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FORCE MULTIPLIER FOR USE WITH MASTER SLAVES

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ABSTRACT

A force multiplier has been designed at Lawrence Radiation Laboratory. This piece of equipment was made to increase the gripping force presently available in the Model 8 master slave. The force multiplier described incorporates a novel clamp which can be quickly attached to and detached from the master slave hand.

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INTRODUCTION

In the setup of the chemistry equipment inside the enclosed box in the neutron cave it has been highly desirable to use a number of glass ball-and-socket joints for connection of various pieces of equipment. These joints are normally held together by a simple spring-loaded clamp which is removed manually. The grip required to operate this spring clamp is on the order of 15 pounds. This is considerably greater than provided by the fingers of the Model 8 master slave. The possibility of increasing the leverage of every clamp in the system was discarded in favor of the provision of one item that could be quickly attached to and detached from the master slave hand.

The force multiplier as designed fulfills all these basic requirements.

1. It provides the necessary force for handling the ball-joint clamp.

2. It decreases the stress applied to the master slave hand.

3. It is quickly and firmly attached.

4. It can be quickly removed.

5. It requires minimum storage space.

6. As an added bonus, the parts that attach to the master slave fingers can be used on a variety of other special tools.

Design Requirements

Three sizes of ball and socket joints (Fig. 1) were used in this box. The maximum opening required to operate either of the clamps used is 1-1/2 inches. The minimum compressed position is 1/2 in. allowing a total movement of 1 in. The maximum opening of the master slave hand (Fig. 2) is 3-1/8 in. The maximum possible force multiplication, then, is the ratio 3-1/8 : 1. By a simple scissors-type leverage attached to a convenient place on the tong fingers the available force can be readily multiplied at the gripping surface.

*Work done under the auspices of the U. S. Atomic Energy Commission.

