March 29, 1966 J. K. HULBERT ETAL 3,243,144

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Fig. 1.

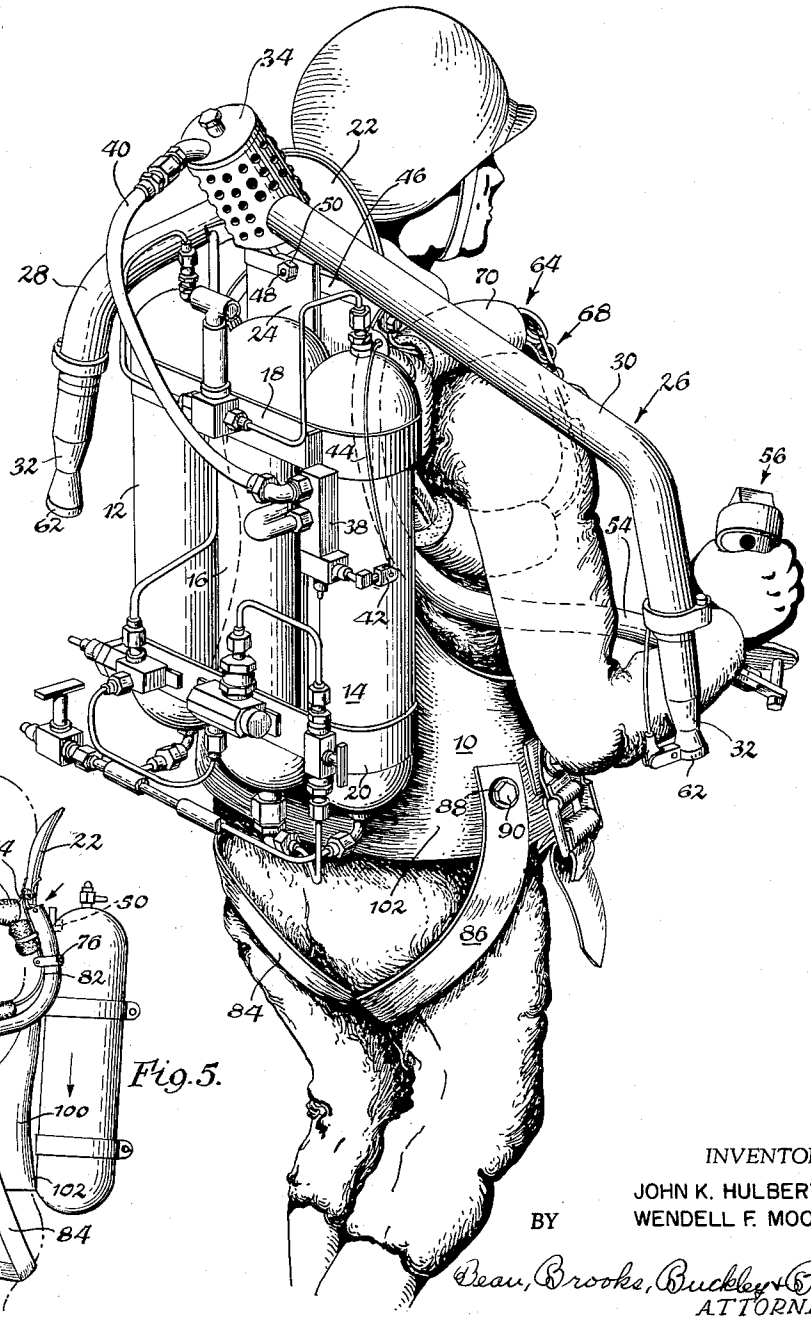

Fig. 5.

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Fig. 2.

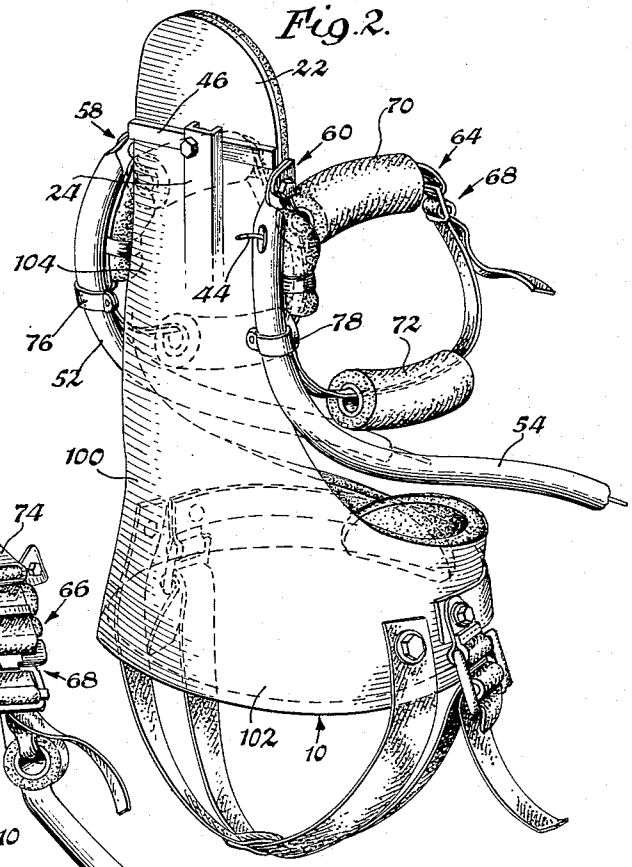


Fig. 3.

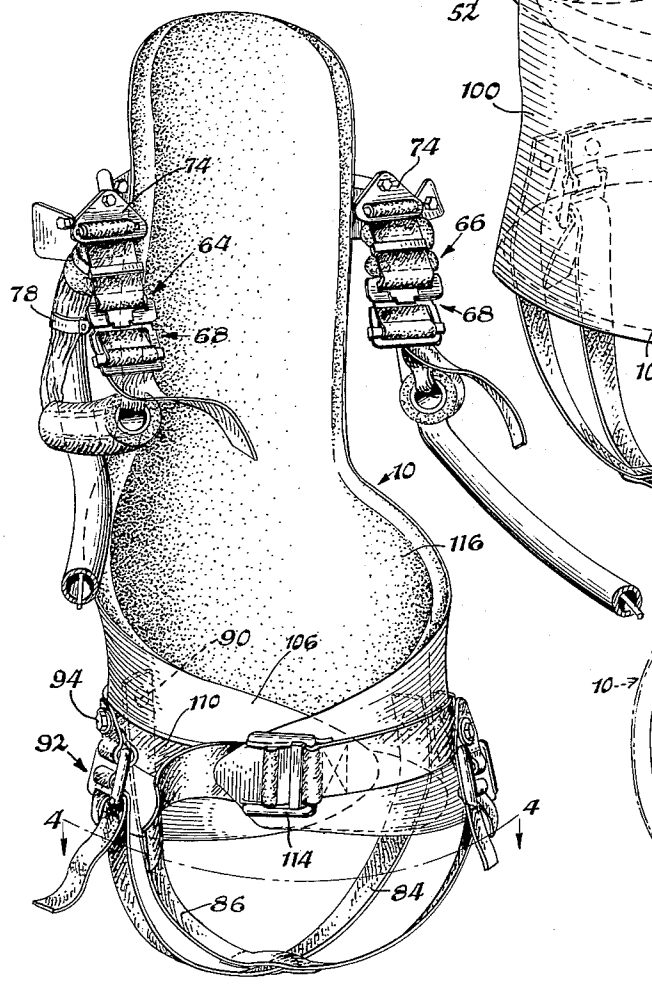
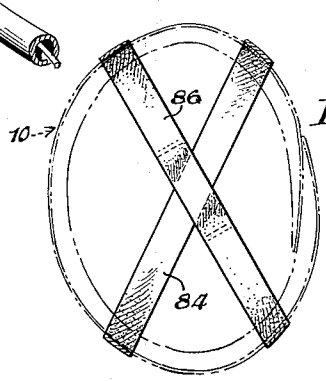


Fig. 4.



