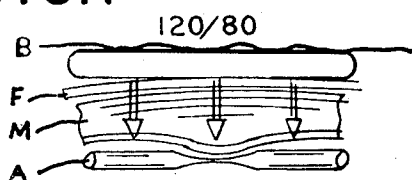
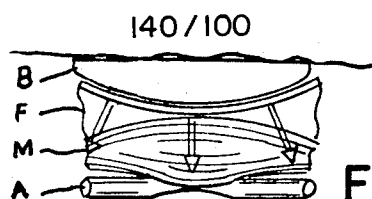
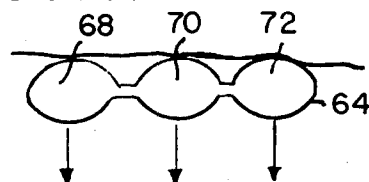


FIG. 8A



NORMAL
ARM

FIG. 9A



OBESE
ARM

FIG. 8B

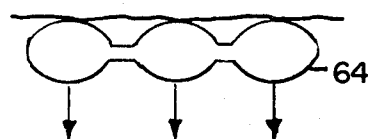
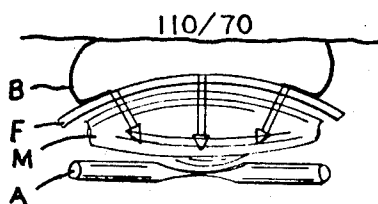


FIG. 9B



THIN
ARM

FIG. 8C

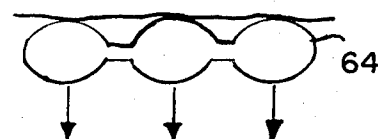


FIG. 9C

BLOOD PRESSURE CUFF AND BLADDER AND APPARATUS EMBODYING THE SAME

The present application is a continuation-in-part of my earlier application Ser. No. 300,507 filed Oct. 25, 1972, now abandoned.

This invention relates to cuff means for use in determining blood pressure and more particularly to cuff means of the type incorporating transducer means such as a crystal microphone or the like.

BACKGROUND OF THE INVENTION

For ascertaining the blood pressure of an individual, it is the customary practice to mount an air-inflatable cuff in a region of arterial blood flow, e.g., over the brachial artery. For this purpose the cuff is applied about, for example, the upper arm in a region overlying the brachial artery.

Generally, for measuring blood pressure a cuff of substantially non-elastic, flexible material containing an inflatable bladder is applied to the upper arm. The bladder is then inflated to a pressure sufficient to occlude blood flow in the artery, the air pressure in the bladder being thereupon relieved until the Korotkoff tapping sounds are detected with a detecting device comprising a stethoscope or a microphone suitably incorporated in the cuff structure. In either case the detecting device is applied to the artery below the blood-occluding portion of the cuff. Should a stethoscope be used as the detecting device, upon detecting therewith the first tapping sounds, a reading is noted from a calibrated pressure gauge connected to measure the pressure in the cuff. The reading thus obtained is the systolic blood pressure of the individual. As the pressure in the cuff continues to fall, the Korotkoff sounds become muffled and finally cease to be heard. At that point the pressure reading on the pressure gauge is noted, this being the diastolic blood pressure of the individual. The same procedure is followed using a microphone instead of the stethoscope except that the tapping pulse sounds are detected by observing the flashing of a lamp and/or listening to the pulse sounds emitted by a speaker, the lamp and/or speaker being energized by the output of amplifier means whose input is supplied with the output of the microphone.

A cuff has greatest advantage when it can be self-applied by an individual using one hand only. Cuffs conventionally used by doctors require the use of two hands, one for applying the cuff to the limb and the other for wrapping the remaining cuff length about the limb while the initially applied cuff portion is held in place.

Cuff devices have been proposed for self-application. For example, U.S. Pat. No. 3,669,096 discloses a cuff device the diameter of which is preadjusted by connecting connecting means on one side of a non-elastic portion of the cuff with cooperating connecting means on the opposite side of the cuff. The diameter of the cuff is preadjusted for limbs of a predetermined girth. For example, snap fasteners are generally provided as primary fasteners for permitting the cuff to be preadjusted to a predetermined diameter, and secondary fasteners are used for fastening the cuff. A cuff of this type cannot directly be applied to a limb because its initial adjustment is in closed-loop form. Accordingly, when the cuff is to be applied to the upper arm, it must first be slid over the hand and then the forearm. The cuff,

after use, is manually deflated by applying squeezing forces to the bladder, particularly before each blood pressure-determining procedure, to enable ready mounting of the cuff.