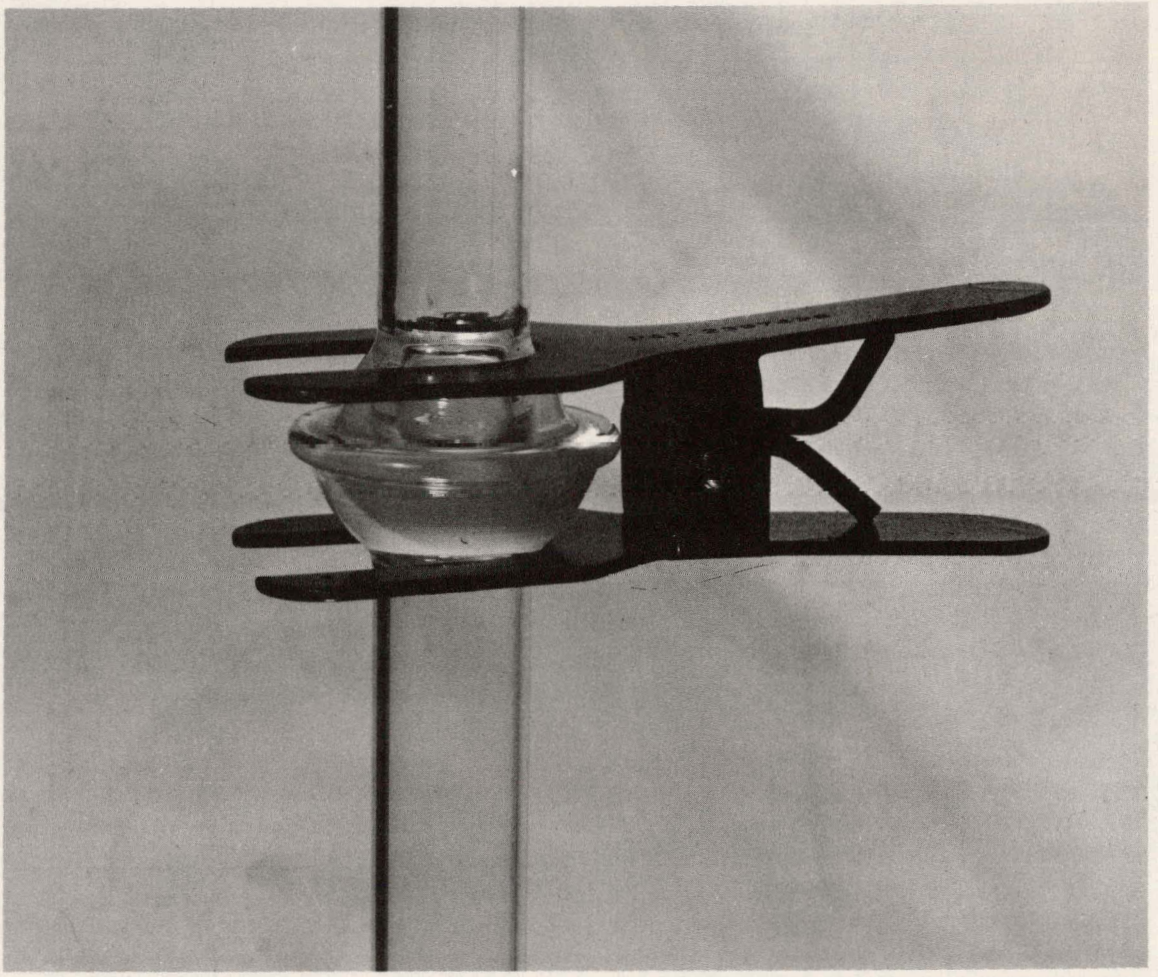

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Fig. 1. Ball-and-socket joint.

