

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

REPLY TO  
ATTN OF: GP

October 15, 1970

TO: USI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General  
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned  
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,286,274

Corporate Source : Manned Spacecraft Center

Supplementary  
Corporate Source : \_\_\_\_\_

NASA Patent Case No.: XMS-00784

Gayle Parker

Enclosure:  
Copy of Patent

FACILITY FORM 602

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Nov. 22, 1966

J. H. O'KANE

3,286,274

PRESSURE SUIT TIE-DOWN MECHANISM

Filed April 7, 1964

3 Sheets-Sheet 1

FIG. 1

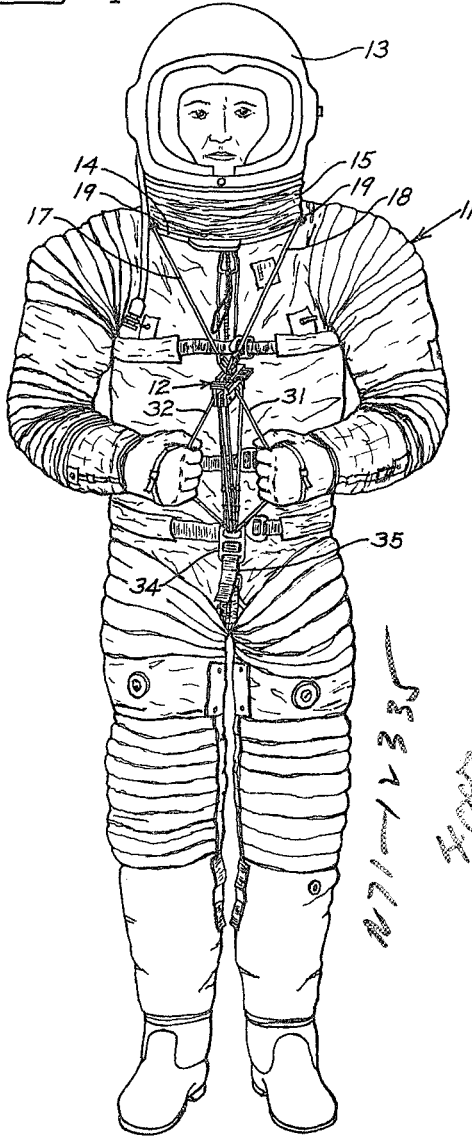
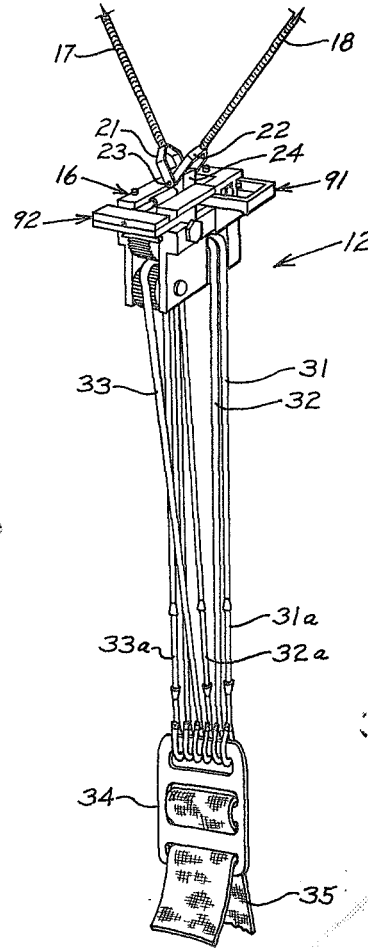


FIG. 2



N71-12335  
4070

INVENTOR  
James H. O'Kane

BY

*C. W. O'Brien*  
*m. j. Monroch*  
ATTORNEYS

(811)



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PRESSURE SUIT TIE-DOWN MECHANISM

