Sept. 13, 1955 A. P. CHALLENNER 2,717,949

HEATING MEANS

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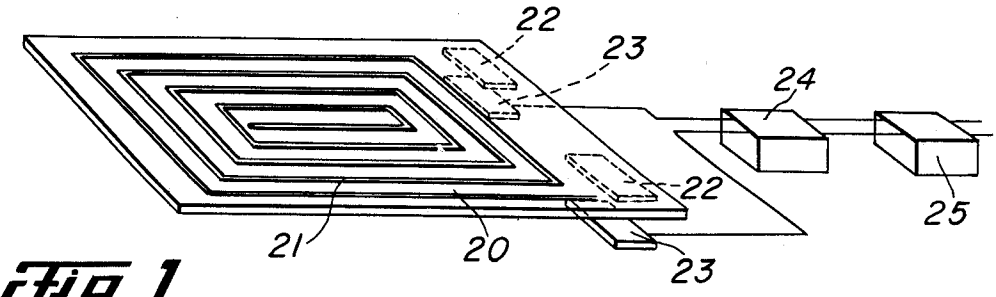

Fig. 1

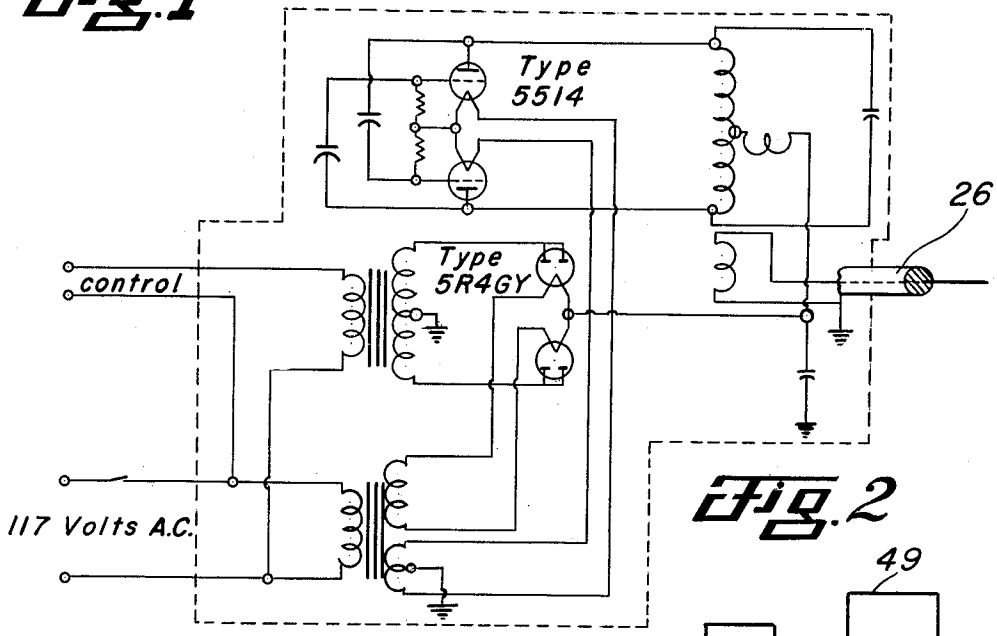

Fig. 2

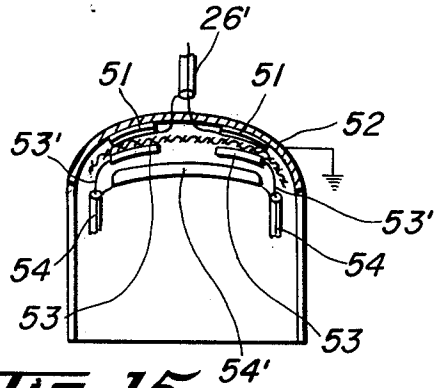

Fig. 15

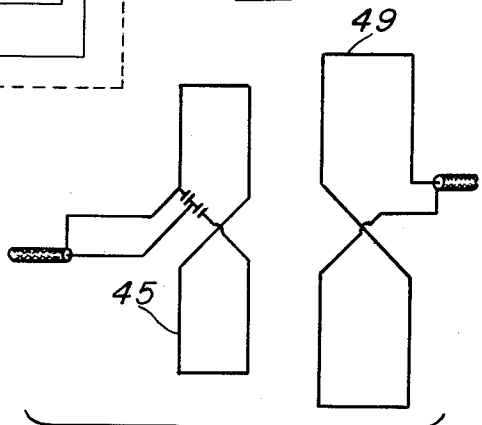

Fig. 16

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HEATING MEANS

