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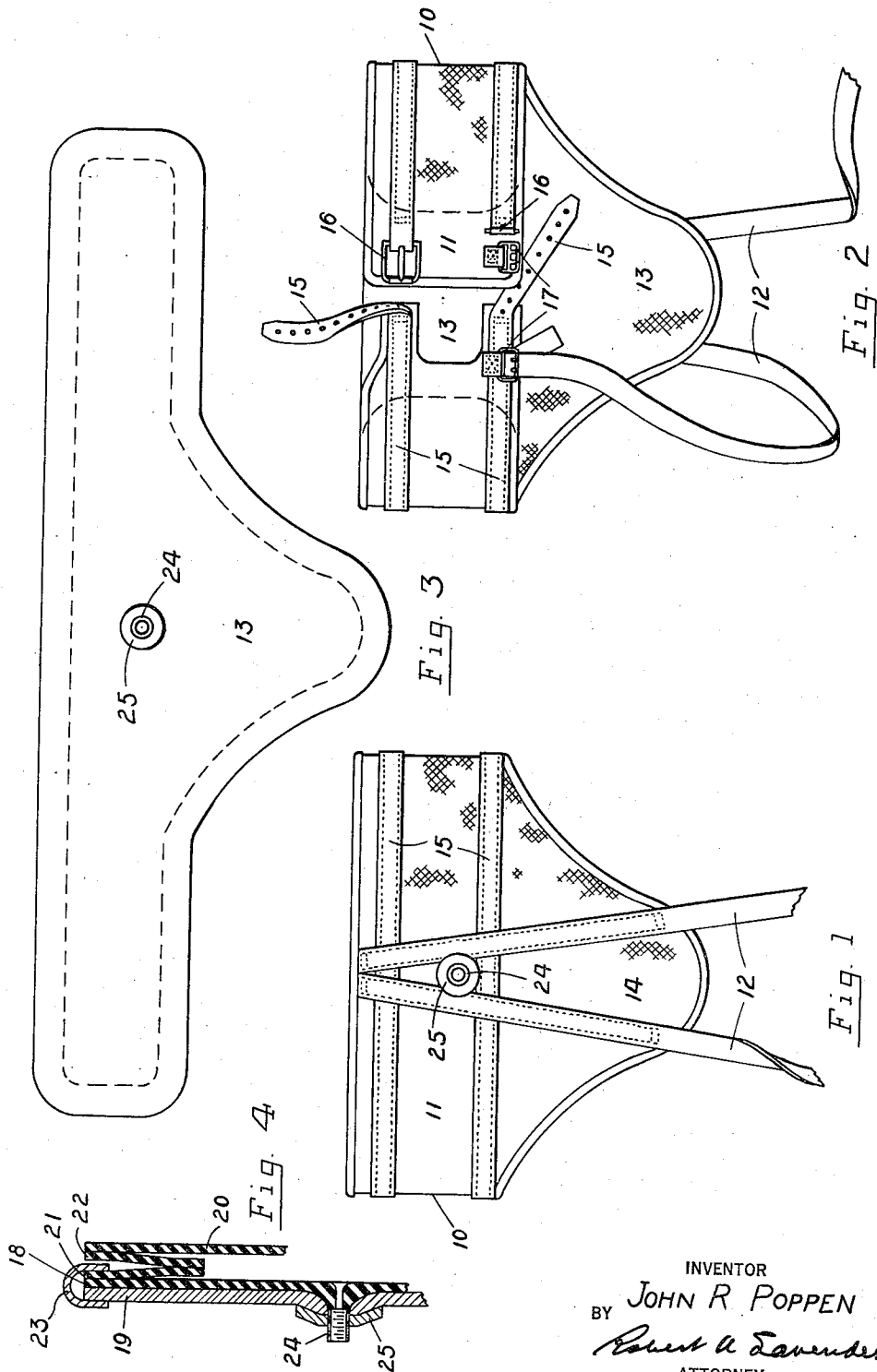
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2,104,758