U.S. Pat. No. 3,633,567 discloses a pneumatically actuated pressure device which may be used as a dressing for wounds or as a cuff for checking blood pressure. Self-application of the device is made possible by the use of separate, spaced apart, generally C-shaped, narrow width, springs into pockets formed in the outer surface of the device. These springs because they can act independently of one another may affect blood pressure determination, especially when a transducer is incorporated in the cuff. This is so because the transducer, e.g., a microphone may be moved away from the brachial artery during flexure of the springs.

It is also known that errors in determining blood pressure will be introduced if a cuff of predetermined width is used for measuring blood pressure in an arm of normal girth as well as arms of slender and large girths. For example, for an arm of large girth, when utilizing a bladder intended for a "normal" size arm, the pressure exerted on the arm by the bladder will be distributed such that higher pressures will be required to occlude blood flow in the artery. This will result in not only the systolic but also the diastolic readings being on the high side. Conversely, for an arm of slender girth, a smaller pressure will be required to occlude blood flow in the artery, for which reason the systolic and diastolic readings will be on the low side.

One way of avoiding the foregoing problem is to provide cuffs of three different widths, one width for limbs of normal girth, a second width for limbs of large girth, and a third width for limbs of slender girth. However, this expedient is impractical for obvious reasons.

In French Pat. No. 551,084 it is proposed to provide a pneumatic arm band or cuff which incorporates a plurality of air chambers arranged in such manner that a substantially continuous surface is formed on that side of the arm band adapted to engage the limb about which the arm band is wrapped. The air chambers are isolated from one another and a separate inlet line for air under pressure, supplied from a pressurized tank, is provided for each chamber. A shut-off device is provided for each air inlet line leading from the pressurized tank. In this known device air flow to each chamber is separately controlled and the plurality of chambers are selectively pressurized.

SUMMARY OF THE INVENTION

With the foregoing in mind, the blood-pressure cuff of the present invention comprises an elongated non-elastic cover including a rectangularly shaped hollow inflatable portion, in which a rectangularly shaped inflatable bladder is positioned. A fastening portion extends from such inflatable portion, with such two portions having a common outer surface and a common inner surface. The outer surface of the inflatable portion and the inner surface of the fastening portion respectively have devices cooperating to fasten the cover when the inner surface of the inflatable portion is applied to a limb of the user, means being provided to inflate the bladder when such cover is so applied.

In accordance with the invention, to permit self-application of such cuff while obviating the shortcomings of prior self-applied cuffs, an integral, prestressed resilient clip of spiral shape is freely disposed in the in-

flatable portion of the cover between the bladder and the outer cover surface. Due to its prestressed resilient characteristic, such clip thereby imparts its spiral shape to both the cover and the bladder. Generally, the clip is substantially co-extensive in length and width with the length and width of the inflatable portion.

Advantageously, the spring clip has at least two cut-out portions separated by a cross-strap. Preferably, the clip is made of about 0.010-inch thick steel and in its fully open position has a length greater than twice its width, with the cut-out portions being symmetrical with respect to the central longitudinal and transverse axes of the clip.

When the cuff is used with means for electrically determining the user's blood pressure, it houses a transducer between the bladder and the inner surface of the cover. The transducer, which may comprise a crystal microphone or the like, is positioned in registration with the cross-stop and underlies the same so that, when the cuff is in use, it presses the microphone against the user's arm.

The invention also contemplates the provision of a cuff of a single predetermined width, which will permit accurate determination of the user's systolic and diastolic pressures without regard to the size of the user's limbs. This purpose is achieved in accordance with the invention by providing a blood-pressure cuff comprising a hollow elongated non-elastic cover having an outer surface and an inner surface, an elongated inflatable bladder positioned in such cover and having a single fluid inlet, means operable for inflating the bladder and being connected to such single fluid inlet for supplying fluid under pressure thereto, and means for fastening the cover with its inner surface applied about a limb of the user, the bladder having a plurality of contiguous chambers each in fluid communication with its adjoining chambers and with the single fluid inlet.

Preferably, each chamber of the multi-chamber bladder extends along the length of the bladder in aligned relation to the other chambers, alternate pairs of contiguous chambers being in fluid communication at their respective opposite end portions. Advantageously, the chambers are formed by longitudinally extending, fluid-occluding seams in the bladder that are shorter than the bladder in order to afford the indicated communication between contiguous chambers.