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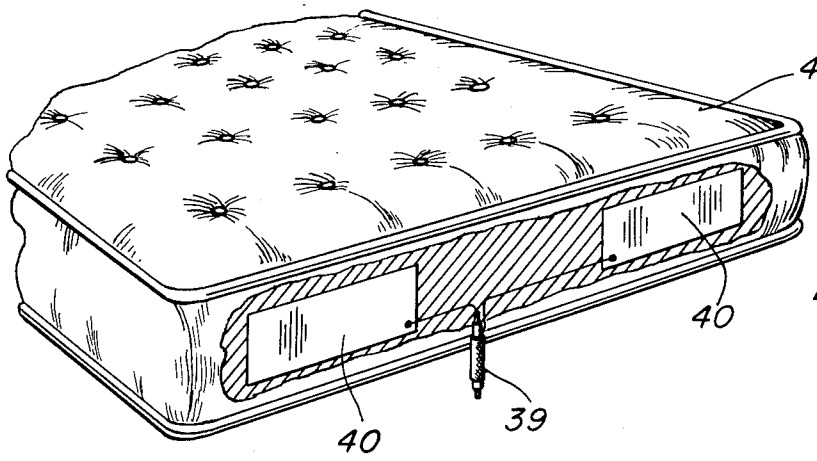

Fig. 3

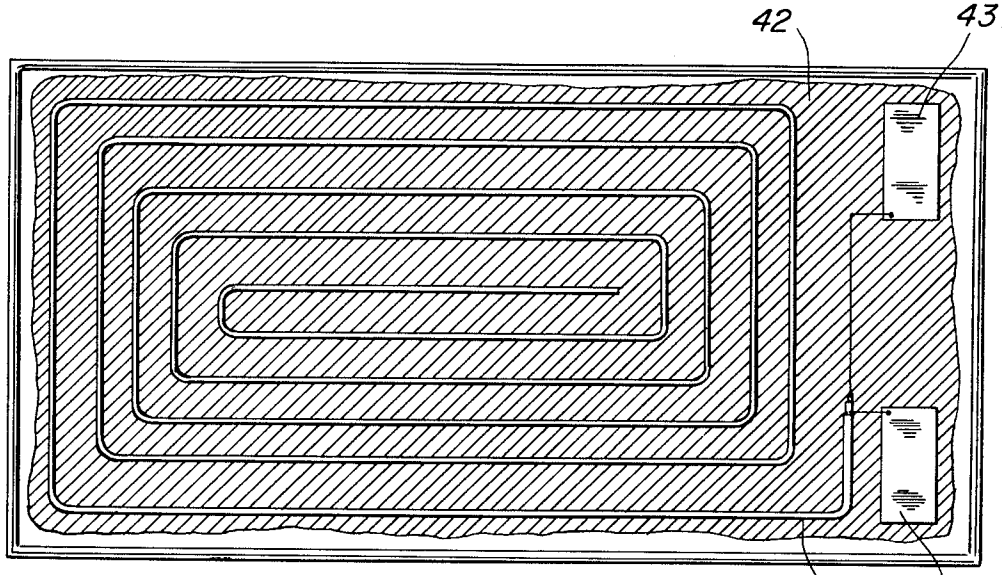

Fig. 4

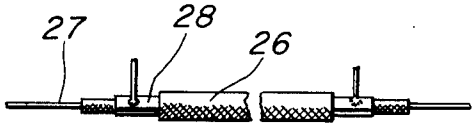

Fig. 5

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HEATING MEANS

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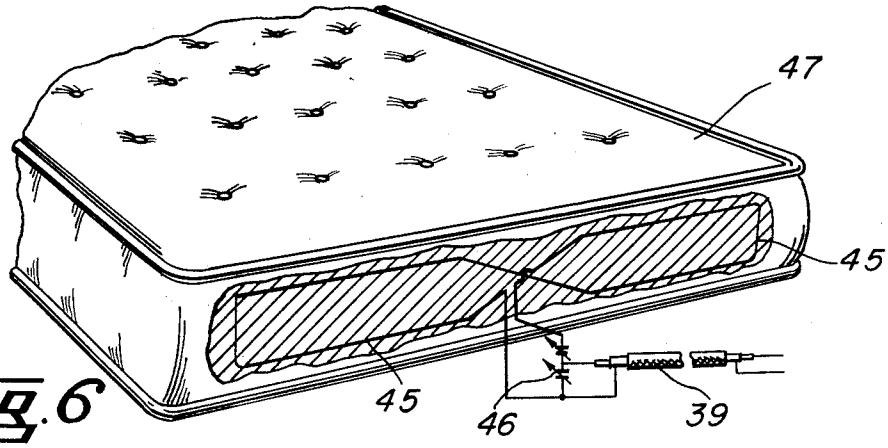