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3 Sheets-Sheet 3

FIG. 8

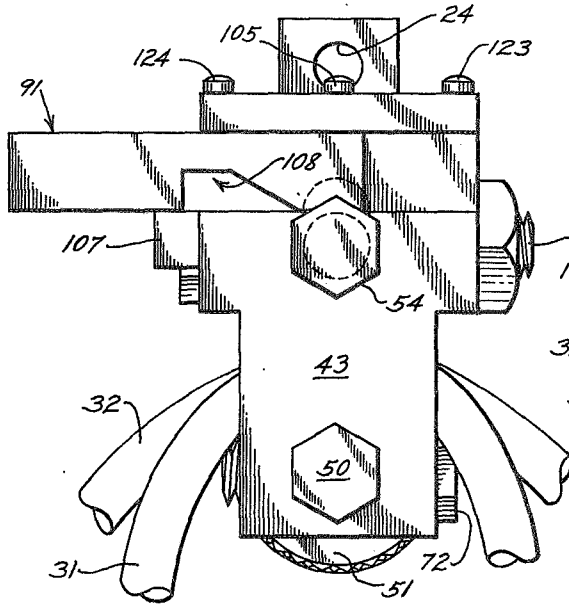


FIG. 9

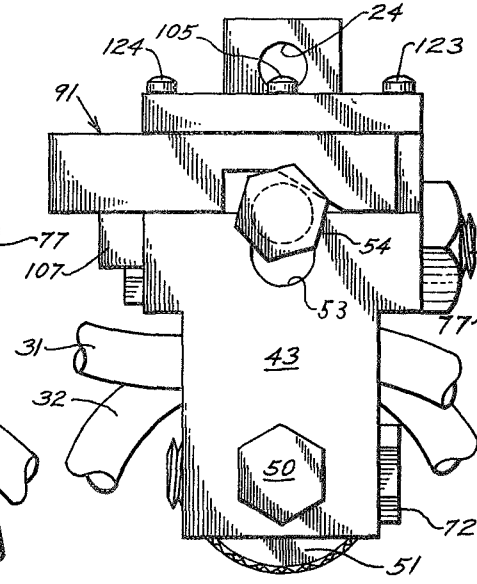


FIG. 6

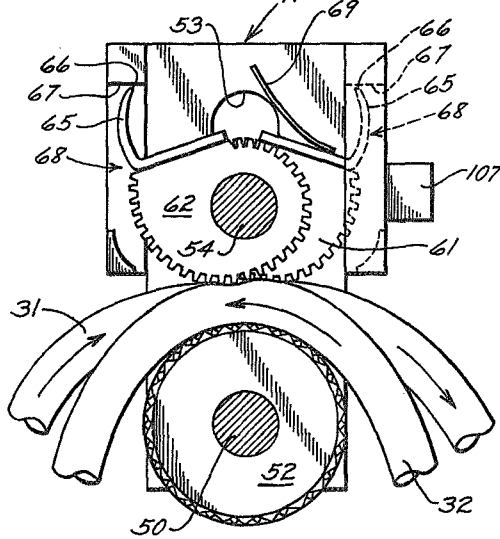
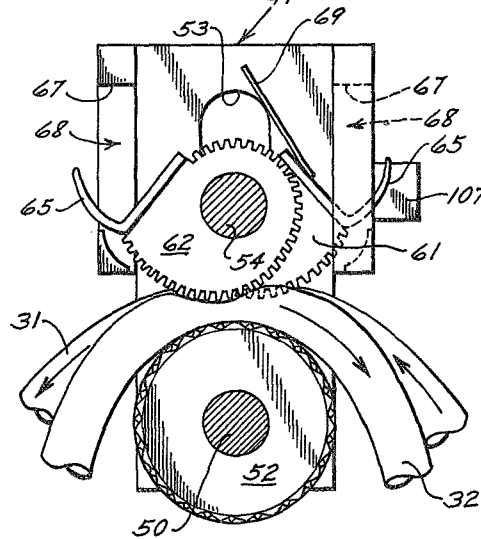


FIG. 7



INVENTOR

James H. O'Kane

BY

*C. D. O'Kane*  
m. j. Marnoch  
ATTORNEYS

1

2

3,286,274

**PRESSURE SUIT TIE-DOWN MECHANISM**

James H. O'Kane, Friendswood, Tex., assignor to the United States of America as represented by the Administrator of the National Aeronautics and Space Administration

Filed Apr. 7, 1964, Ser. No. 358,127  
12 Claims. (Cl. 2—2.1)

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.

This invention relates generally to pulley-type tightening devices and more particularly to a helmet and torso tiedown mechanism for pressure suits.

With the exception of the helmet, which is conventionally a type of hard plastic, pressure suits designed for use by aviators and astronauts are generally fabricated from a flexible air-impermeable material, such as rubberized stretchable fabric. It is therefore a characteristic of pressure suits that upon inflation to standard pressures of 3.4 to 5.0 p.s.i.a. the suit tends to increase in over-all length due to the difference between the internal gas pressure of the suit and the atmospheric pressure or space vacuum environment external to the suit. This lengthening of the suit causes the helmet and shoulders of the suit to ride up on the person wearing the suit with consequent increased discomfort and impairment of his mobility. In addition, the resulting upward movement of the helmet causes displacement of communication devices within the helmet from their normal operating positions and thereby hinders their effective use. The movement of the helmet also displaces the helmet visor to a position where the angles of visibility through the visor are decreased and visibility reduced.

Another problem characteristically associated with pressure suits is the difficulty in sitting or bending at the waist due to the internal suit pressure which tends to maintain the suit in rigid configuration. Sitting or bending at the waist also results in the suit lifting up on the torso and exerting an upward pull on the wearer's head since the person, in effect, sits down within the suit and his head moves downward into the neck part of the suit.

Various devices have been used in an attempt to alleviate these problems. One such device is a suspender built within the suit with its ends fastened to the trousers part and the loops or bights passed over the shoulders. This suspender device cannot be adjusted after the suit is inflated and is difficult to adjust once the suit is donned. It is also ineffectual in keeping the helmet from rising up on the wearer since it does not attach to the helmet.

Another type of pressure suit tiedown system, disclosed in U.S. Patent No. 2,973,521, uses external cinch belt arrangements located in the front and back of the suit. The cinch belts can be adjusted only by the person wearing the suit when the suit is unpressurized and do not provide for any mechanical advantage in operation. Also, for any adjustment of the suit after pressurization, caution must be exercised to insure that the tiedown mechanism is in a securely locked condition before releasing in order to avoid possible injury. Other tiedown systems have been used which are similar to the cinch-belt type but which incorporate pulleys to provide mechanical advantage when making adjustments. These systems, however, require the use of cords which are so long that they easily become fouled or snarled. They also require the safeguard of making certain that the mechanism is securely locked before releasing.

The pressure suit tiedown mechanism of this invention which has been devised to overcome attendant disad-

vantages of the prior art requires little effort on the part of the suit wearer to operate and it possesses the added advantages of reliability and safety. The mechanism is positioned in the front of the suit and attached thereto by cables fastened to opposite sides of a rigid neck ring of the suit on which the helmet is removably secured, or they may alternatively be attached to opposite sides of the helmet itself. The mechanism is also secured by flexible cords to one end of a crotch belt which is secured at its other end to the suit in the vicinity of the crotch, or alternatively, is passed under the crotch and attached to the back of the suit. The mechanism includes a pulley block assembly on which are mounted a pair of rollers or pulleys for supporting a pair of the cords, each of which is reeved over one of the pulleys and attached at its ends to the crotch belt. Each of the cords is adapted for free movement in one direction and is precluded from movement in reverse direction by a pivotal clamp which is normally in frictional engagement with the cord and clamps the cord when the cord is pulled in the direction opposed to its direction of free movement. As arranged, the direction of free movement for each cord is opposite the direction of free movement of the other.