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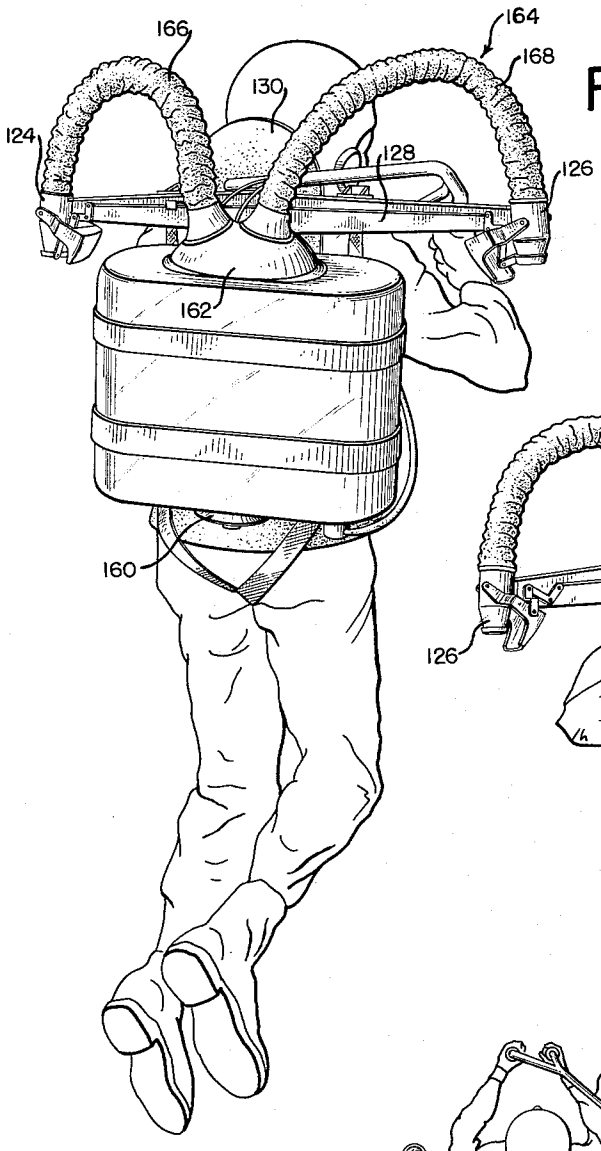
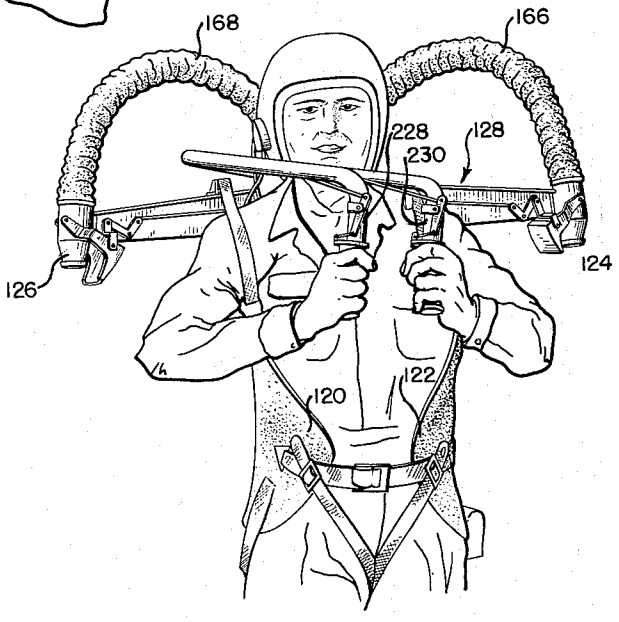


FIG. 6

FIG. 7



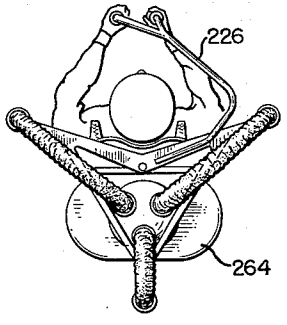


FIG. 17

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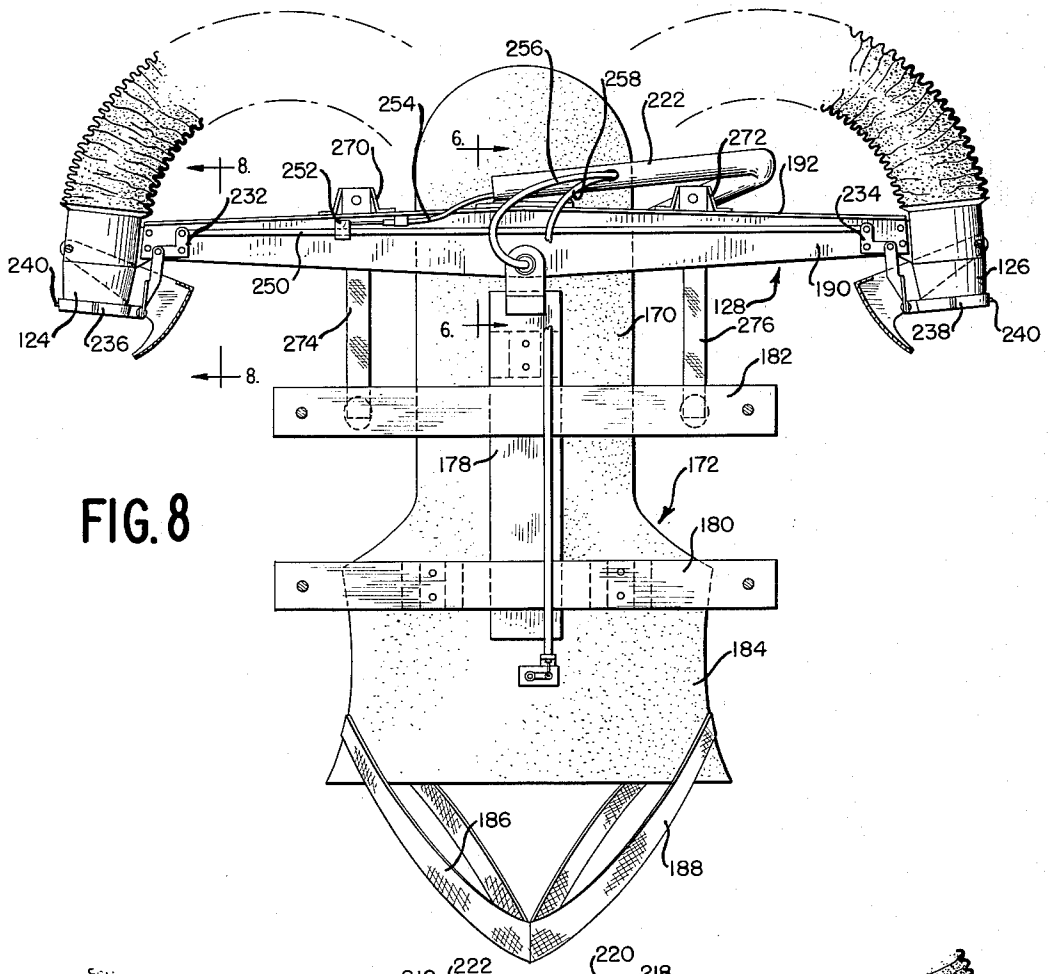