Fig. 6

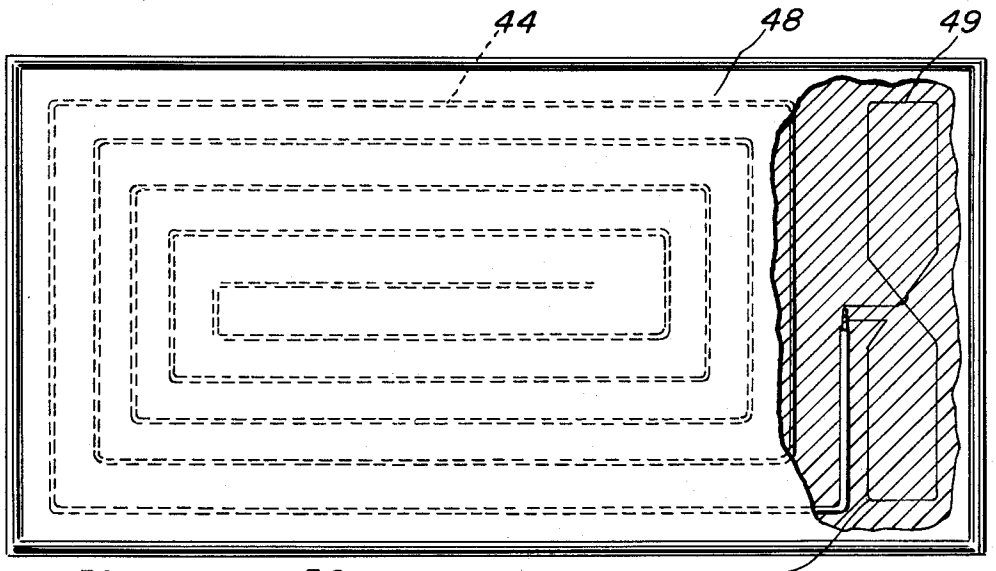

Fig. 7

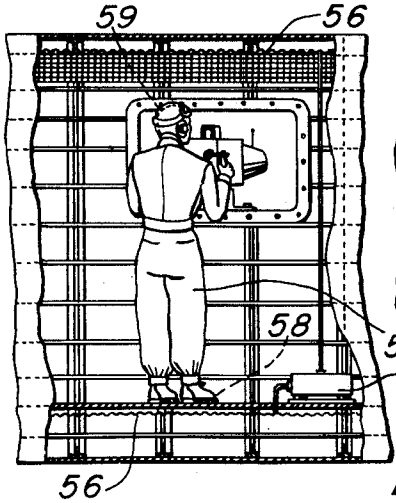

Fig. 14

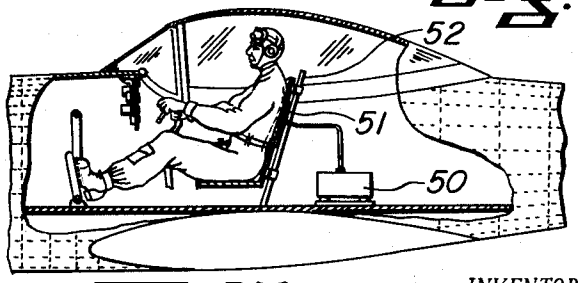

Fig. 13

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HEATING MEANS

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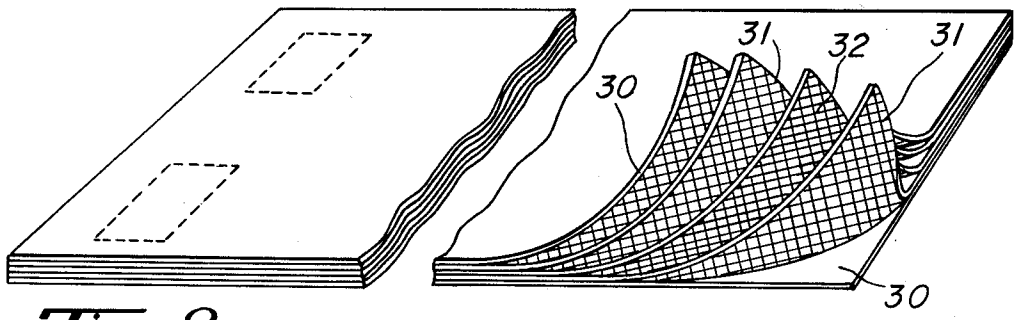