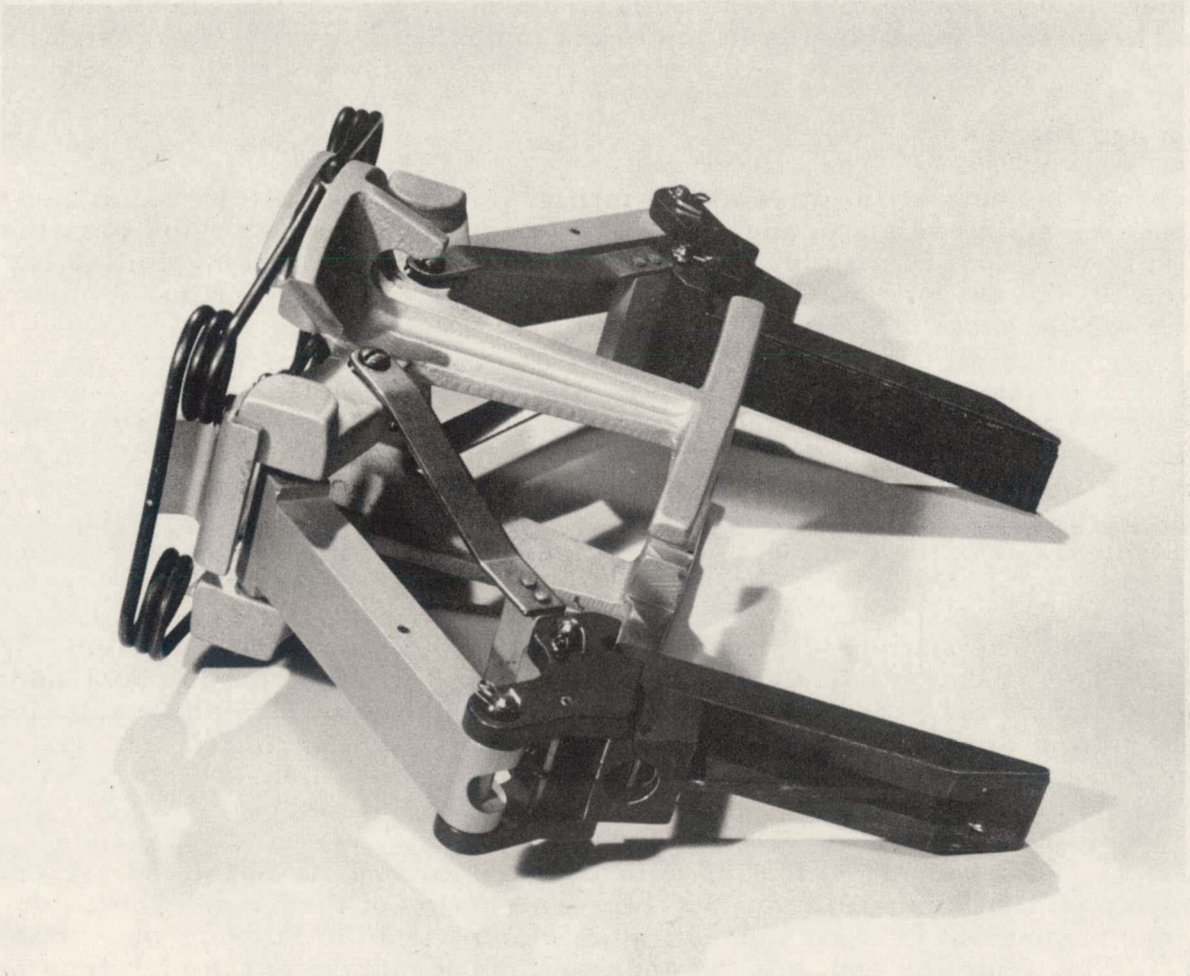

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Fig. 2 Model 8 hand.

The next problem to be solved incorporates Items 3 and 4 in the requirements. We must find a way of firmly attaching the gadget and must be able to remotely attach it and detach it quickly. There is a point on the outside of the slave finger which is suitable for attaching a locking device. This is a shoulder between the ears that attach to the outer link connecting the finger to the top part of the hand. Since this point is on the outside of the finger and pressure must be applied to the inner face of the finger, the two parts must be joined and fastened to the multiplying lever. The restraining hook must also be easily released for removal of the multiplier when desired.

Design Details

The multiplier is shown in Fig. 3. The saddle (1) was formed of .020-in. stainless steel, making a flat-bottomed "U" which slips over the finger with approximately 1/32 in. clearance, the ends being drilled for a No. 10-32 screw so that the screw will cross over the finger on the tapered part of the back.

The spring (2) was formed of .020-in. stainless steel, 3/8 in. wide. The spring was folded flat and bent around to form a loop to fit the No. 10 screw. One end was formed into a hook to fit into the notch on the finger, the length between screw and hook being gaged accurately to provide the proper fit of the saddle on the finger. The other end of the spring strip extends to near the outer end of the finger to provide the necessary spring action.

The stirrup (3) also was formed of .020-in. stainless steel, 3/8 in. wide, so that it could attach to the spring 3/16 in. from the hook and wrap around the saddle at right angles to the bottom of the saddle and clear the bottom of the saddle 1/8 in. The stirrup (3) and spring (2) are spot-welded in proper position. The stirrups are used in disassembly to lift the hooks on the springs out of engagement with the fingers.

The arms (4) for the scissor were formed so that in the extreme open position they would not interfere with action of the hand. The outer ends were opened out to clear the ball-joint clamp, and the fulcrum was established 1-1/4 in. from the end. At the ends we took advantage of the high friction coefficient of tygon tubing. Therefore we used a No. 4 S.S. screw over which we used a sleeve of 1/8-in. i.d. × 1/4-in. o.d. tygon, and over that a piece of 1/4-in. i.d. × 7/16-in. o.d. tygon. This prevents the ball-joint clamp from slipping out of the force multiplier. The long end of the arm was determined from the ratio 3-1/8 : 1. The distance between the contact points is set so that when the hand is closed to a point where the stirrups do not release the hooks, the distance between the contact points is 1/2 in., the minimum required closing position.

A simple storage holder is a piece of 2-in.-diameter 1/8-in.-wall lucite tube 3 in. long, with one end cemented to a 4-in.-square lucite plate for a base.