METHOD AND APPARATUS FOR CONTROLLING THE DISTRIBUTION AND
PRESSURE OF CERTAIN HUMAN BODY FLUIDS AND CONTENTS

Filed March 12, 1936

2 Sheets-Sheet 1



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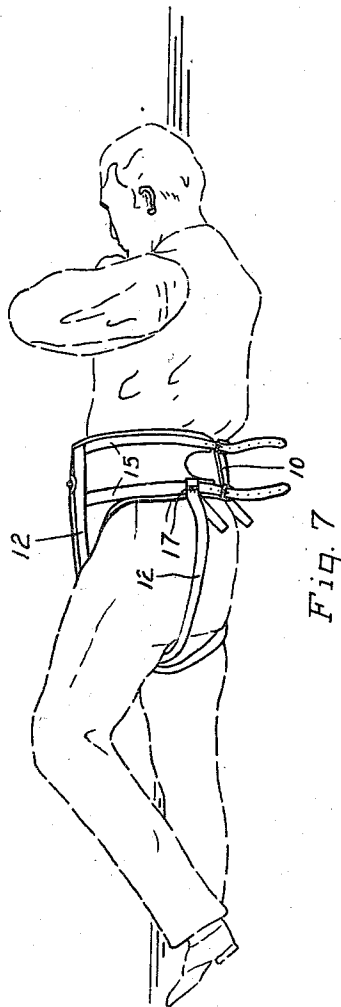
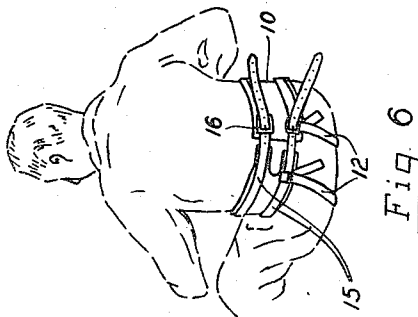
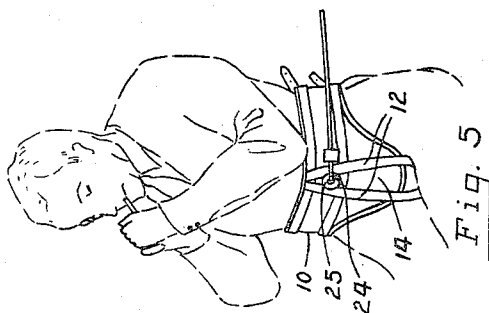
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METHOD AND APPARATUS FOR CONTROLLING THE DISTRIBUTION AND
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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR CONTROLLING THE DISTRIBUTION AND PRESSURE OF CERTAIN HUMAN BODY FLUIDS AND CONTENTS

John R. Poppen, United States Navy

Application March 12, 1936, Serial No. 68,422

4 Claims. (Cl. 128—96)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

This invention relates broadly to methods and apparatus for reducing physiological symptoms due to improper distribution of blood volumes and pressures and abnormal pressure relationships between the visceral contents of the body; and more particularly for reducing those physiological symptoms due to the interplay of pressures within the abdominal region produced by high accelerations such as are encountered in aircraft maneuvers.

An object of this invention is to provide a belt that will effectively control the volume of the intraabdominal blood vessels by modifying the intraabdominal pressure.

Another object of this invention is to provide a belt so constructed that it will readily adapt itself to the irregularities of the body structure to equally distribute pressures within the abdominal cavity.

A further object of this invention is to provide a belt that is readily accessible for quick and convenient adjustment.

Having these general objects in view, and others that will appear as the nature of the improvements is better understood, the invention consists substantially in the novel construction, combination and method of operation of parts hereinafter fully described, illustrated in the accompanying drawings, and pointed out in the appended claims.

