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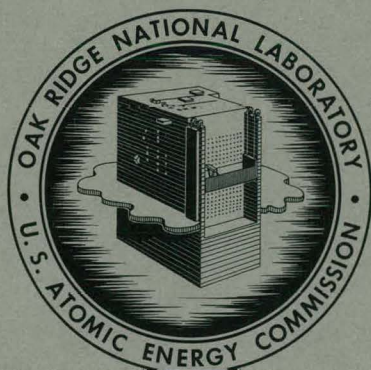
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UC-38 — Engineering and Equipment

REMOTELY CONTROLLED SHEARING OF  
PIPE AND STRUCTURAL MEMBERS

A. A. Abbatiello



**OAK RIDGE NATIONAL LABORATORY**

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# REMOTELY CONTROLLED SHEARING OF PIPE AND STRUCTURAL MEMBERS

A. A. Abbatiello

## Abstract

A shearing tool has been developed for remotely controlled severing of pipes or structural members. The shear is rotated about its axis in a wrist motion by the pumped hydraulic fluid that also powers the shear blade. It can be used in a stationary mounting or suspended from a crane. A C-shaped support for the shear has been designed to pass through a small top opening of a shielded cell. The controls for manipulating the shear pass through or along the C-frame. The shear jaw opens to 5 in. in height and 7 in. in width, and the total weight of the tool is only 575 lb. It has been used to cut metal sections 4 3/4 in. thick and 4-in. sched.-40 stainless steel pipe.

## Introduction and Summary

The remotely controlled hydraulic shear described here was planned and built as a general-purpose tool for severing operations in a complex maze of heat transfer fluid pipes, service and instrument lines, and structural members. With proper arrangement of equipment and allowance for shear width between lines, radioactive systems can be prepared for disassembly or maintenance in a shielded cell. Remote shearing is particularly useful where later access for reassembly is desired.

The shearing tool is simple, compact, and reliable. Shearing produces no chips or other particles and in no way causes the spread of radioactive contamination. In fact, a severed line is pinched to a nearly closed condition, and the possibility of the spread of contamination is thus minimized. This is especially valuable in a remote operation where later cleanup of the cell would be particularly difficult if radioactive contamination were present.

Preliminary tests to determine the feasibility of shearing were carried out by two methods. First a hand-operated shear<sup>1</sup> was purchased and

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<sup>1</sup>Model 200A, made by Manco Manufacturing Co., Bradley, Illinois.

a number of small lines (up to 5/8 in. in diameter) were cut with this tool as shown in Fig. 1. This small shear produced a cleanly severed surface and no chips, and the ease with which it could be operated indicated that further testing was justified.

A pump-driven hydraulic shear,<sup>2</sup> model MC-65, was then purchased for testing under simulated remote operating conditions. This unit was suspended from a crane, positioned by remote controls, and operated from the hydraulic valves mounted on the pump. Finally, a television camera was added as the means of observing and controlling the operation. It was found that an operator could easily position the shear with the crane controls while observing the image in the television receiver. Steel rods up to 1 1/4 in. in diameter were cut (Fig. 2) with this model MC-65 power-driven shear.

The tests indicated that remote operation was feasible, but they also pointed up some limitations. For instance, binocular or stereo vision, for better depth perception, would be preferable to the single view produced by a conventional television receiver. A camera mounted on the shear for close viewing and a second camera in the cell for general viewing provide, however, an acceptable minimum installation.

Following these tests, a specification (UCNC Specification JS-P3-56) was prepared, and the shear shown in Figs. 3 and 4 was designed, built, and successfully tested for cutting 3 1/2-in. sched.-40 Inconel pipe, 4-in. sched.-40 mild steel pipe, and 4-in. sched.-40 stainless steel pipe. This shear is available for any remote cutting operation where its size and power are applicable. It provides a powerful new tool having a capacity adequate for severing 4-in. pipe. A high degree of versatility is provided by the suspension and handling system.

Since the initial testing of this shear, it has proved useful in several applications. One was the experimental dissection of depleted fuel elements for fuel recovery processing. Based on these tests, the Chemical Technology Division specified the type of shear needed, and one has since been built by another manufacturer. In another situation this

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<sup>2</sup>Model MC-65, made by the same manufacturer.