FIG. 8

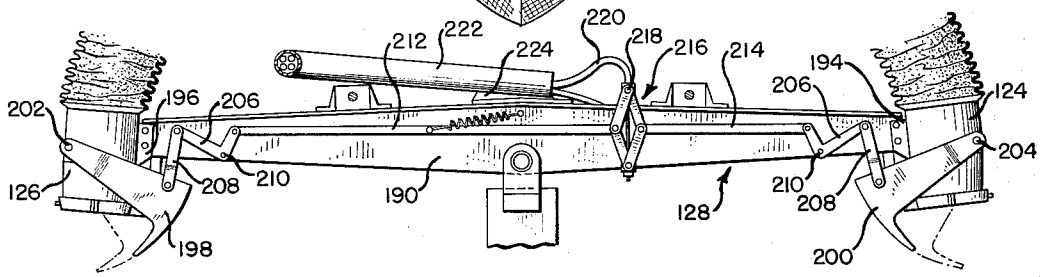

FIG. 10

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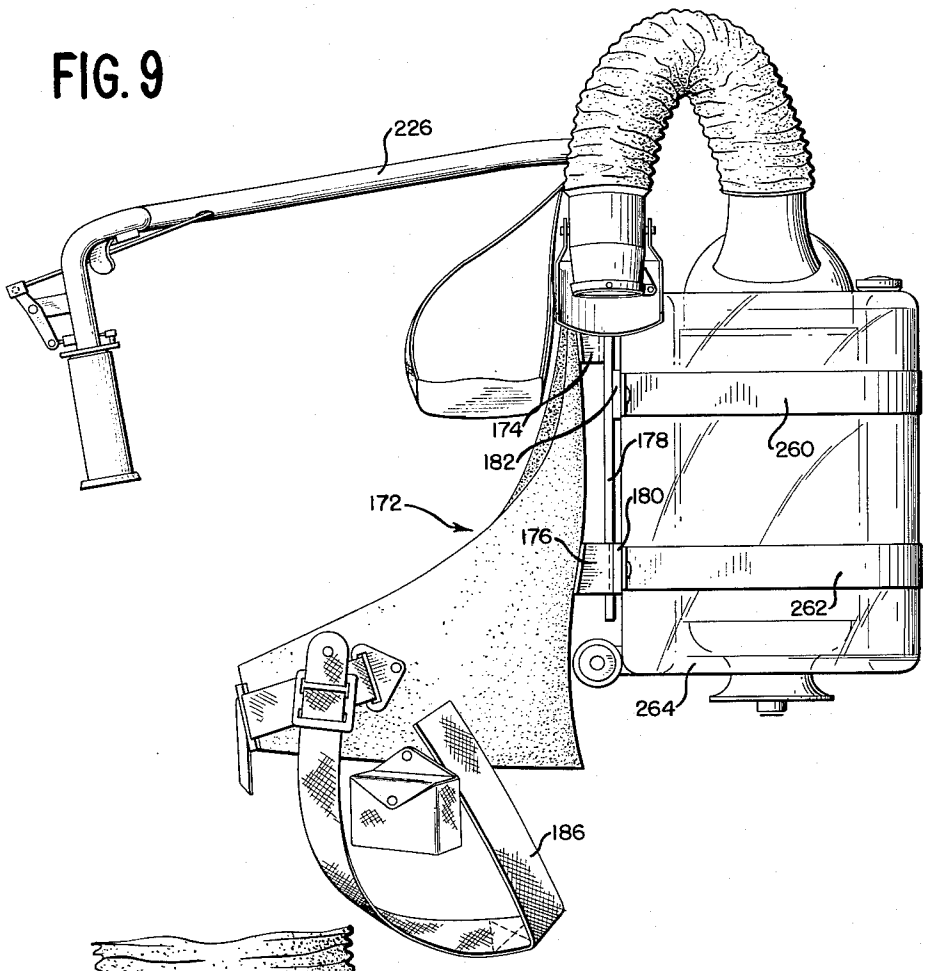
FIG. 9



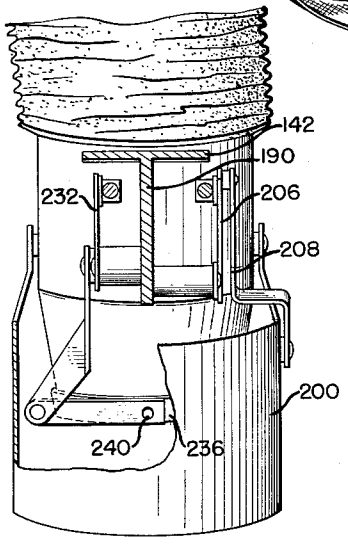


FIG. 13

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FIG. 12

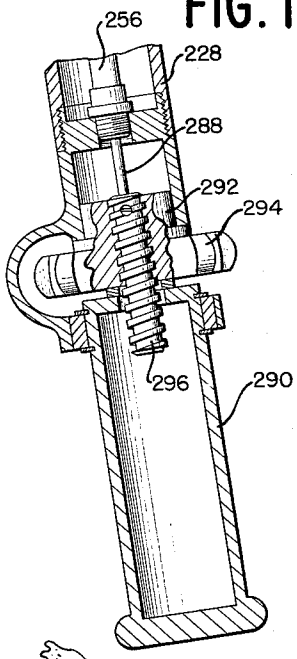
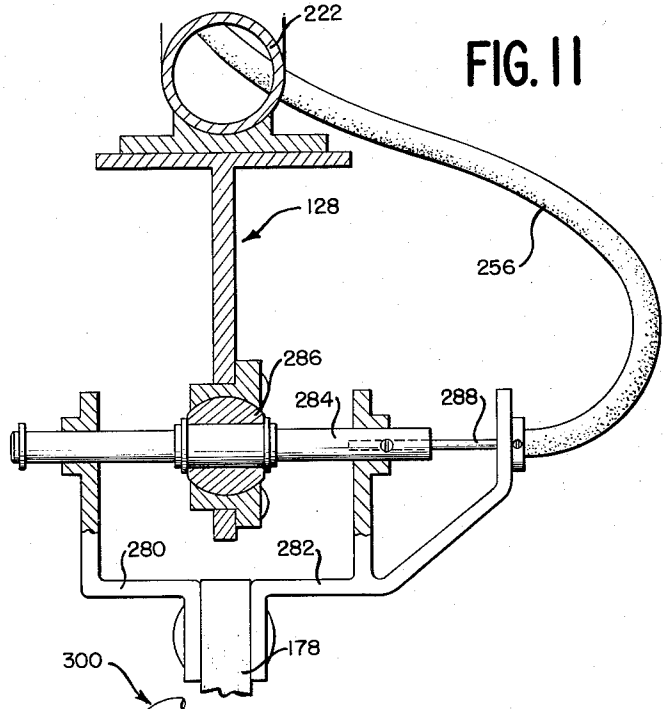