Reference is to be had to the accompanying drawings forming part of this specification, in which the reference characters indicate corresponding parts throughout the several views, and in which,

Figure 1 is a front view of the apparatus removed from the body;

Figure 2 is a rear view of the apparatus removed from the body;

Figure 3 is a view in elevation of the elastic bag separated from the supporting belt;

Figure 4 is a partial view in section through the apparatus showing manner of construction of belt and bag and method of attachment of the several parts;

Figure 5 is a front view of the body, showing the apparatus as applied thereto;

Figure 6 is a rear view of the same, and

Figure 7 is another view from the side, showing the arrangement of the apparatus.

There is in the abdominal cavity a blood circulating system known as the portal system. It is a system of veins and capillaries whose principal function is in connection with digestion. It is flanked on the supply side by the capillaries of the mesenteric arteries, and on the discharge side

by the liver capillaries, through which it communicates with the general venous circulation of the body.

The pressure of the blood in the portal system is relatively low, being essentially that of the intraabdominal tension. It is largely dependent upon the tension of the abdominal wall and such extraneous forces as may apply to that wall.

The relative volume of the portal veins under varying intraabdominal pressures is dependent upon the nervous tone in the walls of the portal veins. Under certain conditions, such as shock, syncope, etc., in which this tone is reduced, the veins dilate and expand to such diameters that the system can contain a considerable portion of the blood of the entire body. This increase in the blood volume of the abdomen is at the expense of the general circulation of the body, and the symptoms encountered are the result of impaired circulation in other parts of the body, e. g., the brain.

Furthermore, if the body be subjected to certain physical forces tending to force a disproportionate amount of blood into the portal system at the expense of the general circulation, there results an abnormally reduced supply to the heart which, in turn, results in reduced general circulation. This is illustrated by the finding that an acceleration downward along the long axis of the body amounting to several times gravity will reduce the arterial blood pressure in the neck by approximately two-thirds. The reduction in circulation through the brain, which necessarily follows, accounts for the symptoms attending such an acceleration. The cause of this reduced arterial pressure is the reduced supply of blood to the heart as a result of hydrostatic pooling in the portal system.

If, then, the volume of the intraabdominal vessels is controlled by modifying the intraabdominal pressure by extraneous means, thus avoiding an abnormal amount of blood in these vessels as a result of abnormal physical forces and/or abnormal physiological processes, the symptoms resulting from such abnormal distribution of blood will be ameliorated or completely relieved. Such symptoms due to high accelerations are well recognized and encountered with increasing frequency. They are generally described in terms of decreased vision, e. g. "going black," "twilight", etc. Such conscious subjective symptoms are poignant and tangible. Of lesser severity and below the threshold of conscious awareness there are other symptomatic manifestations of high accelerations. In this category fall such symptoms

as slight reduction in attention, motor coordination, judgment, abstract reasoning, etc. These are symptoms which naturally result from the cerebral anoxemia produced by the high accelerations. They can be of as much significance as the more tangible ones.

Increasing the intraabdominal pressure by the application of external pressure causes an alteration in the distribution of blood pressure and volume which makes it possible for the normal circulatory system to preserve cerebral circulation at a level above that causing anoxic symptoms. The present invention is a means for controlling this intraabdominal pressure.

As is indicated in Fig. 1 and Fig. 2, the numeral 10 indicates the belt ensemble, which is essentially composed of the belt 11, the perineal straps 12, and the expansible elastic bag 13.

The belt 11 is made of a pliable inelastic material of such length as to pass completely around the body and to provide a suitable overlapping of the ends to insure snugness of fit, and of such width as to adequately cover the entire body abdominal area, thus necessitating that the frontal area of the belt 11 be transversely enlarged to conform to the contour of the lower abdomen, as indicated by the numeral 14. Longitudinally attached to the outside of the belt 11 are straps 15 provided with buckles 16 for securing the belt in position around the body.