Fig. 1. Hand-Operated Shear Used to Cut Pipe and Bars up to  $5/8$  in. in Diameter.



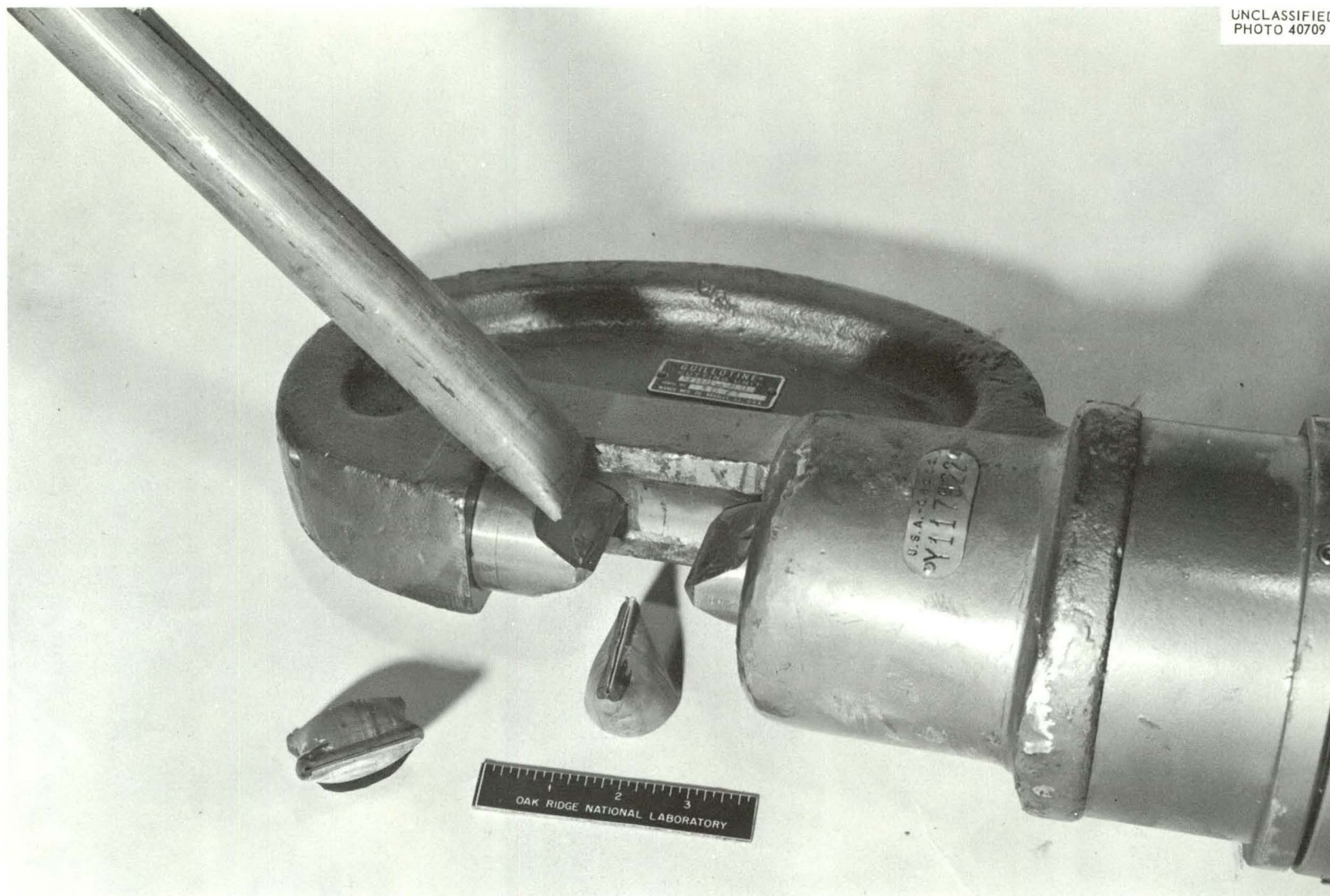


Fig. 2. A Piece of 3/4-in. Pipe Severed in an MC-65 Shear Showing the Type of Closure Produced.