FIG. 11



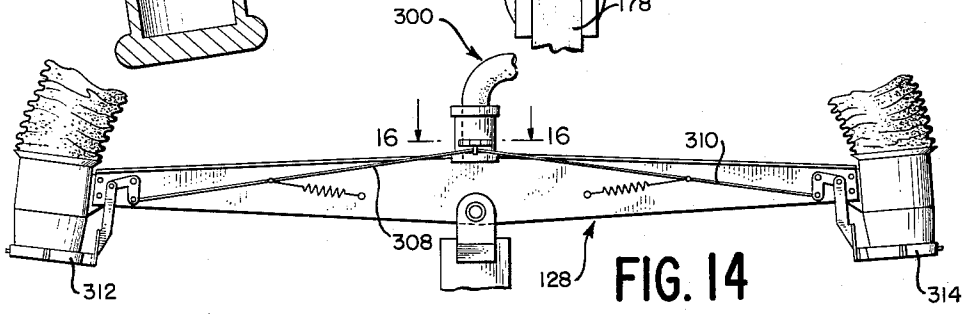


FIG. 14

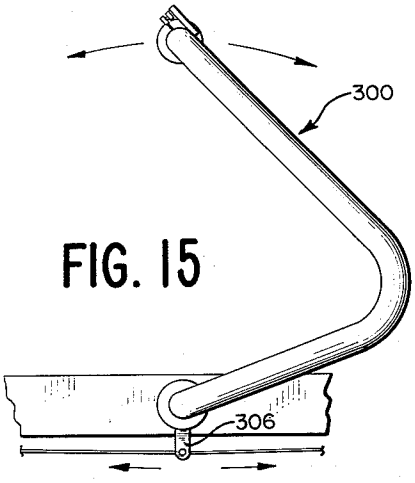


FIG. 15

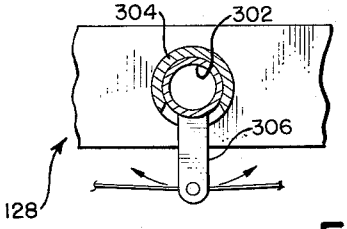


FIG. 16

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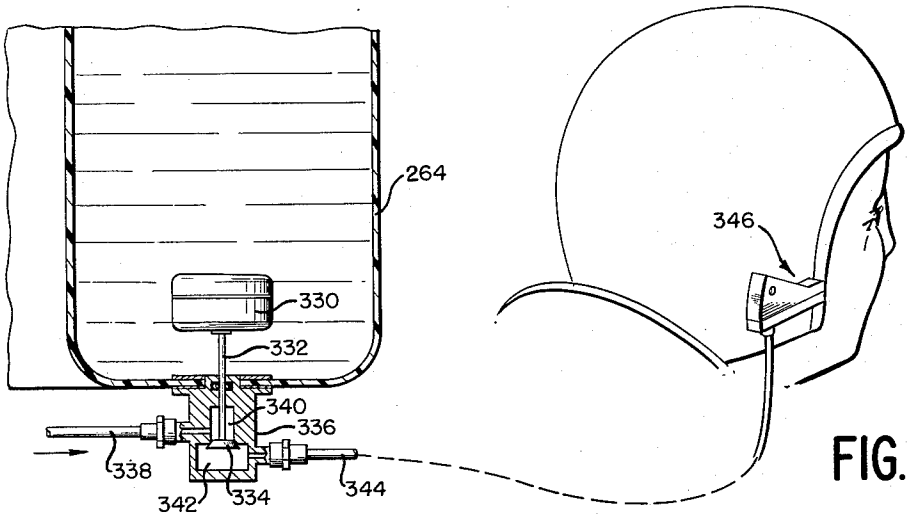

FIG. 18

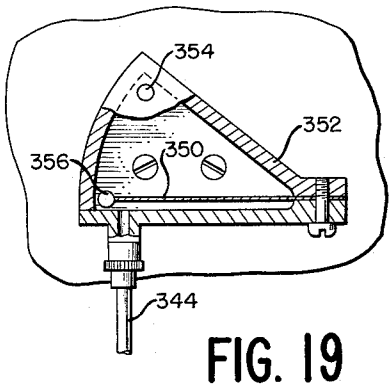

FIG. 19

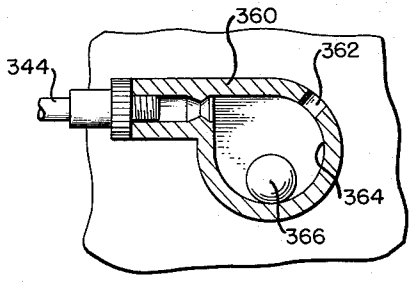

FIG. 20

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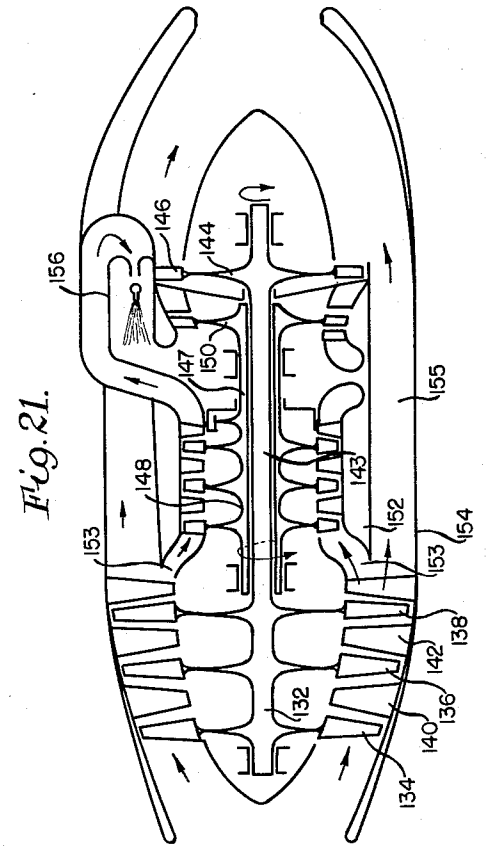

Fig. 21.

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United States Patent Office 3,243,144 Patented Mar. 29, 1966

3,243,144

PERSONNEL PROPULSION UNIT

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Filed July 17, 1964, Ser. No. 383,271
14 Claims. (Cl. 244—4)

This invention relates to means for rendering a person airborne and, in particular, is directed to certain improvements in propulsion units as shown for example in Patent 3,021,095, issued February 13, 1962.

The aforementioned patent discloses a propulsion unit for individuals which comprises a pivotally articulated airframe consisting essentially of two components, a corset assembly to which the individual's body is secured and which serves as an entity for mounting the heavier components of the assemblage, and a cross arm assembly provided with shoulder-engaging means and being articulately connected (i.e. connected for relative movement) to the stated corset assembly. By virtue of the pivotal connection between these two components, the shoulder-engaging component which carries the propulsion means is capable of being controlled in pitch and roll relative to the torso-engaging component so that fore and aft, and lateral motion respectively may be achieved by kinesthetic control movements imparted by the user to to the shoulder-engaging component. As might be expected, only very slight movements of the shoulder-engaging component in pitch and/or roll will effect significant movements of the man-machine combination. Thus, in order to impart a large degree of inherent safety to the system, the operator must be permitted of a high degree of nicety in control of the shoulder-engaging cross arm assembly. This is especially true when one considers the fact that improvements in the power generating means, tending to materially increase available flight time, will permit the user to attain altitudes of several thousands of feet. It is, therefore, a primary concern in connection with this invention to provide certain improvements in units of this type which materially and significantly increase the control capability and which, in general, extend the usefulness of the device.

More specifically, it is an object of this invention to provide an improved apparatus of the character described wherein a greater nicety of control in pitch is achieved, permitting fore and aft movements to be freed from extraneous influence and thereby allowing more precise and accurate control thereof.

Essentially, the above objectives are achieved by modifying the combination in such fashion as to suspend the user by his shoulders from the cross arm assembly while at the same time allow some relative movement between the suspending means and the cross arm assembly. This relationship significantly alters the control phenomena in such wise as to effectively disassociate pitch and roll movements of the cross arm assembly. At the same time, this arrangement also minimizes the inducement to pitch change resulting from moments arising from the suspended weight of the user's body and transmitted to the cross arm assembly.

Further, controlled movements of the shoulder-engaging cross arm assembly are allowed of greater accuracy according to the present invention by supporting a minor portion of the user's weight from the corset assembly while the major portion of the user's weight is suspended from the cross arm assembly. This proportioning of the user's weight also significantly and favorably influences the control factor, as aforesaid.

In addition to the above, it will be appreciated that devices of the nature described would ideally employ a power plant and accessories of minimum weight so that

a maximum fuel load could be accommodated. In this way, the range capability of the device may be extended to the utmost. At the same time, the distribution or placement of weight must be optimized so that control and maneuverability does not suffer. The present invention is also primarily directed to improvements in these areas. More particularly, this invention is directed to an assembly including the combination of a corset assembly having a back plate portion, an upper extension, and a hip portion, all cooperating to present a load platform adapted to transmit the weight of the load largely to the hip region of the wearer; in which the power plant is vertically disposed to lie in close adjacency to the back plate and is of such construction as to allow the fuel supply to be disposed in surrounding relation and even in actual contact with the power plant, without hazard. In this way, the major portion of the weight (i.e. the power plant and fuel supply) is effectively concentrated so that the center of gravity of the man-machine combination, and particularly the vertical axis passing therethrough, may be optimally located. Moreover, the fuel supply may thus be located so as to minimize forward shifting of the center of gravity as the fuel is consumed.