In a preferred embodiment the volumes of the chambers are equal. Also, the fluid inlet is adjacent one end of the bladder in communication with a first of such chambers, the remaining chambers being arranged in serial serpentine fluid communication with the first chambers.

The cuff of the invention is advantageously so formed that the two chambers of each pair are separated along the greatest part of their length by a seam connection between the outer and inner surfaces of the bladder, such outer and inner surfaces, when the bladder is inflated, forming convex surface portions spaced by such seams.

Such multi-chambered cuff construction of the invention may be employed per se as indicated. It may also be utilized with advantage, however, in combination with the self-applied cuff of the invention. Each inventive feature thereby augments and reinforces the other, to the practical benefit of the user.

An advantage of utilizing a transducer in connection with the self-applied cuff of the invention is that it thus

becomes feasible for the user to take his own blood pressure very simply and conveniently. The electrical circuit means associated with the transducer can be included within a casing or housing, which can be suitably made of a size to fit the hand of the user. Moreover, such casing or housing mounts signal-indicating means operated by the electrical output signals from the circuit means for observation by the user, the bladder-inflating means, and a pressure gauge from which blood pressure readings may be made. The invention thus provides a self-usable system for detecting and measuring blood pressure without resort by the user to outside assistance.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the self-applied blood-pressure cuff in accordance with the invention;

FIG. 2 is a perspective view of such cuff in the process of application about a limb of the user, the dotted-line position illustrating the position of the cuff when released;

FIG. 3 is a perspective view illustrating the self-supported position of the cuff about a limb of the user;

FIG. 4 is a longitudinal section viewed in the direction of the arrows through line 4—4 of FIG. 1;

FIG. 5 is a plan view of the cuff in its fully open position with the outer surface of the cuff cover partly broken away;

FIG. 6 is a transverse section viewed in the direction of the arrows through line 6—6 of FIG. 5;

FIG. 7 is a schematic representation of the cuff together with a system for electrically determining the blood pressure of the user;

FIG. 8 is a plan view of a conventional bladder for a cuff;

FIGS. 8A, 8B and 8C illustrate the shape of the FIG. 8 bladder when it is applied to normal, large and slender limbs, respectively;

FIG. 9 is a plan view of a multi-chambered bladder in accordance with the invention; and

FIGS. 9A, 9B and 9C are end views of the bladder of FIG. 9 and illustrate the direction of the forces generated when such bladder is used on normal, large and slender limbs, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIGS. 1 to 6, the present self-applied cuff comprises an elongated non-elastic cover 10 divided into two general sections. One such section constitutes the hollow inflatable portion 12, which is essentially rectangularly shaped. The other such section forms the fastening portion 14, which is integral with and extends from the inflatable portion. Both portions have the common outer surface 16 and the common inner surface 18, which are transversely stitched together at 17 and 18 respectively (see FIG. 5) to form such hollow inflatable portion.

Positioned within the hollow inflatable portion is an inflatable bladder 20, which is also essentially rectangularly shaped and the dimensions of which are somewhat less than those of the hollow portion itself. Extending from such bladder outwardly through the cuff cover is flexible tube 22, which may be connected, as

shown in FIG. 5, to a mid-section of the bladder. Tube 22 communicates at its other end with a bladder-inflating means such as a conventional hand-squeezable pressure bulb 24 (see FIG. 2).

The hollow inflatable portion is designed to be wrapped around a limb such as an upper arm of the user, with the inner surface 18 applied to the limb, when it is desired to take the user's blood pressure. To maintain such inflatable portion in place, the fastening portion is then wrapped about the former and suitably fastened thereto. For this purpose there may be provided on such two portions any appropriate cooperative fastening means such as that sold under the trademark "Velcro," which comprises small barbs 26 formed on the outer surface of the inflatable portion and small loops 28 formed on the inner surface of the fastening portion for mutual cooperative action.

The length of such hollow inflatable portion and its enclosed inflatable bladder should, of course, be sufficient that the brachial artery is properly overlaid thereby. Any suitable flexible material, whether a fabric, a plastic, or otherwise, may be utilized in the manufacture of the cuff cover so long as it is non-elastic or non-stretchable. In this way, when the bladder is inflated during a blood-pressure determination, the resulting bladder pressure serves to occlude the flow of blood through the artery, as is desired.