Operation of the mechanism to shorten the suit involves grasping the two movable cords with both hands and pulling in the directions opposed to their directions of free movement to spread the cords in front of the chest. Since the cords are held clamped during this action, forces are exerted on the crotch belt and the neck ring which draw the two together and effectively shorten the suit and hold down the helmet. Further, since the pull on the cords by the hands is directed substantially perpendicular, a practically infinite mechanical advantage is initially attained which decreases as the cords are spread but nevertheless insures that little effort is required to operate the mechanism.

The cord pair are also each provided with an elastic section which maintains the cord taut while permitting variation in its length. The elastic section exerts a constant pull on the cord in the direction of its free movement whereby when the cords are released by the hands their elastic sections pull the cords over the pulleys and cause the cord clamps to release. However, the adjustment which has been made in the length of the suit by spreading of the cord pair is maintained when the cords are released by the hands by a restraining means comprising a restraining cord.

The restraining cord, like the other cords, is reeved over a pulley carried by the mechanism and fastened at its ends to the crotch belt. It is also permitted free movement in one direction but is limited in reverse movement by a pivotal clamp which is normally in frictional engagement with the cord. As the suit is shortened by spreading of the cord pair, an elastic section of the restraining cord keeps the restraining cord taut and pulls it in free movement over its associated pulley as the cord becomes shorter. However, when the cord pair are released by the hands the internal pressure of the suit causes an initial lengthening of the suit and the restraining cord which moves a limited distance over its pulley in the direction opposed to its direction of free movement until it is clamped by pivotal movement of its associated clamp. This clamping action prevents any further movement of the restraining cord or lengthening of the suit and thereby maintains most of the adjustment made in the length of the suit by spreading of the cord pair. To further shorten the suit the cinching process of pulling outward on the cord pair and then releasing them is repeated as many times as is required.

The tiedown mechanism of this invention also comprises a pair of release devices for relaxing the hold by the tiedown mechanism on the suit as would be neces-

sary, for instance, for resuming an erect stance from a sitting or bending over position. One of the release devices is operable to render the restraining cord clamp inoperative and the other release is operable to remove the clamps from frictional engagement with the other cords. If desired, the two release devices may be operated simultaneously to release all of the cord clamping devices and permit the full lengthening of the suit in only one operation. In most instances, however, it would generally be desired to operate the two releases in alternate fashion and permit a step-by-step release of the tiedown mechanism and a gradual lengthening of the suit.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same become better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 is a front view showing an astronaut wearing an inflated pressure suit in the act of operating the pressure suit tiedown mechanism of this invention;

FIG. 2 is an enlarged view of part of the tiedown mechanism in FIG. 1, showing the mechanism in greater detail;

FIG. 3 is an exploded view showing parts of the pulley block assembly of the tiedown mechanism of this invention but omitting the movable cords;

FIG. 4 is a side view of the pulley block assembly of the tiedown mechanism of this invention but with the movable cords omitted therefrom;

FIG. 5 is a top view of the pulley block assembly shown in FIG. 4;

FIG. 6 is a view of a part of the pulley block assembly of this invention showing the position of the movable cords reeved over their associated pulleys and in frictional engagement with pivotal eccentric clamping devices, but in unclamped condition;

FIG. 7 is a view similar to FIG. 6 but showing the cords clamped by the pivotal eccentrics;

FIG. 8 is an end view of the pulley block assembly of this invention, and

FIG. 9 is a view similar to FIG. 8 but showing the operation of one of the release devices for rendering a pair of the cord clamping devices inoperative.

Referring more particularly to the drawings, there is shown in FIG. 1 an astronaut garbed in a pressure suit 11 equipped with a pressure suit tiedown mechanism 12 which is a preferred embodiment of this invention. The pressure suit comprises a hard plastic helmet 13 and a rigid neck ring 14 to which the helmet is removably secured but fastened thereto by cables located internally of the bellows-like neck portion 15.

The tiedown mechanism 12 comprises a pulley block assembly 16 which is disposed in front of the chest of the astronaut and is fastened by cables 17 and 18 to opposite sides of the neck ring. The cables 17 and 18 are threaded and secured to eyes 19 on the neck ring and are joined to the pulley block assembly by pivotal yoke members 21 and 22, respectively. The pivotal members each have holes in the arms thereof for receiving a fastening pin 23 which extends through the yoke arms and an eye 24 in the top of the pulley block assembly. The pin 23 is preferably a quick release type which may be readily pulled out of the eye 24 without great difficulty to provide a simple and efficient means of disengaging the tiedown mechanism from the suit.

The pulley block assembly 16 is also connected by nylon cords 31, 32, and 33 to an adapter 34 on one end of a strap 35 as best shown in FIG. 2. The strap 35 is secured at its other end to the suit in the vicinity of the crotch, but alternatively may be passed under the crotch and attached to the back of the pressure suit. The cords 31, 32, and 33 are each reeved over pulleys in the pulley

block assembly and each includes a section of elastic rubber 31a, 32a, and 33a, respectively, the function of which will hereinafter be described.

The pulley block assembly 16 comprises a pair of bracket members 41 and 42 which support the pulleys of the assembly. The bracket 41 is comprised of a central web section 43 with side members 44 and 45 which extend perpendicularly from the web section in parallel relation to one another, as best seen in FIG. 3. The bracket 42 similarly comprises a web section 46 with parallel extending side members 47 and 48. The web 43 of bracket 41 is provided at its lower end with an aperture 49 for receiving a bolt 50 which supports a pair of rollers or pulleys 51 and 52. The bolt is threaded at its end into an aperture (not shown) in the web section 46 of the bracket 42 and joins the brackets together in tandem arrangement. The pulleys are adapted to rotate freely on the shank of the bolt and their peripheral surfaces are provided with cord-engaging teeth. The pulleys might also be provided with grooved rims as are more conventional pulleys.