Another important object of this invention lies in the use of a vertically disposed turbo-jet power plant having its intake at the lower end and its outlet discharging upwardly, and in combination therewith, a flexible nozzle assembly having a base for collecting the gaseous discharge of the power plant, downwardly directed nozzles rigidly mounted at the tips of a corset- and operator-suspending cross arm, and flexible conduit means for directing the gaseous discharge to the nozzles; the cross arm being pivotally mounted to the corset, provided with shoulder-engaging operator-suspending means and with control handle mechanism. This arrangement minimizes the weight characteristics of the power plant and nozzle assembly, allowing a substantial amount of fuel to be carried without exceeding the weight limit for the device, and also allows weight distribution permitting of maximum control safety.

Another object of this invention is to provide certain improvements in throttle control mechanism and in yaw control mechanism, to provide an effective fuel supply warning system, and to provide means for pitch trim control.

Other objects and advantages of the invention will appear from the description hereinbelow and the accompanying drawing wherein:

FIG. 1 is a rear perspective view of the improved unit according to this invention;

FIG. 2 is a view similar to FIG. 1 but with certain components omitted for the sake of clarity;

FIG. 3 is a front perspective of the unit as shown in FIG. 2;

FIG. 4 is a horizontal section taken along section line 4—4 in FIG. 3;

FIG. 5 is a side elevation illustrating certain features of the invention;

FIG. 6 is a rear perspective view of a modified form of the invention but utilizing the principles described in conjunction with FIG. 1;

FIG. 7 is a front perspective view of the assembly shown in FIG. 6;

FIG. 8 is a rear elevational view of the frame and cross arm assembly construction of the modified form of the invention shown in FIGS. 6 and 7;

FIG. 9 is a side elevational view of the complete assembly shown in FIGS. 6 and 7;

FIG. 10 is an elevational view of the cross arm assembly and showing the control mechanism for jet deflector devices associated therewith;

FIG. 11 is an enlarged sectional view showing one manner of mounting the cross arm assembly for effecting pitch trim control of the mechanism;

FIG. 12 is an enlarged sectional view through one of the control handles illustrating a manner in which the mechanism of FIG. 11 may be actuated;

FIG. 13 is an enlarged view partly in section showing details of the jet deflectors and yaw control deflectors associated with one of the nozzles;

FIG. 14 shows a modified form of a control handle assembly and associated mechanism for controlling the yaw deffectors;

FIG. 15 is a top plan view showing a portion of the assembly illustrated in FIG. 14;

FIG. 16 is a sectional view taken substantially along the plane of section line **16—16** in FIG. 14;

FIG. 17 is a top plan view of a still further modified form of the assembly;

FIG. 18 is a view, largely diagrammatic, illustrating the fuel supply warning device;

FIG. 19 is an enlarged sectional view illustrating one form of helmet mounted warning device;

FIG. 20 is a view similar to FIG. 19 but illustrating a modified form of helmet mounted warning device; and

FIG. 21 is a diagrammatic view illustrating the principles of the turbojet engine utilized in conjunction with the mechanism according to the present invention.

Certain principles of the man-machine combination are shown in FIG. 1 and, as may be seen, the propulsion unit may be similar in many respects to the unit disclosed in the aforementioned Patent 3,021,095. Thus, the unit includes a torso-engaging portion **10** upon which the weightier components of the unit are mounted as, for example, the two fuel tanks **12** and **14** and the fuel pressurizing tank **16** sandwiched therebetween. These tanks are rigidly fastened to the torso-engaging portion **10** by suitable means such as the straps **18** and **20**.

The torso-engaging portion **10** includes an upper extension **22** disposed behind the user's neck, as shown, and a rigid frame member **24** which is rigid with the torso-engaging portion **10** terminates at its upper end in the region of the extension **22**. This frame member, as will be seen presently, provides a pivotally articulate mounting for the cross arm assembly **26**. The cross arm assembly may comprise a pair of rigid tubes **28** and **30**, each fitted with a fixed, downwardly directed nozzle **32** at its extremity, the inner ends of these tubes being rigidly joined together at the catalyst bed assembly **34**. As is disclosed in Patent 3,021,095, the fuel which may be hydrogen peroxide is fed to the catalyst bed **34** by forceful displacement from the tanks **12** and **14** under the action of a pressurized fluid, preferably nitrogen, in the tank **16**. A throttle valve block **38** serves as a manifold receiving the fuel from the tanks **12** and **14** and serves ultimately to meter the fuel, through a flexible conduit or line **40**, to the catalyst bed **34**. The valve block **38** contains a suitable valving device for metering the fuel flow to the catalyst bed and such device is under control of the user as through a crank arm **42** connected to a push-pull element **44** manipulated by the user.

The fuel is decomposed in the catalyst bed assembly **34** and the products of decomposition are exhausted to the pipes **28** and **30** for ultimate discharge through the nozzles **32** for providing the propulsive reaction.

As has been mentioned, the cross arm assembly is pivotally articulated to the torso-engaging portion **10** and, more particularly, to a suitable frame member **24** rigid therewith. For this purpose, the pipes **28** and **30** may be joined together by a cross brace member **46** through the center of which the stud or stem **48** of a ball joint element is passed. This stud or stem is fixed to the cross brace member as by the nut **50** and the ball member (not shown) is universally pivoted in a suitable journal or seat therefor carried by the frame member **24**. It will be appreciated that the universal movement permitted of the

cross arm assembly **26** with respect to the torso-engaging portion **10** need not be great since even slight movement will impart a considerable degree of displacement to the man-machine combination.

Extending forwardly from the cross arm assembly **26** are a pair of frame members **52** and **54**, see particularly FIG. 2. At their forward extremities, these members **52** and **54** are each provided with hand grip members such as that indicated by the reference character **56** in FIG. 1 and at their rearward extremities, these members are rigidly affixed to the cross arm assembly as at **58** and **60**. The hand grip assemblies **56** function for two purposes, first, to provide a convenient place for the operator's hands to rest and these hand grips, secondly, permit the operator to control the cross arm assembly in pitch, to control throttling of the fuel, and to impart yaw control to the man-machine combination. Thus, the push-pull element **44** may be operated from one control handle **56** by rotation thereof, in motorcycle fashion, to vary the throttle setting of the fuel valve **38** and the other hand grip member **56** may be provided with a similar mechanism (i.e. Bowden cable) for effecting yaw control by means of differentially actuating the deflectors **62** at the tips of the nozzles **32**. In association with these deflectors **62**, it will be appreciated that when actuated, one will be moved to deflect the jet stream forwardly and the other to direct the jet stream rearwardly so as to provide a yaw couple acting on the man-machine combination.