Detection of the pulse sounds during a blood-pressure determination may be done with a stethoscope in the conventional manner. To facilitate the self-use of the cuff, however, a suitable transducer such as a microphone 30 is desirably incorporated in the hollow inflatable portion preferably between the bladder and the inner surface of the cover. For this purpose, as shown in FIG. 5, such transducer may be positioned in a pocket or pouch 31 formed in the cover inner surface adjacent the area where tube 22 extends through such cover. A conductor 32 leads from the transducer to suitable means, to be described hereinafter, for electrically indicating the blood pressure.

In accordance with the invention, an integral prestressed resilient clip 34 of spiral shape is freely or loosely disposed in the hollow inflatable portion 12 of the cuff cover in order to render the cuff fully and readily self-applicable by the user. For maximum effectiveness such spring clip is positioned between the bladder 20 and the outer surface 16 of the cover.

Because of the prestressed condition, clips 34 imparts its spiral shape to bladder 20 and the portion of cover 10 encasing such bladder. The spring clip may be made substantially co-extensive in length and width with the length and width of the hollow inflatable portion to ensure that the cuff, when it is applied by the user to his limb, will be fully self-supportive, as shown in FIG. 3.

The length of the spring clip 34 is such that, in its prestressed or released condition, its two ends overlap to a considerable extent, as shown more particularly in FIG. 4. In practice it is found that, generally speaking, an overlap of about 110° in its released condition is usually adequate. Desirably, the degree of such overlap should be sufficient to ensure that, when the cuff is applied to his limb by the user, the hollow inflatable portion 12 at least almost substantially encircles the limb.

By reason of the described construction, the cuff of the invention may be easily self-applied directly to one of his upper arms by the user with his free hand. The

overlapping ends of the spiral resilient clip can be readily separated to permit the direct placement of the cuff about the upper arm. More particularly, the cuff may be applied to the upper arm by gripping one end of the inflatable portion, pressing the other end of such inflatable portion against the upper arm, and flexing and adjusting such inflatable portion so that it can be placed about the upper arm, as shown in FIG. 2. Sliding of the cuff onto the upper arm is thus not necessary. When the cuff has been properly adjusted, it can be released and will assume a position such as that shown by the dashed lines in FIG. 2. Under such circumstances, the resilient spring clip will maintain the cuff about the upper arm, no further support being required.

An advantage of the use of such spring clip is that, during its flexure, it stores energy which serves to instantly and totally deflate the bladder once the desired systolic and diastolic pressure readings have been noted and/or recorded. In the absence of such spiral clip 34, a squeezing force would have to be applied to the bladder in order to completely deflate the same.

As shown in FIG. 5, the spring clip is provided with two cut-out portions 36 and 38, desirably substantially equal in size, leaving a cross-strap 40 and two end-straps 42 and 44. Such cut-out portions, as illustrated, are symmetrical with respect to the central longitudinal and transverse axes of the clip.

Any of various resilient materials may be used to fabricate the clip, which, however, is desirably made of thin metal such as, for example, 0.010 inch thick steel. The length of the clip is generally greater than twice its width. A clip of practical dimensions is about 11 inches long by about 4 inches wide, with cut-out portions each measuring about 4 inches by 3 inches and separated by a cross-strap about three-fourths inch in width.

It is an important feature of the invention that, where the hollow inflatable portion 12 includes a transducer 30, the latter underlies the cross-strap 40 of the cut-out spring clip. This relationship ensures intimate contact of the transducer with the artery it overlies upon inflation of the bladder. This is significant in providing more accurate pressure determinations and minimizing spurious signals which may otherwise occur.

As previously indicated, bladder 20 is somewhat less in overall size than hollow inflatable portion 12 in which it is positioned; and it is also generally somewhat less in overall size than the spring clip 34. Where a cut-out spring clip is employed, the length of the bladder is preferably less than the distance between the two transverse end-straps 42 and 44 of such clip, as indicated in FIG. 5. To limit undesirable longitudinal movement of the bladder within the hollow inflatable portion, the outer and inner surfaces of the inflatable portion are partially transversely stitched together as shown at 43 and 45, respectively. Stitching 43 and 45 may, however, be omitted since longitudinal movement of the bladder is limited by the size of the opening in the cover through which flexible tube 22 extends.