The web section 43 is also provided with an elongate slot 53 centrally located in the upper portion of the web and adapted to receive a bolt 54 therethrough which in the assembled form of the pulley block assembly supports a pair of eccentric clamping members 61 and 62 between the bracket sides 44 and 45. The bolt 54 also extends through an elongate slot 63 which is formed in the bracket 42 in alignment with the slot 53 and is secured thereto by a nut 64. The eccentric members which are pivotally supported on the shank of the bolt are disposed directly above the pulleys 51 and 52 respectively, but are spaced a sufficient distance therefrom to permit the passage of the cords 31 and 32 over the pulleys. As best seen in FIGS. 6 and 7, the peripheral edge of each clamp except for a flattened portion 61a and 62a, respectively, is on a curve eccentric to the axis of the bolt and is provided with a knurled surface adapted to provide strong frictional engagement with the cord when engaged therewith. To limit the degree of pivotal movement of the eccentrics and to prevent their tumbling on the shank of the bolt to an inoperative position, each is provided with an L-shaped stop member 65 which has one leg welded flat against the flattened edge of the eccentric. When the eccentrics are pivoted in the directions as shown in FIG. 6, the tip 66 of the other leg of each L-stop is engageable with the top edge 67 of a window opening 68 which is provided in each bracket side 44 and 45. The stop thereby prevents further pivotal movement of the eccentrics in these directions.

As further shown in FIG. 6, the cord 32 is adapted to move freely to the left over the pulley 52 since the eccentric clamp 62 is pivoted in counterclockwise direction by the movement of the cord to a position where the portion of its peripheral surface nearest the bolt axis, that is the thin part of the eccentric, engages the cord. In FIG. 7, however, it is shown that reverse movement of the cord 32 to the right over the pulley 52 will cause pivotal movement of the eccentric 62 in the clockwise direction which will cause the eccentric to clamp and squeeze the cord against the pulley. Further movement of the cord to the right over the pulley is thereby prevented.

It is also shown in FIG. 6 that the eccentrics 61 and 62 are fitted to the bolt 54 with their eccentricities in reverse relationship to the axis of the bolt. Consequently, the cord 31 is adapted to move freely over the pulley 51 but in the direction opposite to the direction of free movement for the cord 32. Movement of the cord 31 to the right causes the eccentric 61 to pivot clockwise wherein it will be disposed in unclamped relation to the cord 31 although in frictional engagement with the cord. As shown in FIG. 7, however, movement of the cord 31 to the left causes pivotal movement of the eccentric 41 in the counterclockwise direction which causes the eccentric

to clamp the cord tightly against the pulley 51 and prevent further movement of the cord in this direction.

To insure that the eccentrics will be pivotally moved whenever there is movement of the cords over the rollers, each eccentric is biased into strong frictional engagement with its associated cord by a leaf spring, 69 and 70, respectively. The spring 69 is attached at one end to the wall of the bracket web 43 and engages the top edge of the eccentric 61 to which it applies a biasing torque in the counterclockwise direction as seen in FIG. 6. In like manner, the eccentric 62 is biased by a constant torque in the clockwise direction as applied by the spring 70 shown in FIG. 5 which is attached at one end to the web section 46 of bracket 42 and engages the top edge of the eccentric 62.

It is to be understood, of course, that means other than the leaf springs 69 and 70 might be employed for biasing the eccentrics into frictional engagement with the cords. For one example, an expansible single coil spring might be utilized wherein the coil would lie constrained in a loop encircling the shank of the bolt 54 with one end of the spring attached near the peripheral margin of the eccentric which is of greatest radius and its other end to the wall of the adjacent web structure. By its tendency to expand, the spring would exert a torque on the eccentric in the direction which would urge it into clamping engagement with the cord.

It will therefore be seen, as is illustrated in FIG. 1 that by grasping the two cords 31 and 32 with the hands and spreading the cords in front of the chest, the two cords are pulled in the directions opposed to their directions of free movement. The cords will therefore be held clamped by the action of their associated eccentric clamps and an upward pull exerted on the crotch belt 35 and a downward pull exerted on the rigid neck ring 14 which draws the two together and thereby effectively shortens the suit. Since the pull on the cords by the hands is directed substantially perpendicularly to the extended cords, practically an infinite mechanical advantage is initially attained which decreases as the cords are spread but insures that little effort is required to operate the mechanism. This is particularly true in view of the fact that the effort to spread the cords takes advantage of the tendency of the inflated suit to force the astronaut's arms outwardly in spread-eagle fashion from the body.

In fitting the tiedown mechanism to the suit, the cords 31 and 32 are placed in tension whereby the elastic sections 31a and 32a of cords 31 and 32, respectively, function to maintain the cords taut while permitting variation in length. In each cord the elastic section is included near one end adjacent the adapter 34 and is so located by the reeving arrangement of the cord over the pulley that the constant pull which the elastic section exerts on the cord is in the direction of its free movement over the pulley. Hence, when the cords are released by the hands their elastic sections pull the cords over the pulleys and cause the cord-clamping eccentrics to pivot to their non-clamping positions as shown in FIG. 6. When the cords are released, however, means in the form of a restraining cord 33 is provided for maintaining the adjustment which has been made in the length of the suit by the spreading of the cord pair.

The restraining cord 33 is reeved over a pulley 71 carried by the bracket 42 and is fastened at its ends to the adapter 34 of the crotch belt. The pulley 71 is adapted to rotate freely on the shank of a bolt 72 which extends through aligned apertures 73 and 74 in the sides of the bracket. Like the cords 31 and 32, the cord 33 is also permitted free movement in one direction over the pulley but is limited in reverse movement by an associated pivotal eccentric 76 which is normally maintained in frictional engagement with the cord.