The manner in which the user is suspended from the cross arm assembly **26** forms an extremely important aspect of the present invention and this is accomplished by the shoulder loops **64** and **66**, see particularly FIG. 3, which are adapted to engage around underneath the user's armpits and up over the shoulder in the fashion shown in FIG. 1 so that the operator or user is literally suspended from the cross arm assembly **26** when the man-machine combination is airborne. Each of these loops is in the form of a flexible strap having an adjustable and quickly releasable buckle portion such as that indicated generally by the reference character **68** in FIG. 2 and these straps may be additionally provided with cushion tubes such as those indicated by reference characters **70** and **72**. The purpose of the cushioning devices is of course to provide comfort for the user but it is to be understood that the flexible strap may be alternatively constructed in such fashion as to integrally incorporate such cushion portions. The strap may be a one or two-piece construction, as desired, but in any event, it is fixed to the cross arm assembly **26** by a suitable connector **74** (see FIG. 3) and is also anchored to the cross arm assembly **26** through the intermediary of the frame members **52** and **54** by suitable strap members **76** and **78**, see particularly FIG. 2. By providing for flexibility in the loops **64** and **66**, relative movement between these loops and the cross arm assembly **26** in the critical areas **80** and **82**, see FIG. 5, is provided. These critical portions or areas **80** and **82** permit movement of the cross arm assembly **26** so as to control the man-machine combination in forward and rearward movement simply by exerting downward or upward force on the frame members **52** and **54** through the hand grips **56** without requiring the user's shoulders to become involved in such motion. To appreciate this, it will be realized that the movement of the cross arm assembly **26** in pitch so as to control the aforesaid fore and aft movements of the man-machine combination are not required to be great, so that a relatively small amount of flexibility at the aforesaid points **80** and **82**, while the user is suspended from the cross arm assembly **26**, will permit the requisite motion in pitch of the cross arm assembly **26** to occur without requiring the user to cause his shoulders to follow such pitch control movement of the cross arm assembly **26**. Additionally, the flexibility at the points **80** and **82** provides for lateral movement of the loops **64** and **66** relative to each

other so as not only to accommodate for users having varying chest widths but also to prevent differential shoulder shrugging movements for effecting roll control of the cross arm assembly **26** from also automatically imparting pitch control movements to the cross arm assembly **26**. These several features stemming from the flexibility at the points **80** and **82** have been found to be extremely important in effecting the nicety of control required in order to render the man-machine combination a safe, versatile and highly maneuverable combination.

A further feature of the invention which goes to the question of nicety of control, maneuverability and safety is the utilization of the groin straps **84** and **86**, see example FIG. 1. Each of these straps is secured at one end **88** to the lower end of the torso-engaging portion **10** as by a suitable fastener **90** and such strap extends therefrom to cross with the other strap in the manner which can be seen best in FIG. 3 for connection at its opposite end with a quick release buckle and adjustable fastener **92** secured, as at **94** to the torso-engaging assembly **10** somewhat forwardly of the fastener **90** for the other strap element.

The significance of the groin straps **84** and **86** is probably best illustrated by discussion of the operation of the device. The corset assembly **10** is a substantially rigid mechanism and serves two main purposes in accord with the present invention. First of all, the corset assembly provides a mounting platform upon which the weightier components of the assemblage are directly mounted so that the weight load thereof is transferred substantially directly to the hip region of the user, as will hereinafter more particularly appear. Secondly, the corset assembly **10** is adapted to snugly engage the user's body, and is in at least partly encircling relationship to the user's torso so as to substantially immobilize or rigidify the user's torso, and particularly the region of the last few lower vertebrae of the back when the user or individual is rendered airborne. This latter effect is enhanced by the provision of the groin straps **84** and **86** and also these groin straps render the device more comfortable and less fatiguing inasmuch as their presence relieves the user's shoulders of some of his own body weight when the individual is airborne. To appreciate the rigidifying or immobilizing effect of the corset assembly, it will be realized that although when not airborne, the corset assembly places the load directly upon the user's hips, the user is largely suspended by means of his shoulders, from the cross arm assembly, when the individual is airborne. When thus suspended, the human body will elongate (as much as several inches) so that, in effect, the user's body is narrowed in the waist region and the hip region of the user's body will actually "droop" downwardly from the corset assembly **10**. This elongation and "droop" destroys to some extent the rigidifying or immobilizing effect of the corset assembly **10** and, as a result, the lower extremity of the user's torso, particularly the last few lower vertebrae of the back, are free for movement relative to the corset assembly which, in actual flight, are propense to the setting up of body oscillations in the fore and aft as well as in lateral directions so that the problem of control may be degraded thereby. Actual experience has shown that whereas the user will find little difficulty in precluding the initiation of oscillations of his legs relative to his body, that the same is not true with regard to a situation in which, as aforesaid, the user's lower extremity of his torso is not immobilized, as for example when the last few vertebrae at the lower region of the back are free to move. Thus, it is very important not only for comfort but also for safety purposes that the user's body be substantially rigidified or immobilized throughout the back, waiste and hip regions thereof.

The provision of the groin straps **84** and **86**, therefore prevent the hips from "drooping" downwardly from the corset assembly **10** and thus militate against the initiation of largely uncontrollable lower body oscillations as aforesaid. In short, the groin straps **84** and **86** prevent the user's body from "rattling" within the confines of the corset assembly **10** when the individual is airborne, and which may occur even though the corset assembly is very snug upon the user throughout all regions of his torso when not airborne.

The immobilization effect of the corset assembly is realized by generally contouring the corset assembly in conformity with the contours of the user's body. Thus, the corset assembly may be considered as being formed from a waist portion **100** which is somewhat narrowed with respect to the outwardly flaring hip region portion **102** which depends from the waist portion. The corset assembly also includes the back plate portion **104** rising upwardly from the narrowed waist portion **100** and to the upper extremity of which is connected the aforementioned neck or upper extension **22**.

The corset assembly **10** is also provided with ventral extension portions **106** and **108**, see particularly FIG. 3, which may be, as shown, disposed to completely encircle the user's body and overlap at the ends as illustrated. The strap members **110** and **112** and the associated buckle mechanism **114** serve to maintain the snug fit of the corset assembly around the user's body. As has been stated, the contours of the corset assembly **10** are generally configurated in accord with the contours of the human body and to provide cushion means and also to provide means for accommodating for variations in shapes between different individuals, the corset assembly **10** is lined with cushioning material as indicated by the reference character **116**. The corset assembly may be constructed principally from fiberglass reinforced epoxy material or the like and is substantially rigid in a vertical plane whereas, in a horizontal plane, it is capable of being "opened up" so as to permit the corset assembly to be engaged upon and removed from a user's body.

The modified propulsion device shown in FIGS. 6 and 7 operates generally on the principles described above in conjunction with FIGS. 1–5 inclusive although the corset assembly, as can be best seen in FIG. 7, which is illustrated in conjunction with this modified form of assembly, illustrates that the ventral extensions **120** and **122** of the corset assembly need not completely encircle the user's waist. The main difference in the modification as shown in FIGS. 6 and 7 lies in the gas generating mechanism. In the particular instance shown in these figures, the burning of a hydrocarbon fuel is utilized as the source of propellant gas which is routed to the fixed nozzles **124** and **126** which are, in turn, rigidly mounted on a cross arm assembly **128** universally pivoted to the upper extension portion **130** of the corset assembly in a fashion similar to the construction described in conjunction with FIGS. 1–5.

Turning now to FIG. 21, a representative type of power plant which may be used in association with this invention is shown therein. The showing herein in FIG. 21 is identical with FIG. 15 of Patent 2,396,911 which will be seen to consist of a low pressure compressor rotor **132** having blade rows **134**, **136** and **138** fixed thereto cooperable with the fixed or stator blades such as those indicated by the reference characters **140** and **142**, in the well known conventional manner. The low pressure compressor rotor **132** is connected, by means of a shaft **143** to the rotor **144** of a low pressure turbine having blades such as those indicated by the reference character **146**. A quill shaft **147** disposed in concentric surrounding relationship to the shaft **143** interconnects the high pressure compressor rotor **148** to the high pressure turbine rotor **150**. It will be noted that the housing for the power plant includes an inner wall structure indicated generally by the reference character **152** within which some of the air operated upon the low pressure compressor assembly is routed through channel **153** to the high pressure compressor **148** whereas bypass air

is ducted through the channel or passageway **155** formed between the inner wall structure **152** and the outer wall **154** of the power plant assembly. It will be noted that the construction of the low pressure compressor and of the ducting systems is such that the bypass air arrives at the discharge of the power plant at or substantially at the same pressure as the combustion gases emanating therefrom so that mixing occurs between these two gases to provide a high mass rate of flow to the nozzles **124** and **126**. The high pressure compressor **148** dicharges in the fashion indicated by the arrows in FIG. 21 to the combustor **156**. The low and high pressure compressor-turbine systems are rotated in relatively opposite directions so as to minimize gyroscopic effects and, as is seen in FIG. 6, the turbojet mechanism is mounted vertically with its inlet horn **160** disposed adjacent the bottom extremity of the corset assembly and with this outlet discharging upwardly. The outlet is covered by a base portion **162** of the nozzle assembly indicated generally by the reference character **164**, the base portion **162** being mounted on the outer wall **154** of the power plant to collect the combustion gases and the bypass air mixture emanating therefrom. The nozzle assembly is flexible to permit freedom of motion between the cross arm assembly **128** and the rest of the mechanism and, for this purpose, flexible corrugated conduits **166** and **168** may be utilized to connect the base portion **162** to the nozzles **124** and **126**.