Fig. 8

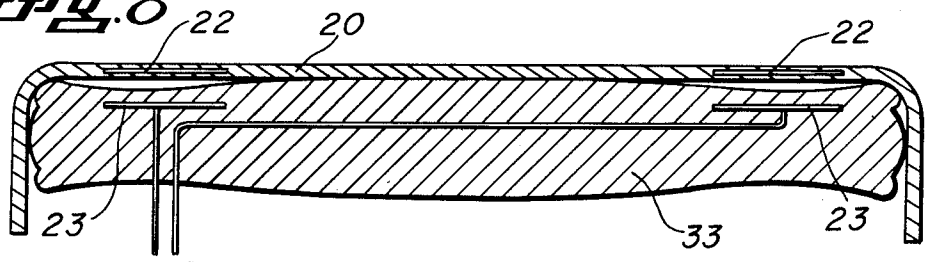

Fig. 10

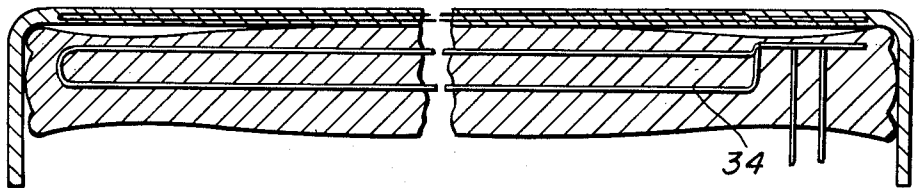

Fig. 11

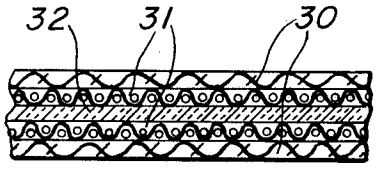

Fig. 9

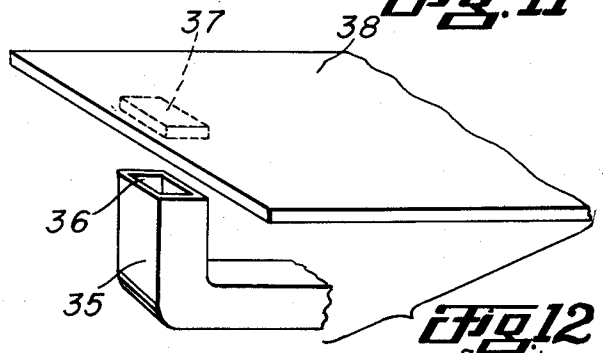

Fig. 12

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United States Patent Office

2,717,949

Patented Sept. 13, 1955

2,717,949

HEATING MEANS

Ansel P. Challenner, Norman, Okla., assignor to Denison Mattress Factory, Denison, Tex., a partnership

Application September 28, 1950, Serial No. 187,293

13 Claims. (Cl. 219—10.49)

This invention relates to new and useful improvements in heating means.

The invention is particularly concerned with the heating of blankets, quilts, or other bed accessories, flying suits, and other articles of a type intended to preserve the warmth of the human body and alleviate the discomfort of low temperatures. The invention specifically contemplates the accomplishing of such heating without the connection to the heated article of wires or electrical conductors, or other conductors which are cumbersome and dangerous, and provides for the transfer of heating energy without physical conductors.

The common types of blankets, quilts, flying suits and the like, which are now available, are adapted to be heated electrically, and in each case it is necessary that suitable electrical conductors be connected to the article. In the case of flying suits, the electric wires encumber the wearer, and in cases of emergency, hamper his efforts to leave or "bail out" of the airplane. Further, in certain types of aircraft, it is necessary that the personnel be free to move about within the airplane, and electrical conductors become a hindrance in such cases and prevent the occupant of the aircraft from functioning at full efficiency.

In the case of electric blankets, electric quilts, and the like, the supply wiring often gets tangled and interferes with the bed clothing. The connection is a nuisance, and unless carefully designed, may be quite dangerous as to the possibility of electrical shock or fires resulting from an electrical short circuit. The electrical connection is troublesome when the article of bed clothing is being cleaned, and great care must be exercised in the fastening of the conductor to the article to prevent damage to the article by tearing and to minimize the possibility of an electrical short occurring at the point of connection.

The present invention overcomes this multitude of difficulties by providing an improved heating article of the character described which is free of connecting wires and the impediments and hazards characteristic of such connecting wires.

A further advantage and object of the invention is the providing of an improved heating article of the character described employing inductive or capacitive coupling between a source of electrical energy and the heating article, electrical power thus being transferred without the requiring of physical electrical conductors, and offering manifold advantages.

Yet another object of the invention is to provide an improved heating article of the character described which may be laundered, cleaned, and otherwise handled in the same manner as similar articles not having provision for heating, whereby the care and maintenance of the article is greatly simplified.

A further object of the invention is to provide an improved heating article of the character described employing high frequency electrical power rather than the lower frequency power in widespread commercial use.

A particular object of the invention is to provide an improved heating article of the character described in which the heating element is arranged in a novel fashion to minimize radiation and other undesirable effects commonly encountered in the use of high frequency electrical power.

A still further object of the invention is to provide an improved heating arrangement including a heating article of the character described wherein electrical coupling agents are employed for transmitting electrical power to the heating article, and in which arrangement the coupling elements are so arranged and positioned as to insure proper maintenance of the coupling conditions.

Specifically, one object of the invention is to provide an improved electrical blanket having electrical coupling elements adapted to be arranged specifically with respect to similar elements carried by a mattress, and wherein the elements are so positioned as to insure their proper relationship.

Specifically, another object of the invention is to provide an improved heated flying suit and heating arrangement in which the coupling elements are positioned so as to insure warmth and maximum comfort of the bed occupant.