The perineal straps 12 are attached to the belt 11 downwardly across the frontal area. The suspending ends of the straps are of such length as to pass snugly under and between the legs and to properly engage fastening buckles 17 secured at the back near the lower edges of the ends of the belt 11 when the latter is in position about the body. The perineal straps 12 are so attached that they keep the frontal portion of the belt 11 closely pressed against the lower abdomen.

The elastic bag 13 is attached to the inner side of the belt 11. It consists of an airtight rubber bladder expansible when inflated. The Fig. 4 indicates the manner of construction of belt and bag and method of attachment of the several parts. The bag 13 conforms to the general shape and contour of the belt 11, as shown in Fig. 3, and extends well into the sides over the flanks. The front wall 18 of the elastic bag 13 is cemented to the back of the front wall 19 of the belt 11. The back wall 20 of the elastic bag 13 is joined to the front wall 18 of the elastic bag 13 by two narrower strips 21 and 22, having their edges cemented so as to make a bellows-like junction between the bag walls 18 and 20. This construction permits the back wall 20 of the bag to conform exactly to the contour of the abdomen and to distribute the contained pressure evenly over the whole pressure area. A binding strip 23 is cemented over the adjacent edges of the walls 18 and 19 and the bellows strip 21. Attached to the front section of the elastic bag 13 is a tube 24 adaptable for the installation of a quick release fitting and a control check valve assembly for connection to a source of air pressure, or other gaseous substance, for inflating the elastic bag. The tube 24 is suitably supported by a reinforcing piece of flexible material 25 cemented around the tube and against the front wall 19 of the belt.

It is to be understood that a constant pressure within the elastic bag is capable of being controllably maintained from a gaseous source of supply, such as an air flask, suitably connected to the elastic bag by means of a quick release

fitting and control valve assembly, operated either manually, automatically, or a combination of both.

The operation of the belt ensemble is as follows:

The belt is placed in position about the abdominal region of the body under the clothing. It is closely drawn to the body by suitably tightening the straps 15 and buckles 16 forming a part of the upper belt structure.

When the belt 11 has been properly adjusted around the body the perineal straps 12 are passed downwardly between the legs and snugly drawn through buckles 17 at the back of the belt until the frontal section of the belt ensemble conforms to the contour of the lower abdomen.

After the belt 11 is in place and adjusted to the body, the elastic bag 13 is inflated to the desired pressure by connecting the tube 24 located in the front of the belt 11 to a source of air supply. This source may be either a manually operated pump, a mechanically operated pump, or a pressure flask, depending upon the uses to which the belt is to be put.

The belt ensemble is designed to conform to the body structure in the abdominal region, when in a deflated condition. When the expansible elastic bag 13 is inflated the whole structure tends to more completely and surely shape itself to conform to the contour of the abdomen and to exert a pressure within the abdominal cavity. This conformity is assured by the construction of the elastic bag 13 which allows of a bellows-like action. By this construction the back wall 20 of the bag, as shown in Fig. 4, is susceptible to evenly distributed pressures within the bag, tending to shape the said back wall 20 so that it will conform exactly to the contour of the abdominal structure.

With the belt thus appropriately in position about the body, any expansion of the bag 13 as a result of inflation, by whatever method employed, will cause an increase of pressure which will be transmitted directly into the abdominal cavity. This will result in a rise in pressure of all the contents, including the portal circulation, which in turn will cause a new distribution in volume and pressure in the general circulation of blood in the rest of the body. When for any reason, physical or physiological, the pressure and volume in the general circulation has been reduced by pooling in the portal circulation to a point incompatible with health and circulatory efficiency, inflation of the bag will correct this discrepancy and reestablish healthy circulation.

The operational functioning of the belt is characteristically exemplified in connection with airplane maneuvers. When the maneuver is such as to subject the occupant of the airplane to an acceleration downward along the long axis of his body, as would be the case in dive bombing, there results a reduction in the amount and pressure in the upper part of the body which causes symptoms; (a) directly, by reducing the flow of blood through the brain; and (b) indirectly, by reducing the supply to the heart, which further reduces the circulation above the heart. Increasing the intraabdominal pressure by inflating the belt will reduce the hydrostatic accumulation in that part of the body and will result in redistribution of the blood, so that the supply to the heart will not be reduced below the normal amount.