As can be seen in FIGS. 8 and 9, the back plate portion **170** of the corset assembly **172** mounts, through suitable brackets **174** and **176**, a vertically extending frame piece **178** of suitably rigid construction. The upper bracket **174** is secured directly to the upper extremity of the frame piece **178** while the brackets **176**, being two in number, are secured to a cross piece member **180** which is in turn rigidly secured to the lower end of the vertical frame member **178**. An upper cross piece member **182** is also rigidly mounted to the frame member **178**, substantially as is shown. The hip portion **184** of the corset assembly **172** carries the groin straps **186** and **188** as previously described in conjunction with FIG. 1. The upper extremity of the frame member **178** carries a ball joint or other suitable articulating means universally mounting the cross arm assembly **128** relatively to the corset assembly **172**. The cross arm assembly **128** is preferably of T-shaped cross sectional configuration as is seen best in FIG. 13 including an upstanding web portion **190** and a top plate portion **192**. The nozzles **124** and **126** are provided with bracket ear portions **194** and **196** which are riveted or otherwise suitably fixedly fastened to the extremities of the cross arm assembly **128**, the brackets **194** and **196** being rigid with the nozzle assemblies. Each of the nozzles is provided with a deflector such as those indicated by reference characters **198** and **200** pivotally mounted to their respective nozzles as indicated by reference characters **202** and **204**, the deflectors being movable between the full and dotted line positions as shown for modulating the propulsive effect as for example before take-off. A bell crank **206** is associated with each of the deflectors **198** and **200** and is connected thereto through a link member **208**, the bell crank **206** in each case being pivotally mounted to the web **190** of the cross arm assembly as by pivot pin members **210**, as shown. The opposite ends of the bell cranks **206** are connected to the drag links **212** and **214** extending to a parallelogram linkage assembly indicated generally by the reference character **216**. This parallelogram link assembly is fixedly pivoted as at **218** to the cross arm assembly **128** and a Bowden cable device **220** has its cable operator anchored or secured otherwise to the lower extremity of the linkage assembly **216** for opening and closing the same for causing simultaneous movement of the two deflectors **198** and **200**. The Bowden cable **220** extends into a control arm member **222** fixedly secured, as by means of a bracket **224** to the cross arm assembly **128**. The control arm assembly extends first laterally and then forwardly in the forwardly reaching portion **226** which terminates, preferably, in a pair of depending handle mouth portions **228** and **230**. On the opposite side of the cross arm assembly **128** is mounted a pair of bell cranks **232** and **234** for operating deflector rings **236** and **238** mounted on the nozzle tips. These deflector rings are mounted as by pin elements **240** for deflecting the jet stream in fore and aft directions and the linkage controlling the bell cranks **232** and **234** is effective for operating these deflectors **236** and **238** in relatively opposite directions to thereby attain yaw control for the man-machine combination. For this purpose, the bell cranks **232** and **234** are provided with a control rod **250** connected, as at **252**, to a Bowden wire device **254** which is also extended into the portion **222** of the control handle assembly. Two more Bowden wire connectors **256** and **258** extend into the control handle assembly, the operation of all of the Bowden wire assemblies being described hereinafter in more detail, the Bowden wire **256** being provided for achieving pitch trim of the assembly, as hereinafter described, and the Bowden wire **258** being provided for throttle control of the turbojet assembly.

The aforementioned frame members **180** and **182** mount strap devices **260** and **262** which support a fuel tank **264** which is disposed in substantially surrounding relationship to the engine shown in FIG. 21. The engine itself is provided with brackets (not shown) which may mount directly to the frame member **178**. It is preferred that the fuel tank **264** be transparent so that the level of fuel can be visually checked and it will be understood that the aforementioned bypass air arrangement for the turbojet engine makes it possible for the fuel tank to be disposed in such close proximity to the power generating device as is shown.

The cross arm assembly **128** is also provided with a pair of brackets **270** and **272** mounting the depending flexible shoulder straps **274** and **276** whereby kinesthetic control of the cross arm assembly **128** in roll is achieved.

With reference to FIG. 11, both the universal mounting of the cross arm assembly **128** relative to the corset assembly **172** and the manner of pitch trim adjustment will be seen therein. As shown, the frame member **178** is provided with bracket members **280** and **282** at its upper extremity which slidably carry therebetween a rod **284** upon which a ball member **286** is mounted. The Bowden wire assembly **256** is attached to the rod **284** and is effective to move the same back and forth in a fore and aft direction to carry with it the cross arm assembly **128**. To effect movement of the Bowden wire actuator **256**, or more precisely the core wire **288** thereof, one of the control handles of the device may be constructed as is shown in FIG. 12.

As is shown in FIG. 12, the control handle grip **290** rotatably mounts a nut member **292** having a knurled hand knob portion **294** integral therewith, the nut member being engaged with the worm or screw device **296** in turn attached to the Bowden wire core member **288**. Thus, by manipulating the knob **294** by thumb action or otherwise, the pivot point and consequently the point of lifting between the cross arm assembly **128** and the rest of the man-machine combination may be shifted in a fore and aft direction permitting "hands off" hovering or like maneuvering as may be required for example if the operator is to perform duties requiring the use of both hands.

FIGS. 14–16 illustrate a modified form of the control handle assembly **300**. In this particular modification, the base portion **302** of the control handle assembly is pivotally mounted in a retaining boss **304** on the cross arm assembly **128**, the boss **304** preventing removal of the control handle assembly but permitting of relative rotation therebetween. The control handle base **302** is provided with a lever extension **306** for operating the cables

308 and 310 in turn connected to bell cranks for operation of the deflectors 312 and 314 which are identical to the previously mentioned deflectors 236 and 238. Thus, in the modification of FIGS. 14–16, yaw control is effected by swinging the control arm assembly 300 relative to the corset assembly.

FIG. 18 illustrates the manner in which warning upon the attainment of low fuel capacity may be provided for. In this figure, the fuel tank 264 is shown as provided with a float 330 having a valve stem portion 332 provided with a valve head 334 operating within the transfer block 336. The conduit or line 338 leading into the upper chamber 340 of the transfer block 336 is connected to a pressurized gas line such as a suitable outlet connection at the power plant and when the fuel has reached a dangerously low level, the valve 334 will unseat and permit the pressurized air to enter the lower chamber 342 of the transfer block 336 and to thus pass through the line 344 to the helmet mounted warning device indicated generally by the reference character 346. The warning device may be, as is shown in FIG. 19, simply a vibrating reed 350 mounted within a suitable housing 352, the housing having a suitable outlet as at 354 and the reed provided with a clapper 356 so that vibration as imparted thereto by the gas incoming through the line 344 will repeatedly strike the housing 352 to apprise the operator that the fuel is low. A modified form of warning device is shown in FIG. 20 which may include a housing 360 having an outlet 362 and having a chamber 364 housing the ball 366. When the pressurized gas enters the chamber 364, the ball 366 will be caused to rattle within the housing and since the device is mounted against the user's helmet, the operator will be immediately apprised that only a predetermined amount of fuel remains in the fuel supply system.