An additional object of the invention is to provide an improved heating article of the character described to which electrical energy is conducted by a wave guide, and in which electrical energy of very high frequency is employed.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein examples of the invention are shown, and wherein:

Fig. 1 is a diagrammatic view in perspective of an electrical blanket and heating arrangement constructed in accordance with this invention and illustrating the application of the teaching of this invention to an apparatus for the preservation of human warmth,

Fig. 2 is a wiring diagram of a suitable type of oscillator as employed in this invention,

Fig. 3 is a fragmentary view in perspective, partly broken away to show the mattress coupling elements,

Fig. 4 is a plan view of a blanket broken away to show the blanket coupling elements and the heating element,

Fig. 5 is a side elevation of a conductor which may be a heating element or an electrical supply conductor, showing the mode of connection,

Figs. 6 and 7 are views similar to Figs. 3 and 4 showing an alternate coupling arrangement,

Fig. 8 is an isometric view showing an alternate heating element arrangement.

Fig. 9 is an enlarged, fragmentary, cross-sectional view of the structure shown in Fig. 8,

Fig. 10 is a transverse, vertical, sectional view of a mattress and blanket showing an alternate coupling arrangement,

Fig. 11 is a longitudinal, vertical, sectional view of a mattress and blanket showing another modification of the heating arrangement,

Fig. 12 is a fragmentary isometric view of an alternate coupling structure,

Fig. 13 is a fragmentary view in elevation, partly broken away, of a single-seater aircraft illustrating the mode of application of the invention to a flying suit worn in such aircraft,

Fig. 14 is a similar view illustrating the mode of application of the invention to larger aircraft in which the personnel are free to move about,

Fig. 15 is a horizontal, cross-sectional view further illustrating the coupling arrangement of Fig. 13, and

Fig. 16 is a diagrammatic view illustrating a modification of the coupling arrangement.

This invention is applicable to all types of heating articles in which it is desirable that the article have a degree of portability and freedom from encumbering connections when it is in use. Therefore, although the invention will be described largely with respect to its application to specific types of articles, it is to be kept in mind that its field of application is broad, and that it possesses considerable latitude in the particular means employed to carry out its various teachings.

Proceeding specifically with the description of an electric blanket embodying the invention, the numeral **20** designates a blanket which may be formed of wool or any other similar or suitable material and in which is incorporated a heating circuit **21**. Although not essential, it is preferable that the heating circuit be formed of a heating conductor as set forth in my co-pending application, Serial No. 61,488 filed November 22, 1948, now abandoned.

The blanket carries a pair of electrical coupling elements **22** disposed at spaced locations in the blanket and adapted to receive power of an electrical nature which is transmitted to the heating element **21**. The elements **22** are therefore connected to the element **21**, providing power therefor and being adapted to bear a substantially fixed relationship with respect to a similar pair of primary electrical coupling elements **23** which are carried by the frame of the bed upon which the blanket is used, or preferably are carried by the mattress used in conjunction with the blanket. The elements **23** receive power from an oscillator **24** which, in turn, is controlled by a suitable temperature-responsive unit **25**, and which is supplied with electrical power from the ordinary 60 cycle, 110 volt, alternating current, commercial power supply. The oscillator **24** functions to supply to the element **23** a relatively low voltage electrical potential of high frequency. Since the secondary elements **22** are arranged in a substantially fixed relationship with respect to the primary elements **23**, the electric power is transmitted electrostatically or electromagnetically from the primary to the secondary elements, and power is furnished to the heating element **21**. The use of high frequency power permits this inductive or capacitive coupling and provides for the furnishing of power to the heating element without requiring the physical connection of any electrical conductors to the blanket **20**. The blanket may thus be handled as any ordinary type of blanket, may be laundered or cleaned, and the user of the blanket is completely free of the nuisance and encumbrances associated with the ordinary type of electric blanket of which electrical supply conductors are a necessary and integral part.

Many types of oscillators may be employed to supply power to the heating arrangement, an exemplary form being shown in Fig. 2. In this particular type of oscillator which is illustrated a push-pull or Hartley circuit is used to supply a source of high frequency electrical power. Obviously, other types of oscillators or high frequency power sources may be utilized.

The requirements of the oscillator or power source, in general, are that there be no direct current voltage in the output, that there be a low radio frequency voltage in the output, that there be a minimum of tuned circuits, that the oscillator be comparatively free from parasitics, and that it have a power output in the range of 100 to 200 watts. Of course, the power output of the oscillator and the heating capacity of the heating element or article associated therewith, are subject to wide variation. In most cases, however, such as the supplying of an electric blanket or a flying suit with power through this arrangement, the range of 100 to 200 watts power output represents an average figure.

The frequency of the oscillator or power source output is also subject to wide variation, and although a frequency of 300 kilocycles has been found to be desirable in many respects, it is obvious that higher and lower frequencies may be employed. For instance, 13.36 megacycles has been tested as an output frequency, and has been found to be quite suitable.