For electrically determining blood pressure, I may utilize the apparatus disclosed in my co-pending application Ser. No. 432,191 filed Jan. 10, 1974, the disclosure of which, by this reference thereto, is incorporated herein as if fully set forth in this application. Such apparatus, schematically shown in FIG. 7, which corresponds essentially to FIG. 1 of such copending application Ser. No. 432,191, includes the necessary circuitry and devices for suitably indicating the detected pulse

sounds by appropriate conversion of the electrical signals provided by the transducer.

As indicated in FIG. 7, the bladder-inflating means comprising the hand-squeezable pressure bulb 24 is preferably mounted on a casing or housing 46, which is advantageously designed so as to fit conveniently in a hand of the user, as shown in FIG. 3. Such pressure bulb 24 communicates through nozzle tube 48 with the flexible tube 22 leading to bladder 20. Also mounted on casing 46 is a pressure-indicating device such as an aneroid manometer 50, which is in communication with nozzle tube 48 through inlet fitting 52 and restricted passage 54. Nozzle tube 48 may also be provided with a bleed valve 56 upstream of inlet fitting 52.

Casing or housing 46 also contains a conventional amplifier means 58 including a suitable power source. The input of such amplifier means is supplied via conductor 32 with the electrical signals from the output of transducer 30; and the output of such amplifier means energizes suitable pulse sound-indicating means such as lamp L and/or speaker S as a function of such electrical signals. A potentiometer sensitivity control V is included in the amplifier means to bias the trigger circuit of the latter so that the indicating means such as lamp L will initially flash at systolic pressure and will continue to flash until the diastolic pressure is reached, at which point the trigger circuit is rendered inoperative. As a matter of convenience, lamp L and/or speaker S are mounted on the casing.

The compact construction of casing 46, as indicated above, permits the casing to be readily carried in a hand of the user. The pressure bulb 24 should be so mounted on such casing, of course, that it is readily accessible for operation, preferably by the same hand of the user. To facilitate such hand support of the casing and such hand operation of the pressure bulb, the casing may be provided with a suitable hand grip (not shown) that also enables squeezing of the pressure bulb to be more readily accomplished. For convenience, flexible tube 22 and conductor 32 may be jointly sheathed within conduit 60. An on-off switch 62 is provided on casing 46 for the desired control of its operation.

The reduction of pressure through the systolic-diastolic range is accomplished by controlled bleeding through the bleed valve 56. As will be apparent, then, once the cuff has been inflated to a pressure above the systolic, no further positive action is required by the user except to take two readings from the pressure gauge, the first when the lamp L starts flashing and the second when it stops flashing.

Further in accordance with the invention, there is provided a cuff equipped with a multi-chambered bladder, the purpose of which is to enable consistently accurate blood-pressure determinations to be made regardless of the size of the user's limbs. So that the advantages of such improved cuff can be more fully appreciated, there will first be described the manner in which the usual cuff respectively operates with limbs of different sizes.

Such a usual cuff, as indicated above, has a given or "standard" width and is customarily employed for all blood-pressure measurements. It includes an inflatable bladder B which, as shown in FIG. 8, conventionally comprises a single uninterrupted chamber. When such a cuff is applied to a normal arm and inflated, the bladder pressure, as shown by the arrows in FIG. 8A, is

transmitted generally perpendicularly over the width of the bladder to and through the surface flesh F and the muscle M to the artery A, which is shown squeezed to the point of blood cut-off. As the bladder pressure is reduced, the systolic pressure, which can be assumed to be 120 for purpose of illustration, is first noted. Thereafter, upon continued reduction of the bladder pressure, the diastolic pressure, which can be assumed to be 80 also for purpose of illustration, is then noted. Thus, the blood-pressure readings for such "normal" arm are 120 over 80.

When such cuff is applied to a large or obese arm having the same basic arterial blood pressure and inflated, the shape of the bladder becomes distorted, as shown in FIG. 8B, due to the thickness of the flesh F. As a result, the bladder pressure over the width of the bladder will no longer be normal to the flesh and muscle and will be dispersed because of the bladder distortion, as shown by the arrows. Excess bladder pressure is thus required to stop the flow of blood in artery A, with the consequence that false blood-pressure readings, for example on the order of 140 over 100, are obtained.

