WHITMORE ENTERPRISES, INC.

Designing and Manufacturing

Specialized Equipment in Support of NASA Space Program

Hypobaric & Hyperbaric Chamber Controls   Research Treadmills, Ergometers

Human Body Volumeters

Specialized Medical & Aerospace Research Devices

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The information and concept disclosed in this and all our proposals is to be treated as confidential and proprietary information for our use and to be used in a contract or purchase order with Whitmore Enterprises, Inc. only. This materials is to convey our thoughts and approach to specific problems and not to be used by NASA and/or other contractors.

Enclosed is a proposal we made in December of 1986. This proposal is much more than what you are presently asking for.

What we are recommending at this time is a prototype of the quad system without any flight models.

We can furnish this for $50,000.00 if we furnish the Horizontal Treadmill Subject Suspension at the same time. This suspension system would incorporate smaller versions of tension system used on the Treadmill Hold-Down System to suspend the knee and ankle and use a sling device to support the torso and head.

This system would include a frame system that would support the treadmill and the subject. This system would be adjustable for subject weight and height variation. This system will have the capability of being dissembled and reassembled in a new location in a room with an eight foot ceiling.

This system will cost $50,000.00 if ordered at the same time as the Treadmill Tensiometers for a total of $100,000.00.

WHITMORE ENTERPRISES, INC.

PROPOSAL FOR TENSIOMETERS FOR SPACE SHUTTLE TREADMILLS

Whitmore Enterprises, Inc. will design and build an improved subject hold-down system (tensiometer). This system will be used to load a person down on the treadmill on the space shuttle in zero gravity,

The present system incorporates four elastic hold-down units which consist of multiple bungee cords (See Figure 1). These elastic units are wound back and forth over and around delrin pulleys (shives). These pulleys are located at both ends of the treadmill side panels and the elastic units form a pattern which resembles a flattened "S". One end of each elastic unit is attached to the tackle assembly which is fastened to the treadmill. The other end of the elastic unit is attached to a harness which the subject wears while using the treadmill.

This system produces a large amount of friction due to the pulley arrangement and has no simple method of adjustment as to the force placed upon the individual.

It is our intention to provide a system which will involve either a dual or quad tension cord arrangement for each treadmill (See Figures 2 and 3). If we provide the quad tension system, the harness already qualified for space use would be useable without any modifications.

However, if we provide a dual tension system, the harness would require modification or possibly need to be redesigned in order to hold the subject at the correct angle of incline. This modification would be necessary because the dual cord system will not have the same angle of alignment as the previous four hold-down system does. The dual system will have the capability of creating the same hold-down force as the quad system. As well, the dual system would require only two tension adjustment cranks at most. There is a possibility of needing only a single crank that would adjust both sides simultaneously. This would be accomplished by a cross shaft arrangement under the treadmill or a similiar arrangement across the front of the unit.

This new design will eliminate all of the tackle assembly now being used. Instead, we will provide shaft mounting brackets on both ends of both side panels (See Figures 4, 5, and 6). These will use the same bolt hole system used on the present tackle assembly brackets. This means that no modification will be required on the treadmill itself.

The shaft brackets will support two parallel shafts, one on each side of the treadmill. On each of these shafts one or two compound tension elements will be mounted. A compound tension element will involve essentially two parts which are connected to one another as follows. On the left side are a number of individual bungee cords of which a single end of each cord is attached to a stationary unit near the shaft bracket mount. We have already designed and built a test model proving the concept (See photo enclosed). This unit used a spring instead of bungee. The dual system will have one tension element on each shaft and the quad system will have two on each shaft. On the dual system the stationary end of this element will be locked near one end of this shaft with the shaft passing through the core of this element (See Figure 5). The other end of this element will be fastened to a group of pulleys and incorporate a ball bearing longitudinal bushing. A stationary group of pulleys will be locked on the shaft next. Then a take-up reel will be locked on the shaft last.

During assembly of this unit (See Figure 5) a cord or cable fastened to the subjects harness is threaded through a locking ball then through a guide pulley and around one of the stationary pulleys. It then passes around one of the moveable pulleys fastened to the tension element. The cord is then wound back and forth across these pulleys like a block and tackle. The other end of the cord is fastened to a take-up reel. When the crank on the take-up reel is turned the cord is wound up onto the reel stretching the bungee tension units providing the subject with hold-down force. This action moves a pointer (located on the moving pulley unit) forward on a graduated scale mounted on the treadmill side panel. The pointer will be claibrated to read the amount of force placed upon a person as they use the treadmill.

The bungee pulley arrangement and the pulleys on the stationary block are the only parts that move by the restraint force applied by a subject in the harness. This movement will be most readily seen when a subject is using the treadmill and causing the harness to change in vertical height. This movement is reduced in the compound tension element due to the twelve to one ratio between the harness cord and the tension element. The force will remain close to linear over the small change in vertical high during exercise on the treadmill.

Ball or roller bearings will be incorporated into the pulley system and the tension element will use a ball bushing to reduce the friction created as the unit travels horizontally along the shaft. All components will be manufactured in such a fashion as to be of the least weight. This will reduce hysteresis and inertia to the very minimum.

We will cover the bungee bundle in the compound tension element with a fire retarding sleeve. This sleeve would be of adequate length assuring no interference with extension and contraction of these elements.

We put forward the recommendation of making a prototype of the dual system and use one of the present harnesses to test this new unit. This would require the development of an interface fixture for the harness similiar to the one shown in Figure 3. The load force would then be transferred from the front and rear of the treadmill to the middle of each side while still maintaining the same angle of pull down force.

While testing the dual system we will begin fabricating the quad system. We will use the knowledge gained during these tests in the design of this quad system.

The quad system will be similiar to the dual system with two smaller systems mounted on each shaft (See Figure 6). The quad system will be slightly heavier and more complex. Each individual unit will only require about half the force of the dual system.

We will require the use of a treadmill for design and testing purposes of these units, but it would make no difference whether it is a flight treadmill or the prototype.

After thorough testing of both the dual and the quad systems, we will make final modifications and select the best of the two. At this stage we will be ready to build a flight model of the unit.

Should we get the go ahead in mid December of 1986 we would have the first flight model no later than mid June of 1987. We would then follow with the production of additional units in intervals of two months with a completion of four flight units by mid December 1987.

If we select the dual system this would require redesign and fabrication of four new harnesses which we will furnish. The harnesses will retain the best features of the old units and combine them with the needs for the new. We will do all the research, development and testing necessary, but we request that the harness material be furnished by the government (GFE).