The eccentric 76 which is identical in shape to the eccentrics 61 and 62, although slightly larger, is adapted to pivot on the shank of the bolt 77 which extends

through aligned elongate slots 78 and 79 in the bracket sides 47 and 48 and is supported directly above the pulley 71 but spaced a sufficient distance therefrom to permit the passage of the cord 33 over the pulley. The eccentric is limited in its pivotal movement by a stop member 80 which is secured to the flat edge of the eccentric in transverse relation thereto and engages the edges 47a and 48a of the bracket sides 47 and 48 for two pivotal positions of the eccentric. It is also biased into frictional engagement with the cord 33 by a resilient appendage 83 which is attached to the eccentric and engages the edge 47a of the bracket side 47.

The cord 33 is adapted to move freely over the pulley 71 in the left direction as seen in FIG. 4. Movement of the cord 33 to the right, however, causes eccentric 76 to pivot clockwise wherein it will be disposed to clamp the cord tightly against the pulley and prevent further movement of the cord in this direction. As the suit is shortened by spreading of the cords 31 and 32, the elastic section 33a keeps the restraining cord taut and pulls it in free movement over the pulley 71 as the cord becomes shorter. However, when the cords 31 and 32 are released by the hands, the internal pressure of the inflated suit causes an initial lengthening of the suit and the restraining cord which moves a limited distance over the pulley 71 in the direction opposed to its direction of free movement until it is clamped by pivotal movement of the eccentric 76. This clamping action prevents any further movement of the restraining cord and lengthening of the suit and thereby maintains most of the adjustment made in the length of the suit by spreading of the cords 31 and 32. To further shorten the suit, the cinching process of pulling outward on the cords 31 and 32 and then releasing them is repeated as many times as is required.

The tiedown mechanism 12 also comprises a pair of release devices 91 and 92 which are operable to release or relax the hold by the tiedown mechanism on the suit. This would be desirable, for instance, in order to resume an erect stance from a sitting or bending position. The release device 91 which is adapted to release the hold by cords 31 and 32 is a U-shaped member comprising a central web section 93 with parallel extending arms 94 and 95. The arms 94 and 95 are adapted to slide in grooves 96 and 97 which are formed respectively in the web sections 43 and 46 of the brackets 41 and 42. The arms 94 and 95 are provided with camming surfaces 98 and 99, respectively, which normally engage the shank of the bolt 54 as shown in FIG. 8 and hold the bolt in the lower ends of the slots 53 and 63. In this position of the bolt the eccentrics 61 and 62 are maintained in strong frictional engagement with the cords 31 and 32 and will move pivotally in response to movement of the cords over the pulleys.

The release arms 94 and 95 are also provided with elongate grooves 101 and 102 formed in their upper surfaces in which coiled springs 103 and 104 are seated, respectively. One end of the spring 103 engages a stop screw 105 which is threaded from the top surface of the bracket 41 to project downwardly into the groove 101. In like manner a stop screw 106 is threaded from the top surface of the eye 24 of the bracket 42 to project downwardly into the groove 102 where it is engageable by the end of the spring 104. It will therefore be seen that the release device 91 is biased outwardly of the pulley block assembly by the action of the coiled springs 103 and 104 against the stop screws 105 and 106 in which position of the release device the bolt 54 is held cammed in the lower part of the slots 53 and 63. The stop screws are also engageable by the end walls 101a and 102a of the grooves and thereby secure the release device to the pulley block assembly. An ear 107 which protrudes from the side of the bracket 41 as shown in FIGS. 4 and 7 provides support for the release 91 when it is in its normally biased extended position.

The arms 94 and 95 are also provided with notches or recesses 108 and 109 respectively in their lower surfaces adjacent the camming surfaces 98 and 99. Thus, by positioning the release 91 inwardly in the position shown in FIG. 9, the bolt 54 will move upwardly due to the expansion of the cords 31 and 32 into the recesses in the parallel arms whereby the eccentrics 61 and 62 are either removed from engagement with the cords or so lightly engage the cords that they are rendered inoperative and will not pivot in response to movement of the cords. The cords 31 and 32 are thereby adapted to move freely in both directions over the pulleys.

The release 92 which provides a means for releasing the hold on the suit by the restraining cord 33 is in the form of a U-shaped member comprising a central web section 111 and parallel arms 112 and 113. The arms 112 and 113 are slidably seated in grooves 114 and 115 which are formed in the exterior walls of the sides of bracket 42. The release 92 is biased outwardly of the pulley block assembly by means of a coiled spring 116 sleeved within a pair of telescoping cylinders 117 and 118. The cylinder 117 is provided with a screw 119 at one end for attachment to the web section 46 of bracket 42 and the cylinder 118 is similarly provided with a screw 120 at one end for perpendicular attachment to the central section 111 of the release 92. In the position of the release as biased by the spring 116, the shank of the bolt 72 and held in the lower ends of the slots 78 and 79 by projecting camming surfaces 121 and 122 on the undersides of the arms 112 and 113 as shown in FIG. 4. The release is secured to the pulley block assembly by stop screws 123 and 124 which are threaded into bracket sides 47 and 48 and extend from their top surfaces into the bracket grooves 114 and 115 where they are engageable by the end walls of grooves 125 and 126 formed in the top surfaces of the release arms 112 and 113, respectively.