Conversely, when such cuff is applied to a slender or thin arm having the same basic arterial pressure and inflated, the shape of the bladder also becomes distorted but in a different manner, as shown in FIG. 8C, due to the thinness of the flesh F. The bladder pressure over the width of the bladder again will no longer be normal to the flesh and muscle and will be directed, because of the bladder distortion, as shown by the arrows. Less bladder pressure is thereby required to cut off the blood flow in artery A, with the result that false blood-pressure readings in the opposite direction, for example on the order of 110 over 70, result.

As shown in FIG. 9, bladder 64 of the present invention is comprised of a plurality of individual contiguous or adjoining pressure-fluid chambers or compartments, each of which is in fluid communication with its neighboring chambers. Bladder 64 is also provided with a single fluid inlet 66 for the purpose of inflating such chambers, each of which is also in fluid communication with such single inlet. While bladder 64 may contain any appropriate number of such chambers or compartments, for purposes of illustration only three such chambers 68, 70 and 72 have been shown.

Desirably each such chamber extends along the length of the bladder in aligned relation to the other chambers. The formation of each chamber and the separation of the same from each other are accomplished by means of longitudinally extending, fluid-occluding seams such as seams 74 and 76 provided between the inner and outer surfaces of the bladder. Such seams are, of course, longitudinally shorter than the bladder in order to provide the indicated fluid communication between adjoining chambers.

Preferably, alternate pairs of contiguous chambers are in fluid communication with each other at their respective opposite end portions, as indicated by the arrows in FIG. 9. Generally, each chamber or compartment is equal in volume to each of the other chambers. In this manner equilization of the pressure applied against an arm or other limb results upon inflation of the bladder.

Advantageously, the indicated single fluid inlet 66 is positioned adjacent one end of the bladder 66 in communication with the first chamber, such as chamber 68,

formed along the corresponding side of the bladder. The remaining chambers are thereby arranged in serial serpentine flow with such first chamber under the preferred form of construction, such feature also serving to equalize the application of bladder pressure across the entire width of the bladder.

It has also been found desirable to form the fluid-occluding seams or seam connections between the inner and outer surfaces of the bladder in such manner that, when the bladder is inflated, such surfaces bulge outwardly between the respective pairs of seam connections so as to define spaced convex surface portions. Such surface formation also assists the desired equal distribution of bladder pressure when the cuff containing such bladder is placed in position on an arm and inflated.

As will be appreciated, when a cuff containing such multi-chambered bladder is applied to a normal arm and inflated, the bladder pressure, as shown by the arrows in FIG. 9A, is directed normally across the width of the bladder against the surface flesh and muscle (not shown) and has the same effect on blood-flow occlusion in the arm artery as indicated in FIG. 8A.

When such cuff of the invention is applied to an obese arm and inflated, the bladder pressure, as shown in FIG. 9B, will maintain substantially the same distribution across the width of the bladder as shown in FIG. 9A. This result is due to the resistance provided against distortion of the bladder because of its compartmentalization into discrete chambers each materially smaller in size than the single uninterrupted chamber of the prior-art bladder shown in FIG. 8. Thus, an equally accurate blood-pressure determination can be obtained notwithstanding the use of such multi-chambered cuff on a large-size limb.

Essentially the same result is obtained when such present cuff is applied to a thin arm and inflated, the bladder pressure over the width of the bladder, as shown in FIG. 9C, also having basically the same distribution as shown in FIG. 9A.

Such multi-chambered bladder may, of course, be utilized as such in connection with a standard cuff-cover construction as basically shown in FIG. 1. Because of its bladder pressure-equalization characteristic, however, it is particularly advantageous to employ such multi-chambered bladder in combination with the self-applied spring-backed cuff described above in connection with FIGS. 1 to 6. Of still further advantage is the use of such multi-chambered bladder in conjunction with such spring-backed cuff when the latter also includes a system for electrically determining and indicating the user's blood pressure.

Because of the ability of the user to apply the cuff of the invention to one of his limbs without outside assistance, it becomes feasible for such user to measure his blood pressure at frequent intervals. This advantage is extremely important to a hypertensive patient, particularly one on medication to relieve high blood-pressure conditions. When such a patient's blood pressure consistently falls within a more normal range, the amount of the medication can thus be stabilized; and any accompanying side effects can be minimized.

The invention thus not only provides a cuff which can be self-applied to a limb without preadjustment and is self-supportive when so applied but also provides a cuff which enables accurate measurement of blood pressure regardless of the size of the user's limbs.