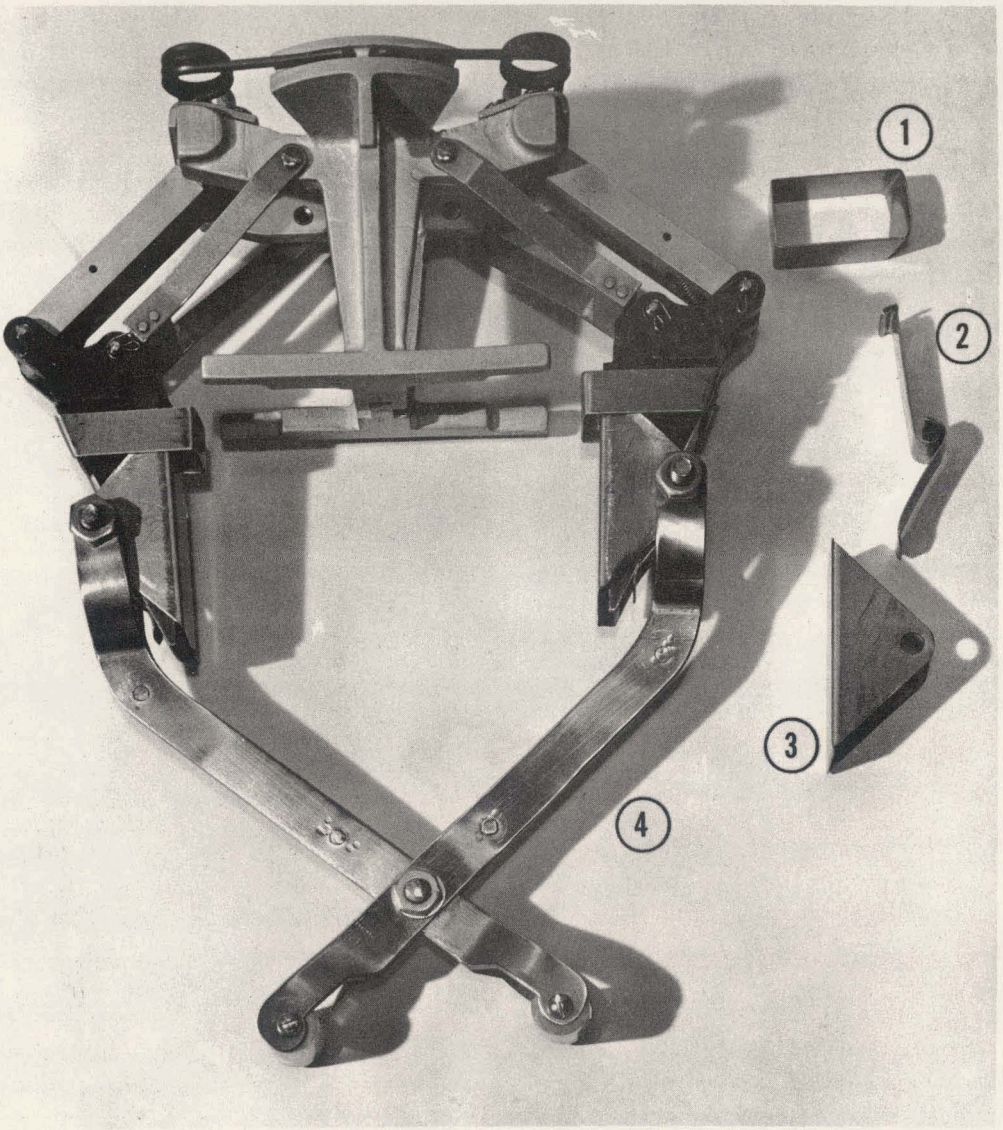

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Fig. 3. Force multiplier.

Operation

The force multiplier is placed in the lucite tube holder with the attachment end up. This holds the saddles in the correct position so that the slave fingers can enter the saddles and be pushed in until the spring hooks click into engagement. The multiplier is now ready for use.

To release the multiplier, one must place it back in the storage tube and squeeze the fingers together until the stirrups lift the hooks out of engagement, then grasp the arms of the multiplier with the other slave hand and pull the fingers out of the multiplier.