It will be appreciated that the various controls, warning devices and mechanism for adjusting fore and aft placement of the pivot joint for the nozzle assembly may be used in conjunction with the form of the invention shown in FIG. 1, or with other forms of the invention, as desired. It is to be understood that certain changes and modifications as illustrated and described may be made without departing from the spirit of the invention or the scope of the following claims.

We cliam:

1. A propulsion unit for rendering an individual airborne comprising, in combination,
- a torso-engaging portion fixedly mounting the weightier components of the unit,
- an upper portion including propulsion nozzles for supplying motivating thrust,
- means pivotally connecting said upper portion to said torso-engaging portion whereby the aforesaid motivating thrust is operable to lift said torso-engaging portion and control the direction of motion thereof,
- a pair of hangers suspended from said upper portion, each hanger presenting a loop for engaging under the user's armpits to suspend the user from said upper portion, said hangers being universally movable with respect to said upper portion.

2. A propulsion unit as defined in claim 1 wherein said hangers are in the form of flexible straps.

3. A propulsion unit as defined in claim 1 wherein said torso-engaging portion is provided with groin straps for supporting a minor portion of the user's weight.

4. A propulsion unit for an individual comprising, in combination,
- a torso-engaging corset adapted to be secured about a user,
- a gas generating device mounted on said corset,
- fuel supply means mounted on said corset and connected to said gas generating device,
- a rigid cross arm assembly,
- universal joint means mounting said cross arm assembly substantially centrally thereof to an upper portion of said corset and in normally horizontal transverse relation thereto,
- nozzle means carried by said cross arm assembly and adapted for movement therewith relative to said corset to effect directional control,
- shoulder-engaging means movably suspended from said cross arm assembly and adapted to loop around under a user's armpits for suspending the user from said cross arm assembly,
- and control means rigidly connected to said cross arm assembly and extending forwardly thereof to permit pitch control of the cross arm assembly relative to the corset and shoulder-engaging means.

5. A propulsion unit for rendering an individual airborne comprising, in combination,
- a corset assembly having a back plate portion generally conforming to the contours of a user's back, an outwardly flaring hip portion for resting upon a user's hips in at least partially encircling relation thereto, and an upper extension adapted to project behind a user's neck,
- a cross arm assembly pivotally attached to said upper extension,
- a turbo-jet engine mounted vertically on said back plate portion and having an inlet adjacent said hip portion and an outlet adjacent said upper extension,
- a flexible nozzle assembly having a base portion mounted at the outlet of said engine for collecting hot gases discharged thereby, a pair of nozzles mounted on the opposite ends of said cross arm assembly and discharging downwardly therefrom, and flexible tube means extending between said base portion and said nozzles for directing the gaseous discharge from said engine to said nozzles.

6. A propulsion unit for individuals comprising, in combination,
- a substantially rigid corset assembly including a back plate portion, an outwardly flaring hip portion, ventral extensions adapted to at least partially encircle a user's abdomen, an upper extension rising upwardly from the back plate portion and adapted to lie behind the user's neck, and fastener means for snugly engaging said ventral extensions with a user's waist so that the corset assembly snugly engages the user's hips, waist and back,
- a cross arm assembly universally pivoted at its central region to said upper extension and projecting laterally on opposite sides thereof, said cross arm assembly including a pair of shoulder engaging loops depending therefrom in spaced relation to and on opposite sides of the pivotal connection between the cross arm assembly and said upper extension and adapted to extend around a user's shoulders to pass beneath his armpits,
- gas generating means including fuel supply means mounted on said back plate portion,
- a pair of downwardly directed nozzles mounted on the opposite ends of said cross arm assembly and connected to said gas generating means,
- control handle means fixed to said cross arm assembly and extending forwardly therefrom into position accessible to a user,
- and groin strap means depending from said hip portion for partially supporting a user's weight and thereby maintaining the aforesaid snug engagement of the corset assembly with the user's hips and waist.

7. A propulsion assembly for rendering an individual airborne comprising, in combination,
- a substantially rigid corset assembly including a waist portion adapted to be secured in at least partially encircling relation to a user's waist and having a back plate portion extending upwardly therefrom and an outwardly flaring hip portion extending downwardly therefrom, fastener means for securing said

waist portion in snug relation to a user and groin strap means depending from said hip portion whereby the user's waist, hips and back are substantially immobilized by and with respect to the corset assembly,

a turbo-jet engine secured to said back plate portion and having a downwardly directed air inlet and an upwardly directed discharge outlet,

a cross arm assembly universally pivoted to the corset assembly adjacent the upper extremity of said back plate portion,

a pair of shoulder-engaging loops depending from and universally connected to said cross arm assembly,

a nozzle assembly including a pair of downwardly directed nozzles mounted on the opposite ends of said cross arm assembly, a base portion mounted on the upper end of said engine for collecting gases from the discharge outlet thereof, and flexible conduit means connecting said nozzles to said base portion,

and control handle means fixed to said cross arm assembly and projecting forwardly thereof for dispositions accessible to a user.

8. A propulsion device for rendering an individual airborne comprising, in combination,

a substantially rigid corset assembly adapted to at least partially encircle a user,

a cross arm assembly universally pivoted to an upper portion of said corset assembly,

a turbo-jet engine mounted vertically on said corset assembly with its inlet disposed downwardly and its outlet disposed upwardly,

a flexible nozzle assembly mounted at the outlet of said engine for collecting discharge gases therefrom and including nozzles at the extremities of said cross arm assembly,

said engine including a compressor adjacent said inlet and a combustor adjacent said outlet, an inner wall forming a duct between said compressor and said combustor, and an outer wall forming a duct for bypass air between said compressor and said outlet,

and fuel supply means mounted on said corset assembly in surrounding relation to said outer wall.

9. A propulsion device for rendering an individual airborne comprising, in combination,

a substantially rigid corset assembly adapted to at least partially encircle and effectively rigidize a user's torso,

fastening means including groin straps for maintaining said corset assembly in place with a user's torso in rigidized condition as aforesaid,

a cross arm assembly universally pivoted on an upper portion of said corset assembly,

flexible shoulder-engaging loops depending from said cross arm assembly for imparting roll control movements to said cross arm assembly,

a control handle fixed to said cross arm assembly and projecting forwardly thereof for imparting pitch control movements to said cross arm assembly,

downwardly directed nozzle means mounted at the extremities of said cross arm assembly,

and means on said corset assembly for supplying gaseous discharge through said nozzle means.

10. The device as defined in claim **9** wherein the last means comprises a turbo-jet engine mounted on said corset assembly having inner and outer walls defining an ambient air bypass duct, and a fuel supply mounted on said corset assembly in surrounding relation to said outer wall.

11. A propulsion device for rendering an individual airborne comprising, in combination,

a substantially rigid corset assembly adapted to at least partially encircle and effectively rigidize a user's torso,

fastening means including groin straps for maintaining said corset assembly in place with a user's torso in rigidized condition as aforesaid,

a cross arm assembly,

a pivot universally mounting said cross arm assembly on an upper portion of said corset assembly,

shoulder-engaging loops movably mounted on and depending from said cross arm assembly,

a control handle fixed to said cross arm assembly and projecting forwardly thereof for imparting pitch control movements to said cross arm assembly,

downwardly directed nozzle means mounted at the extremities of said cross arm assembly,

and means on said corset assembly for supplying gaseous discharge through said nozzle means.

12. The device as defined in claim **11** including means for shifting said pivot toward and away from said corset assembly.

13. The device as defined in claim **12** wherein the last means includes an actuator mounted on said control handle.

14. The device as defined in claim **11** including a fuel supply mounted on said corset assembly, and warning means actuated in response to diminishment of said fuel supply to a predetermined volume.

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