What is claimed is:

1. In a blood-pressure cuff including an elongated non-elastic cover having a hollow inflatable portion having an outer wall and an inner wall, an inflatable bladder within said inflatable portion between inner facing surfaces of said outer and inner walls, means extending from said inflatable portion for fastening the cover with the inner wall of said flexible portion applied to a limb of the user, and means operative to inflate said bladder when the cover is so applied, the improvement comprising an integral, single component, prestressed resilient clip of spiral shape loosely disposed within said inflatable portion between the bladder therein and the inner surface of the outer wall of the inflatable portion, said clip being substantially co-extensive in length and width with the length and width of the inflatable portion to impair its spiral shape to said cover and said bladder.

2. A cuff according to claim 1, wherein said clip has at least two cut-out portions bounded by transverse end straps and a cross-strap therebetween.

3. A cuff according to claim 2, including means for electrically determining blood pressure, said means including a transducer positioned within said inflatable portion between the bladder and the inner surface of the inner wall of the inflatable portion and substantially underlying said cross-strap of the spiral clip for ensuring intimate contact of the transducer with the artery it overlies during inflation of the bladder.

4. A cuff according to claim 2, wherein said single component spiral clip is movable to an open position from its normal prestressed position for application of the cover about the user's limb, the cross-strap of said clip being substantially equally spaced from the transverse end-straps thereof.

5. A cuff according to claim 2, wherein the clip is of about 0.010 inch thick steel and in its fully open position has a length greater than twice its width, said cut-out portions being symmetrical with respect to the central longitudinal and transverse axes of the clip.

6. A cuff according to claim 2, wherein said clip in its fully open position is about 11 inches along and about 4 inches wide, said cut-out portions being each about 4 inches long and about 3 inches wide and being separated by said cross-strap of about three-fourths inch width, the remaining length of the clip being made up by said transverse end straps.

7. A blood-pressure cuff comprising an elongated non-elastic cover having a hollow inflatable portion having an outer wall and an inner wall, a single inflatable bladder positioned in said inflatable portion between inner facing surfaces of said outer and inner walls, single fluid inlet means for inflating said bladder and for supplying fluid under pressure from said bladder to a fluid pressure responsive device, means subdividing said single bladder into a plurality of contiguous chambers, each in communication with the others and with said fluid inlet means, and means for fastening the cover with said inner wall of the cover applied about a limb of the user; said bladder having more than two chambers formed therein, each chamber extending along the length of the bladder in aligned relation to the other chambers, alternate pairs of contiguous chambers being in fluid communication at their respective opposite end portions.

8. A cuff according to claim 7, wherein said subdividing means comprise longitudinally extending, fluid-

occluding seams of a longitudinal extent less than that of the bladder, each of said seams being between inner surfaces of inner and outer walls of the bladder.

9. A cuff according to claim 7, wherein the chambers are each equal in volume, said single fluid inlet means being adjacent one end of the bladder in communication with a first of said chambers, the remaining chambers being arranged in serial serpentine fluid communication with said first chamber.

10. A cuff according to claim 1, wherein the two chambers of each pair are separated along the greatest part of their longitudinal extent by a seam connection between the outer and inner surfaces of the bladder, said inner and outer surfaces, when the bladder is inflated, bulging outwardly to define spaced convex surface portions respectively interconnected by said stem connections.

11. A blood-pressure cuff comprising an elongated non-elastic cover having a rectangularly shaped hollow inflatable portion having an outer wall and an inner wall and a fastening portion extending from the inflatable portion for fastening the cover with the inner wall of the inflatable portion applied about limb of the user, a rectangularly shaped inflatable bladder positioned within said hollow inflatable portion between inner facing surfaces of said inner and outer walls and having a single fluid inlet, inflating means connected to said fluid inlet to inflate the bladder, the latter being formed with a plurality of contiguous chambers each in communication with adjoining chambers and with said single fluid inlet, and a single component prestressed resilient clip of spiral shape loosely disposed within said inflatable portion between the bladder and the inner surface of the outer wall of the inflatable portion, said clip being substantially co-extensive in length and width with the length and width of said inflatable portion to impart its spiral shape to said cover and said bladder.

12. A cuff according to claim 11, wherein said clip has at least two cut-out portions bounded by transverse end straps and a cross-strap therebetween, said cuff including means for electrically determining blood pressure, said means including a transducer positioned within said inflatable portion between the bladder and the inner surface of the inner wall of the inflatable portion and substantially underlying said cross-strap of the spiral clip for ensuring intimate contact of the transducer into the artery it overlies during inflation of the bladder.