As to the control element **25**, any suitable or desirable type of arrangement may be employed to regulate the heating in accordance with the ambient temperature. Simple thermostatic on-and-off controls may be employed, but it has been found desirable to utilize a constantly operating type of control with which continuous regulation of the heating is obtained. Controls of the type using negative temperature coefficient type resistors have been found suitable.

As stated hereinbefore, the heating element **21** is preferably constructed in accordance with the disclosure of my co-pending application, Serial No. 61,488, filed November 22, 1948, now abandoned, involving a coaxial conductor, and in use, the two electrical paths of the coaxial conductor are connected to the two secondary coupling elements **22**, as illustrated in Figs. 4 and 7. Some latitude in the arrangement of the heating element is permissible, and is dependent partially upon the intended location of use of said article. When the coaxial heating element is employed, a modified spiral arrangement of the heating element is suitable, as illustrated in Figs. 4 and 7. In employing other types of heating elements or conductors, other configurations (not shown) may be found suitable and desirable and to afford a minimum of interference radiation to radio receivers, along with a minimum diathermic effect upon the user of the blanket.

While in no way to be considered a limitation, it is desirable that the high frequency power be transmitted between the oscillator and the primary coupling elements **21** by a coaxial cable **26**. As illustrated in Fig. 5, provision is made at each end of the cable **26** for connection of a dual electrical path, there being an inner conductor **27** and an outer conductor **28**. These conductors lead from the oscillator as shown in Fig. 2, and are variously connected to the primary coupling elements as shown in Figs. 1, 3, 6, 10, 11 and 15.

An alternate arrangement for the heating element is shown in Fig. 8 wherein the blanket is laminated so as to include a pair of outer layers **30** of wool or other fabric, a pair of inner layers **31** of flexible wire cloth or metalized porous fabric separated by an innermost insulating or dielectric layer **32**. One of the heating screens **31** is connected to one of the secondary coupling elements **22**, while the other layer **31** is connected to the opposite element **22**. In this case, the elements heat by internal resistance and by dielectric loss through the layer **32**. Of course, this heating element is applicable in all of the forms of the invention disclosed herein, including the heated garments later described.

One coupling arrangement is illustrated in Fig. 10 in which the primary coupling elements **23** are positioned within the upper portion of the body of the mattress **33** adjacent one end thereof and spaced laterally from one another so as to be disposed near the corners of said mattress. The blanket **20** carries the secondary coupling elements **22** in similar locations, whereby, when the blanket is placed upon the mattress, the coupling elements **22** and **23** are juxtaposed to provide a capacitive couple or coupling means. The mattress may also include a secondary heating element **34** as illustrated in Fig. 11 so as to provide a degree of heating within the body of the mattress and add to the comfort of the blanket user.

Another coupling arrangement is illustrated in Fig. 12 in which very high frequency energy is conducted to the lower end of the mattress from a suitable generator (not shown) through a wave guide **35**. The outlet **36** of the wave guide is directed toward a receiving unit **36** carried in the blanket **38** and energy is transmitted to the receiving element and thence to the heating means (not

shown) carried by the blanket 38. In this case, the unit 37 may be a resonant cavity or other suitable element. Here again, wireless coupling and the furnishing of high frequency power to the blanket is provided.

Preferred embodiments of the coupling arrangement are illustrated in Figs. 3 through 7. In Figs. 3 and 4, electrostatic or capacitive coupling is employed, the power supply line 39, leading from the oscillator, being of the coaxial type and having its two conducting paths connected to a pair of capacitive plates 40 positioned in one end, preferably the foot, of the mattress 41. The accompanying blanket 42 is illustrated in Fig. 4 and carries a pair of capacitive plates 43 at one end thereof. The plates 43 are connected to the two electrical conducting paths of a coaxial heating element 44 arranged in a modified spiral pattern over the area of the blanket 42. For the purposes of illustration, the conductor 44 has been greatly enlarged, but since, in actuality, the conductor is extremely small in diameter and of the magnitude of the yarn used in weaving the blanket 42, it is obvious that the heating element may be woven directly into the fabric of the blanket.

Another preferred modification of the coupling means is shown in Figs. 6 and 7, in which the cable 39 is coupled to a pair of inductive loops 45 through adjustable condensers 46. The loops 45 are positioned in the end wall of the mattress 47 similarly to the positioning of the plates 40 in the mattress 41, and the blanket 48, shown in Fig. 7, carries similar inductive loops 49 arranged to be positioned in inductive relationship with the loops 45. In this case, the electric power is transferred electromagnetically to the loops 49 and passes therefrom to the coaxial heating element 44 as in the modification shown in Fig. 4.