When the release is pushed inwardly, however, against the action of the coiled spring 116, the shank of bolt 72 is disengaged from the camming surfaces and due to the expansion of the cord 33 moves upwardly in the slots 78 and 79 into the recessed areas formed by the cut-away lower surfaces of the release arms 112 and 113. In this position of the bolt 72 the eccentric 76 is either removed from frictional engagement with the restraining cord 33 or so lightly engages the cord that it will not pivot in response to movement of the cord which is then adapted to move freely over the pulley 71 in either direction.

It will therefore be seen that by operation of the release devices 91 and 92 the hold exercised by the tiedown mechanism on the suit may be relaxed. If desired, the two release devices may be operated simultaneously to release all of the cord clamping eccentrics and permit the full lengthening of the inflated suit in only one operation.

In most instances, however, for purposes of safety it would generally be desired to operate the two releases in alternate fashion. In this manner, for example, pushing the release 91 inwardly into the pulley block assembly while leaving the release 92 in its normally biased outward position, the cords 31 and 32 will be released for free movement, while the restraining cord will be pulled over the pulley 71 by its elastic section 33a for a limited distance until such time as the pivotal eccentric 76 clamps the cord against the pulley and prevents its further movement. By then permitting the release 91 to be biased to its normally outward position wherein the eccentrics 61 and 62 are again in operative condition and then releasing the restraining cord 33 by forcing the release 92 inwardly of the block assembly, the hold exerted by the tiedown mechanism will be released by a limited amount determined by the distance of movement of the cords 31 and 32 over their associated pulleys until clamped by the action of the eccentrics

61 and 62. By repeating the process of alternately moving the release devices 91 and 92 inwardly of the pulley block assembly, the hold exercised by the tiedown mechanism on suit will be relaxed in a step by step manner.

It will therefore be seen that a novel pressure suit tiedown mechanism which may be operated by only a minimum effort of the suit wearer is described herein. The mechanism constitutes a reliable and safe means for preventing helmet rise when the suit is bent to conform to a sitting position and provides means for adjusting the torso length of an inflated pressure suit to relieve the suit wearer of strain when in a position other than standing. Although the mechanism has been herein illustrated in operation with pressure suits and in particular a pressure suit designed for astronauts, it may be used with other inflatable pressure suits such as those used by aviators and in other applications where it is desired to draw spaced objects together. A variety of materials may, of course, be used in the make-up of the components of the mechanism. The pulley block assembly, however, is preferably metallic to withstand the large forces which act on the mechanism. The cords are preferably nylon, similar to nylon parachute shrouds, and the elastic sections of these cords are preferably surgical gum rubber which is tough and elastic.

It should also be understood of course, that the foregoing disclosure relates only to preferred embodiments of the invention and that it is intended to cover all changes and modifications of the examples in the invention herein chosen for the purposes of the disclosure and which do not constitute departure from the spirit and scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In combination with an inflatable pressure suit having a crotch, a helmet and a rigid neckring to which the helmet is removably secured, a pressure suit tiedown mechanism comprising:

- a pulley block assembly disposed on the front of said suit;
- cable means attaching said pulley block assembly to opposite sides of the neck ring;
- first and second pulleys rotatably mounted on said pulley block assembly;
- a first cord reeved over said first pulley;
- a second cord reeved over said second pulley;
- a crotch strap attached to said suit in the vicinity of the crotch and having a longitudinally upwardly extending end portion;
- coupling means joining the upward end of said crotch strap with the ends of said cords;
- clamping means associated with each of said cords, each said clamping means responsive to movement of its associated cord in a given direction over its supporting pulley for clamping the cord whereby when said cords are pulled by the suit wearer's hands in the directions adapted to actuate said clamping means a downward pull will be exerted on the neck ring and an upward pull exerted on the crotch strap to thereby shorten the suit and hold down the suit helmet;
- means for rendering said clamping means inoperative and maintaining said cords in a taut condition when the pull exerted on said cords by the suit wearer's hands is released; and
- means for maintaining the adjustment made in the length of the suit by the suit wearer in pulling the cord in the directions adapted to actuate said clamping means.

2. In combination with an inflatable pressure suit having a crotch, a helmet and a rigid neckring to which the helmet is removably secured, a pressure suit tiedown mechanism comprising:

- a pulley block assembly disposed on the front of said suit;



cable means attaching said pulley block assembly to opposite sides of the neck ring;  
 first and second pulleys rotatably mounted on said pulley block assembly;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 a crotch strap attached to said suit in the vicinity of the crotch and having a longitudinally upwardly extending end portion;  
 coupling means joining the upward end of said crotch strap with the ends of said cords;  
 clamping means associated with each of said cords, each said clamping means responsive to movement of its associated cord in a given direction over its supporting pulley for clamping the cord whereby when said cords are pulled by the suit wearer's hands in the directions adapted to actuate said clamping means a downward pull will be exerted on the neck ring and an upward pull exerted on the crotch strap to thereby shorten the suit and hold down the suit helmet;  
 means for rendering said clamping means inoperative and maintaining said cords in a taut condition when the pull exerted on said cords by the suit wearer's hands is released;  
 a third pulley rotatably mounted on said pulley block assembly;  
 a restraining cord reeved over said third pulley and coupled at its ends to the upward end of said crotch strap by said coupling means; and  
 means responsive to movement of said restraining cord over said third pulley for clamping said restraining cord when the pull exerted on the first and second cords by the suit wearer is released.

3. In combination with an inflatable pressure suit having a crotch and provided with a rigid helmet, a pressure suit tiedown mechanism comprising:  
 a pulley block assembly disposed on the front of said suit;  
 means attaching said pulley block assembly to opposite sides of the helmet;  
 first and second pulleys rotatably mounted on said pulley block assembly;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 means securing the ends of said cords to said suit in the vicinity of the crotch;  
 a first clamping means operatively associated with said first cord and a second clamping means operatively associated with said second cord, each said clamping means responsive to movement of its associated cord in a given direction over its supporting pulley for clamping the cord whereby when said cords are pulled by the suit wearer's hands in the directions adapted to actuate said clamping means a downward pull will be exerted on the helmet and an upward pull exerted on the crotch strap to thereby shorten the suit and hold down the helmet;  
 means for rendering said clamping means inoperative and maintaining said cords in a taut condition when the pull exerted on said cords by the suit wearer's hands is released; and  
 means for maintaining the adjustment made in the length of the suit by the suit wearer in pulling the cords in the directions adapted to actuate said clamping means.