13. Blood-pressure measuring apparatus comprising an elongated non-elastic cuff cover having a rectangularly shaped hollow inflatable portion and a fastening portion extending therefrom, said two portions having a common outer wall and a common inner wall, a rectangularly shaped inflatable bladder within said inflatable hollow portion between inner facing surfaces of said inner and outer walls of said hollow portion, cooperative fastening means on the outer wall of said inflatable portion and on the inner wall of said fastening portion to fasten the cover when the inner wall of said inflatable portion is applied to a limb of the user, means operative to inflate said bladder when the cover is so applied, a single component, prestressed, resilient clip of spiral shape loosely disposed within said inflatable portion between the bladder therein and the inner facing surface of the outer wall of the hollow portion, said clip having a length and width which occupy the major part of the length and width of the hollow inflatable

portion for imparting its spiral shape to said cover and said bladder, transducer means provided in said inflatable portion between said bladder and the inner facing surface of the inner wall of the inflatable portion for translating pulse sounds into electrical signals, indicating means for providing an indication when the pulse sounds are detected, and electrical circuit means having an input supplied with said electrical signals from said transducer means and an output for energizing said indicating means as a function of said electrical signals.

14. Apparatus according to claim 13, wherein said clip is substantially co-extensive in length and width with the length and width of said inflatable portion.

15. Apparatus according to claim 13, which includes a casing, said inflating means and said indicating means being mounted on said casing, with said inflating means accessible for operation, and said electrical circuit means being included within said casing.

16. Apparatus according to claim 15, wherein said casing is of a size enabling ready support thereof and operation of said inflating means with one hand.

17. Apparatus according to claim 13, wherein said electrical circuit means includes a sensitivity control for controlling the sensitivity of said electrical circuit means to said electrical signals from said transducer means, said sensitivity control being set to provide an indication solely during that interval during which pressure within the bladder corresponds to the systolic-diastolic blood pressure range of the user.

18. Blood-pressure measuring apparatus comprising an elongated non-elastic cuff cover having a rectangularly shaped hollow inflatable portion and a fastening portion extending therefrom, said two portions having a common outer wall and a common inner wall, a rectangularly shaped inflatable bladder within said inflatable hollow portion between inner facing surfaces of said inner and outer walls of said hollow portion, cooperative fastening means on the outer wall of said inflatable portion and on the inner wall of said fastening portion to fasten the cover when the inner wall of said inflatable portion is applied to a limb of the user, means operative to inflate said bladder when the cover is so applied, said inflating means being connected to said single fluid inlet for said bladder, the latter having a plurality of contiguous chambers each in fluid communication with its adjoining chambers and with single fluid inlet, a single component, prestressed, resilient clip of spiral shape loosely disposed within said inflatable portion between the bladder therein and an inner surface of the outer wall of the hollow inflatable portion of the cover, said clip having a length and width which occupy the major part of the length and width of the hollow inflatable portion for imparting its spiral shape to said cover and said bladder, transducer means provided in said inflatable portion between said bladder therein and the inner surface of the inner wall of the inflatable portion for translating pulse sounds into electrical signals, indicating means for providing an indication when the pulse sounds are detected, and electrical circuit means having an input supplied with said electrical signals from said transducer means and an output for energizing said indicating means as a function of said electrical signals.

19. Apparatus according to claim 18, wherein said clip is substantially co-extensive in length and width with the length and width of said inflatable portion.

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20. In a blood-pressure cuff including an elongated non-elastic cover having a hollow inflatable portion having an outer wall and an inner wall terminating in opposed joined longitudinal and transverse edges, an inflatable bladder within said inflatable portion between inner facing surfaces of said outer and inner walls between said longitudinal and transverse edges, means extending from said inflatable portion for fastening the cover with the inner wall of said inflatable portion applied to a limb of the user, and means operative to inflate said bladder when the cover is so applied, the improvement comprising an integral, single compo-

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5 nent, arcuate prestressed resilient clip disposed within said inflatable portion between the bladder therein and the inner surface of the outer wall, said clip extending substantially from one transverse edge to the other so as to be substantially coextensive in length with the length of the inflatable portion and having a width extending between the longitudinal edges of the inflatable portions.

10 21. A cuff according to claim 20, wherein said arcuate prestressed resilient clip is free of connection with the outer wall of the inflatable portion of the cover.

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