A further functioning of the belt is exemplified in counteracting certain abnormal conditions in which the volume of blood in the portal system is increased at the expense of the general circula-

tion by nervous influences. This condition obtains in shock, syncope, fainting, etc. As a result of the nervous manifestations of these conditions, the tone of the blood vessels of the portal system is lowered so that the amount of blood in this system is greatly in excess of the normal, and symptoms are caused by the consequent reduction in the general circulation. Inflating the belt will offset this effect by raising the pressure in the portal system and thus preventing this pooling of blood in the abdomen.

Other uses to which the belt may be put become apparent upon considering the many conditions in which physical and physiological conditions result in abnormal disproportion of blood between the portal and general circulation. Thus:

When the body is subjected to high accelerations or other forces tending to create an abnormal strain upon the abdominal wall, there is apt to result a mechanical failure of this wall with the production of disabilities such as hernia. By providing a support of the lower abdomen and increased outside pressure, the belt will reduce the likelihood of such disability under these circumstances.

When extraneous forces operating upon the body cause an abnormal interplay of the pressures in the several contents of the abdomen which produce symptoms by excessive nervous stimulation arising therefrom, inflation of the belt will result in establishing a new basic pressure relationship which will reduce or remove the influences of these extraneous forces. Such a condition occurs in certain types of seasickness, in which the interplay of pressures and tensions in the several contents of the abdomen incident to the abnormal movements of the ship result in an abnormal stimulation of the nervous system and resulting symptoms. By inflating the belt, a new basic pressure level is established, which reduces the movement of the intraabdominal contents and, consequently, the abnormal nerve stimulation. This will reduce or remove the symptoms.

It will be understood that the above description and accompanying drawings comprehend only the general and preferred embodiment of the invention and that minor changes in details of construction, proportion and arrangement of parts may be made within the scope of the appended claims and without sacrificing any of the advantages of the invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental

purposes without the payment of any royalties thereon or therefor.

Having thus described my invention, I claim:

1. In a device of the character described, an inelastic band adapted to embrace the body over the abdominal region; fastening straps longitudinally attached to the said band for securing the same about the body; perineal straps attached to the said band and downwardly suspending, and of such length as to extend to and engage with the rear section of the said band; an elastic bag attached to the inner surface of the said band, the said elastic bag having two walls, an inner wall and an outer wall, the said outer wall secured against the inner side of the said band, and the said inner wall being connected with the said outer wall by bellows-like strips, to insure the said inner wall lying in close apposition with the abdomen of the body; and a tube means connected to the said elastic bag for inflating the said bag.

2. In a device of the character described, an inelastic band adapted to embrace the body over the abdominal region; fastening straps attached to the said band for securing same about the body; perineal straps attached to the said band and downwardly suspending; an elastic bag attached to the said band, the said elastic bag having two walls, an inner wall and an outer wall, the said outer wall being secured against the inner side of the said band, and the said inner wall being connected with the said outer wall by bellows-like strips, thus adapting the said inner wall to lie in close apposition with the abdomen of the body; and means connected to the said elastic bag for inflating the said bag.

3. In a device of the character described, an inelastic band adapted to embrace the body over the abdominal region; fastening means for maintaining the said band in the desired position about the body; an elastic bag having an inner wall and an outer wall, the said outer wall secured against the inner side of the said band, and connected with the said inner wall by bellows-like strips; and ingress means for inflating the said elastic bag.

4. In a device of the character described, an inelastic band adapted to embrace the body over the abdominal region; fastening means for maintaining the said band in the desired position about the body; an elastic bag having an inner wall and an outer wall, the said outer wall secured against the inner side of the said band, and expansible means connecting the said inner wall with the said outer wall; and ingress means for inflating the said elastic bag.

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