4. In combination with an inflatable pressure suit having a crotch and provided with a rigid helmet, a pressure suit tiedown mechanism comprising:  
 a pulley block assembly disposed on the front of said suit;  
 means attaching said pulley block assembly to opposite sides of the helmet;  
 first and second pulleys rotatably mounted on said pulley block assembly;

a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 means securing the ends of said cords to said suit in the vicinity of the crotch;

5 a first clamping means operatively associated with said first cord and a second clamping means operatively associated with said second cord, each said clamping means responsive to movement of its associated cord in a given direction over its supporting pulley for clamping the cord whereby when said cords are pulled by the suit wearer's hands in the directions adapted to actuate said clamping means a downward pull will be exerted on the helmet and an upward pull exerted on the crotch strap to thereby shorten the suit and hold down the helmet;  
 means for rendering said clamping means inoperative and maintaining said cords in a taut condition when the pull exerted on said cords by the suit wearer's hands is released; and  
 a third pulley rotatably mounted on said pulley block assembly;  
 a restraining cord reeved over said third pulley and coupled at its ends to said suit in the vicinity of the crotch; and  
 means responsive to movement of said restraining cord over said third pulley for clamping said restraining cord when the pull exerted on the first and second cords by the suit wearer is released.

5. In combination with an inflatable pressure suit having a crotch and provided with a rigid helmet, a pressure suit tiedown mechanism comprising:  
 a pulley block assembly disposed on the front of said suit;  
 means attaching said pulley block assembly to opposite sides of the helmet;  
 first and second pulleys rotatably mounted on said pulley block assembly;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 means securing the ends of said cords to said suit in the vicinity of the crotch;  
 a first clamping means operatively associated with said first cord and a second clamping means operatively associated with said second cord, said first clamping means being responsive to movement of said first cord in one given direction over said first pulley for clamping said first cord and said second clamping means being responsive to movement of said second cord in a direction over said second pulley which is opposite to said one given direction for clamping said second cord whereby when said cords are spread apart and pulled by the suit wearer's hands in the directions adapted to actuate said clamping means a downward pull will be exerted on the helmet and an upward pull exerted on the crotch strap to thereby shorten the suit and hold down the helmet;  
 means for rendering said clamping means inoperative and maintaining said cords in a taut condition when the pull exerted on said cords by the suit wearer's hands is released; and  
 means for maintaining the adjustment made in the length of the suit by the suit wearer in spreading the cords.

6. In combination with an inflatable pressure suit having a crotch, a helmet and a rigid neckring to which the helmet is removably secured, a pressure suit tiedown mechanism comprising:  
 a pulley block assembly disposed on the front of said suit;  
 cable means attaching said pulley block assembly to opposite sides of the helmet;  
 first and second pulleys rotatably mounted on said pulley block assembly;  
 a first cord reeved over said first pulley;

a second cord reeved over said second pulley;  
 means securing the ends of said cords to said suit  
 in the vicinity of the crotch;  
 a first clamping means operatively associated with  
 said first cord and a second clamping means operatively  
 associated with said second cord, said first  
 clamping means being responsive to movement of  
 said first cord in one given direction over said  
 first pulley for clamping said first cord and said  
 second clamping means being responsive to move-  
 ment of said second cord in a direction over said  
 second pulley opposite to said one given direction  
 for clamping said second cord whereby when said  
 cords are spread apart and pulled by the suit wearer's  
 hands in the directions adapted to actuate said clamp-  
 ing means a downward pull will be exerted on the  
 helmet and an upward pull exerted on the crotch  
 strap to thereby shorten the suit and hold down the  
 helmet;  
 means for rendering said clamping means inoperative  
 and maintaining said cords in a taut condition when  
 the pull exerted on said cords by the suit wearer's  
 hands is released;  
 a third pulley rotatably mounted on said pulley block  
 assembly;  
 a restraining cord reeved over said third pulley and  
 coupled at its ends to the upward end of said crotch  
 strap by said coupling means; and  
 means responsive to movement of said restraining cord  
 over said third pulley for clamping said restraining  
 cord when the pull exerted on the first and second  
 cords by the suit wearer is released.

7. In combination with an inflatable pressure suit hav-  
 ing a crotch, a helmet and a rigid neckring to which the  
 helmet is removably secured, a pressure suit tiedown  
 mechanism comprising:  
 a pulley block assembly disposed on the front of said  
 suit;  
 cable means attaching said pulley block assembly to  
 opposite sides of the neck ring;  
 first and second pulleys rotatably mounted on said  
 pulley block assembly;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 coupling means securing the ends of said cords to the  
 suit in the vicinity of the crotch;  
 clamping means associated with each of said cords,  
 each said clamping means responsive to movement of  
 its associated cord in a given direction over its  
 supporting pulley for clamping the cord and respon-  
 sive to movement of its associated cord in the reverse  
 direction for releasing the cord, said cords each  
 comprising an elastic section intermediate said  
 coupling means and said pulleys for exerting a biasing  
 pull on its associated cord in said reverse direction;  
 a third pulley rotatably mounted on said pulley block  
 assembly;  
 a restraining cord reeved over said third pulley and  
 coupled at its ends to said suit in the vicinity of the  
 crotch by said coupling means; and  
 means responsive to movement of said restraining  
 cord in one direction over said third pulley for clamp-  
 ing said restraining cord and responsive to movement  
 of said restraining cord in the direction opposite said  
 one direction for releasing the restraining cord, said  
 restraining cord comprising an elastic section inter-  
 mediate said coupling means and said third pulley  
 for exerting a biasing pull on said restraining cord  
 in said opposite direction.