The modifications shown in Figs. 3 through 7 have an important advantage in that provision is made for relatively exact positioning of the primary and secondary coupling elements or electrodes. Normally, a blanket is always drawn snugly over the end of a mattress and the position of this portion of the blanket is not subject to the vagaries of the sleeper. In the form shown in Figs. 1, 10 and 11, the relative spacing of the electrodes may vary to some extent in accordance with the position and movements of the sleeper. Manifestly, the rate of energy transfer between the secondary and the primary coupling elements would be affected by such variation. With the elements positioned as shown in Figs. 3 through 7, however, this possibility of change is minimized, and the spacing of the elements is maintained relatively uniform. Such normal lateral displacement or shifting as might take place between the electrodes in the placing of the blanket on the mattress would not be sufficient to affect the coupling materially. Of course, the interposition of sheets or blankets between the primary and secondary electrodes would have some effect on the coupling, but the effect would be constant and subject to compensation.

It is pointed out that the plates 43 may be made somewhat larger than the plates 40, and the loops 49 may be made somewhat larger than the loops 45, as shown in Fig. 16, so that the capacitive or inductive coupling is maintained near full efficiency regardless of moderate shifting of the blanket with respect to the mattress. Of course, if radial shifting or misaligning occurs, a corresponding loss in coupling efficiency and energy transfer will be encountered. Further, this feature of enlarging one pair of the coupling elements may be applied to all the forms and applications of this invention.

The wire forming the loops 45 and 49 is preferably small in diameter and quite flexible so that the softness of the blanket is not affected and the fullest pliability is retained. In the case of the form shown in Figs. 3 and 4, the plates 40 and 43 may be made of wire gauze, thin metallic foil, electrically-conductive plastic or synthetic resin, or any other suitable material capable of proper functioning. Again, it is desirable to retain maximum flexibility while keeping the bulk or mass of the coupling elements at a minimum. Of course, these considerations are not of as much importance in the case of the elements carried by the mattress.

While it is preferable to place the coupling elements in the end of the mattress, and in a corresponding position in the blanket, the elements may be placed in or on the top surface of the mattress, as shown in Figs. 10 and 11, or even in the sides of the mattress. Further, although the primary elements are preferably contained within the mattress so as to be permanently positioned and protected, they may instead be suitably mounted or carried upon any surface of the mattress, either permanently or detachably. Hence, existent mattresses may be adapted for use with the blanket disclosed herein.

Since this invention is adapted for use with high frequency electrical power, dielectric loss heating may be utilized, and the heating element structure shown in Fig. 8 may be employed to advantage. The layers 31, similarly to the plates 40 and 43, may be formed of gauze, foil, or in other suitable shapes, and may be of metal, conductive plastic, or other suitable material. Metallized fabric has been found to function efficiently. An enlarged section of the structure of Fig. 8 has been shown in Fig. 9.

Additional beneficial results are obtained when the auxiliary heating element 34, shown in Fig. 11, is employed. The additional element not only provides for greater comfort and uniformity of warmth for the sleeper, but also may be employed for control purposes. Since the heat loss from the element 34 will be directly dependent upon both the ambient temperature and the temperature under the heated blanket, considerable accuracy of control of the entire heating system may be achieved by suitable connection or association by the control unit with the element 34. This connection or association may include a coupling of the control unit with the element 34 to regulate the power supplied thereto in accordance with the heat loss or load on said element, or a thermal-responsive element juxtaposed with the element 34 and actuated thereby for control purposes. In either case, the blanket heating element will be simultaneously controlled.

The invention may further be applied to the heating of flying suits carrying heating elements therein, preferably of the coaxial type previously described. In the case of a single-seater aircraft (Fig. 13), an oscillator 50 supplies power to a pair of suitable electrodes or plates 51 positioned adjacent the back of the pilot seat 52. The flying suit may carry secondary coupling elements 53 in the back portion of the suit so that energy is transmitted to the heating elements of the flying suit to maintain the body heat of the pilot, and at the same time, to free him from obstructive electrical connections. This use of the invention is important in instances where emergencies require that the pilot abandon the aircraft, since there are no electrical connections to hinder his departure. Similarly, there are no electrical connections which must be maintained in proper condition to assure the transference of adequate power to heat properly the flying suit.

In Fig. 15 is illustrated in greater detail the coupling arrangement of Fig. 13, there being shown the primary coupling elements 51, one connected to each conductor of the coaxial cable 26' leading from the oscillator 50. The two secondary coupling elements 53 are connected to the inner conductors 53' of a pair of heating elements 54, similar to the element 21 described hereinbefore and extending through portions of the flying suit. A shielding electrode or coupling element 54' is connected to the outside conductor of both elements 54 and overlies both of the secondary coupling elements 53 so that the latter are disposed between the element 54' and the primary coupling elements 51. The metal back of the pilot's seat 52 serves as a shield for the primary elements 51, and preferably the seat is grounded to the balance of the aircraft. Although other arrangements may be employed, that

shown in Fig. 15 has been designed to minimize interference with other electrical equipment in the aircraft.

In Fig. 14, a modification is shown for use in larger aircraft wherein the occupants have occasion to move about within the interior of said aircraft. In this case, the oscillator 55 supplied power to primary coupling elements 56 disposed in the bottom and top of the aircraft body, and the flying suit 57 is provided with secondary coupling elements 58 and 59 in the flying boots and helmet, respectively. The secondary coupling elements may alternatively be placed in other portions of the aviation attire. Obviously, the same advantages are obtained here as in connection with the modification described in Fig. 13.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A heating apparatus for preservation of human warmth, including, a body covering, a heating element in and forming a permanent part of the covering, a secondary coupling element carried by and forming a permanent part of the covering and being electrically connected to the heating element, a source of high frequency electrical power, a primary coupling element electrically connected to said source, and means for positioning the primary and secondary coupling elements in a substantially fixed relationship when the body covering is in use as a body covering, whereby electrical energy may pass from the primary element to the secondary element without requiring a physical conductor between the latter elements, the secondary coupling element and the heating element being so carried by the body covering as to retain the body covering capacity of the latter while the latter elements are carried thereby.

2. A heating apparatus as set forth in claim 1, and an air gap between the primary and secondary elements.

3. A heating apparatus as set forth in claim 1, wherein the coupling elements are inductive loops.

4. A heating apparatus as set forth in claim 1 wherein the coupling elements are capacitive plates.

5. A heating apparatus for preservation of human warmth, including, a body covering, means normally associated with said covering in a relatively fixed position when the covering is in use as a body covering, a primary coupling element carried by the latter means, a source of high frequency electrical power electrically connected to the primary coupling element, and a secondary coupling element carried by and forming a permanent part of the body covering and so positioned with respect to said body covering as to have a substantially fixed relationship with the primary coupling element when the body covering and the means associated therewith are in their normal relatively fixed position with respect to one another and the body covering is being employed as a body covering, whereby electrical energy may pass from the primary element to the secondary element without requiring a physical conductor between the elements, the secondary coupling element being so carried by the body covering as to retain the body covering capacity of the latter while the secondary coupling element is carried thereby.

6. A heating apparatus for preservation of human warmth, including, a body covering, means normally associated with said covering in a relatively fixed position when the covering is in use as a body covering, a pair of primary coupling elements carried by the latter means, a source of high frequency electrical power electrically connected to the pair of primary coupling elements, and a pair of secondary coupling elements carried by and forming a permanent part of the body covering and so positioned with respect to said body covering as to have a substantially fixed relationship with the pair of primary coupling elements when the body covering and the means associated therewith are in their normal relatively fixed position with respect to one another and the body covering is being employed as a body covering, whereby electrical energy may pass from the pair of primary elements to the pair of secondary elements without requiring a physical conductor between the elements, the secondary coupling elements being so carried by the body covering as not to impair the capacity of the covering to function as a body covering simultaneously with the functioning of the covering to carry the secondary coupling elements.

7. A heating apparatus as set forth in claim 1 wherein the primary coupling element is a wave-guide and the secondary coupling element is a resonant cavity.

8. A heating apparatus for preservation of human warmth, including, a blanket, a heating element in and forming a permanent part of the blanket, a secondary coupling element carried in and forming a permanent part of the blanket and being electrically connected to the heating element, a source of high frequency electrical power, a primary coupling element electrically connected to said source, and a mattress carrying said primary coupling element in substantially fixed relationship with the position normally occupied by the blanket when in use on said mattress.

9. A heating apparatus as set forth in claim 8, and a heating element in the mattress.

10. A heating apparatus as set forth in claim 8, wherein the primary coupling element is positioned in one end wall of the mattress.

11. A heating apparatus as set forth in claim 1, wherein the heating element includes a pair of porous flexible plates extending over a substantial portion of the body covering, and a dielectric separating said plates.

12. A heating apparatus for preservation of human warmth, including, a body garment, a heating element in and forming a permanent part of the garment, a secondary coupling element carried by and forming a permanent part of the garment and being electrically connected to the heating element, a source of high frequency electrical power, a primary coupling element electrically connected to said source, and means for positioning the primary and secondary coupling elements in a substantially fixed relationship when the body garment is in use as a body garment, whereby electrical energy may pass from the primary element to the secondary element without requiring a physical conductor between the latter elements, the secondary coupling element and the heating element being so carried by the body garment as to retain the body covering capacity of the latter while the latter elements are carried thereby.

13. A heating apparatus for preservation of human warmth, including, a body garment, means normally associated with said garment in a relatively fixed position when the garment is in use as a body garment, a pair of primary coupling elements carried by the latter means, a source of high frequency electrical power electrically connected to the pair of primary coupling elements, and a pair of secondary coupling elements carried by and forming a permanent part of the body garment and so positioned with respect to said body garment as to have a substantially fixed relationship with the pair of primary coupling elements when the garment and the means associated therewith are in their normal relatively fixed position with respect to one another and the garment is being employed as a body covering, whereby electrical energy may pass from the pair of primary elements to the pair of secondary elements without requiring a physical conductor between the elements, the secondary coupling elements being so carried by the garment as not to impair the capacity of the garment to function as a body covering simultaneously with the functioning of the garment to carry the secondary coupling elements.

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