8. In combination with an inflatable pressure suit  
 having a crotch, a helmet and a rigid neck ring to which  
 the helmet is removably secured, a pressure suit tiedown  
 mechanism comprising:  
 a pulley block assembly;

cable means attaching said pulley block assembly to  
 opposite sides of the neck ring;  
 a first pulley rotatably mounted on said pulley block  
 assembly;  
 a first cord reeved over said first pulley;  
 coupling means securing the ends of said cord to the  
 suit in the vicinity of the crotch;  
 clamping means responsive to movement of the cord in  
 a given direction over its supporting pulley for clamp-  
 ing the cord and releasable in response to movement  
 of the cord in the reverse direction, said cord com-  
 prising an elastic section intermediate said coupling  
 means and said pulley for exerting a biasing pull on  
 the cord in said reverse direction;  
 a second pulley rotatably mounted on said pulley block  
 assembly;  
 a restraining cord reeved over said second pulley and  
 coupled at its ends to said suit in the vicinity of the  
 crotch by said coupling means; and  
 means responsive to movement of said restraining cord  
 in one direction over said second pulley for clamp-  
 ing said restraining cord and responsive to movement  
 of said restraining cord in the direction opposite  
 said one direction for releasing the restraining cord,  
 said restraining cord comprising an elastic section  
 intermediate said coupling means and said second  
 pulley for exerting a biasing pull on said restraining  
 cord in said opposite direction.

9. In combination with an inflatable pressure suit hav-  
 ing a crotch, a helmet and a rigid neck ring to which the  
 helmet is removably secured, a pressure suit tiedown  
 mechanism comprising:  
 a pulley block assembly disposed on the front of said  
 suit;  
 cable means attaching said pulley block assembly to  
 opposite sides of the neck ring;  
 first and second pulleys rotatably mounted on said pul-  
 ley block assembly;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 coupling means securing the ends of said cords to the  
 suit in the vicinity of the crotch;  
 a third pulley rotatably mounted on said pulley block  
 assembly;  
 a restraining cord reeved over said third pulley and  
 coupled at its ends to said suit in the vicinity of the  
 crotch by said coupling means;  
 clamping means associated with each of said cords,  
 each said clamping means responsive to movement of  
 its associated cord in a given direction over its sup-  
 porting pulley for clamping the cord and responsive  
 to movement of its associated cord in the reverse  
 direction for releasing the cord, said cords each com-  
 prising an elastic section intermediate said coupling  
 means and said pulleys for exerting a biasing pull  
 on its associated cord in said reverse direction; and  
 release means for rendering each said clamping means  
 non-responsive to movement of its associated cord  
 over its supporting pulley.

10. The combination as recited in claim 9 wherein  
 each said clamping means comprises an eccentric mem-  
 ber pivotally mounted on the pulley block assembly and  
 normally disposed in frictional engagement with its asso-  
 ciated cord whereby said eccentric member is pivotally  
 movable in response to movement of the cord in one di-  
 rection to clamp the cord against its associated pulley and  
 is pivotally movable in response to movement of the cord  
 in the reverse direction to release the associated cord.

11. In combination with an inflatable pressure suit  
 having a crotch, a helmet, a tiedown mechanism com-  
 prising:  
 a pulley block;  
 means for attaching said pulley block to opposite sides  
 of the helmet;

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first and second pulleys rotatably mounted on said pulley block;  
 a first cord reeved over said first pulley;  
 a second cord reeved over said second pulley;  
 coupling means for attaching the ends of said cords to the suit in the vicinity of the crotch;  
 a first clamping means normally engaged with said first cord and responsive to movement of the first cord in a first given direction over the first pulley for clamping said first cord and responsive to reverse movement of the first cord for releasing said first cord;  
 a second clamping means normally engaged with said second cord and responsive to movement of the second cord in a second given direction over the second pulley for clamping the second cord and responsive to reverse movement of the second cord for releasing the second cord, said cords each comprising an elastic section intermediate said coupling means and said pulleys for exerting a biasing pull on its associated cord in said reverse directions;  
 a third pulley rotatably mounted on said pulley block;  
 a restraining cord reeved over said third pulley and coupled at its ends to said suit in the vicinity of the crotch by said coupling means;  
 a third clamping means normally engaged with said restraining cord and responsive to movement of the restraining cord in one direction over the third pulley for clamping the cord and responsive to reverse

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movement of the restraining cord for releasing the restraining cord, said restraining cord comprising an elastic section intermediate said coupling means and said third pulley for exerting a biasing pull on the restraining cord in the reverse direction;  
 a first release device selectively operable for rendering said first and second clamping means non-responsive to movement of the first and second cords over their associated supporting pulleys; and  
 a second release device selectively operable for rendering said third clamping means non-responsive to movement of the restraining cord over the third pulley.

12. The combination as recited in claim 11 wherein said released devices are means for camming the clamping means out of engagement with their associated cords.

## References Cited by the Examiner

## UNITED STATES PATENTS

1,961,081	5/1934	Schrader	24—134
2,315,196	3/1943	Gallione	24—134 X
2,935,985	5/1960	Andrews et al.	
2,973,521	3/1961	McGowan	2—2.1
3,112,816	12/1963	Halford	188—65.2
3,146,754	9/1964	Ohnsman	12—134
3,157,885	11/1964	Lobelle	2—2.1

JORDAN FRANKLIN, *Primary Examiner.*

30 J. R. BOLER, *Assistant Examiner.*