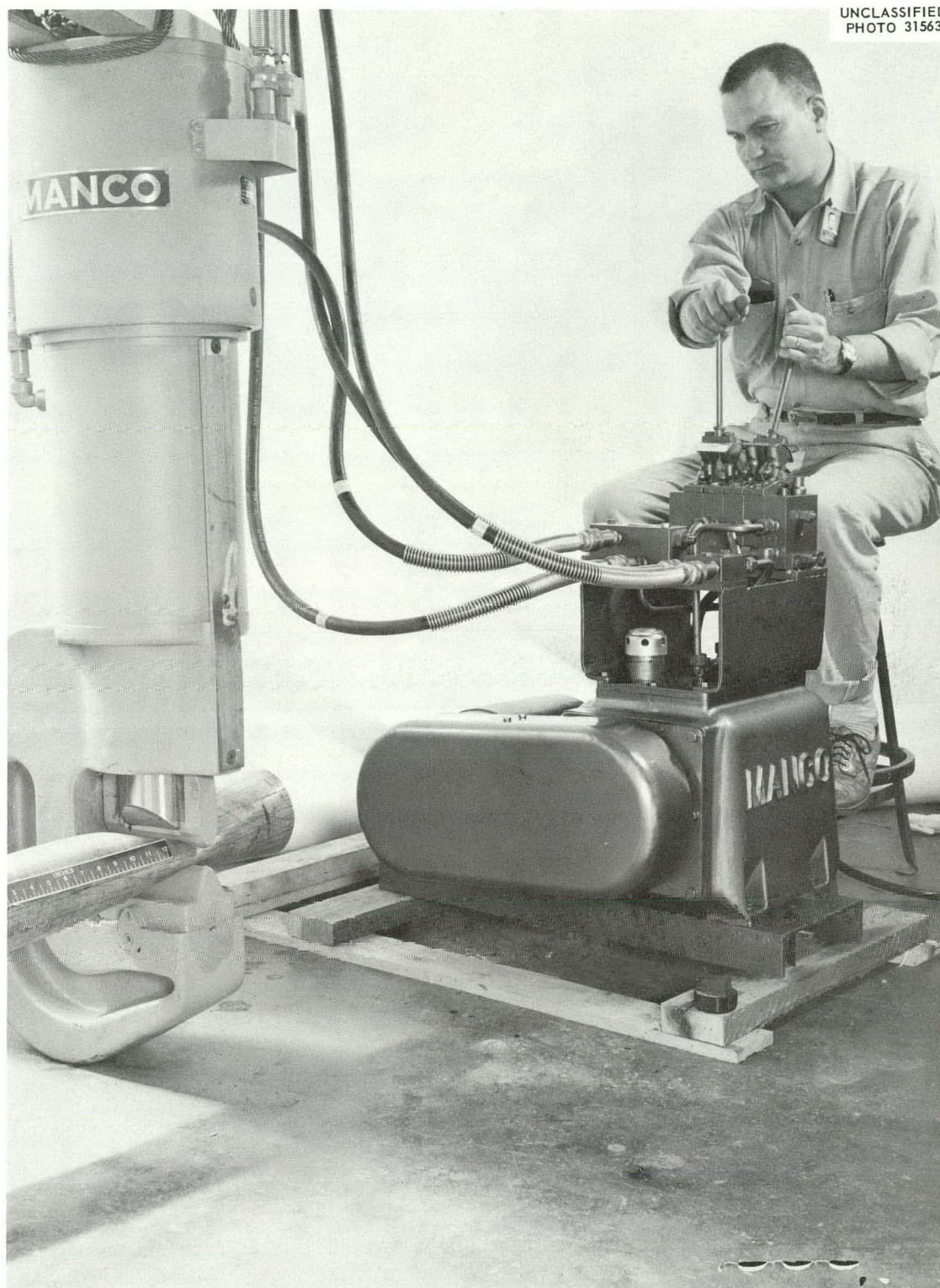


Fig. 3. The MC-125-DA Hydraulic Shear Cutting a 4-in. Sched.-40 Stainless Steel Pipe.



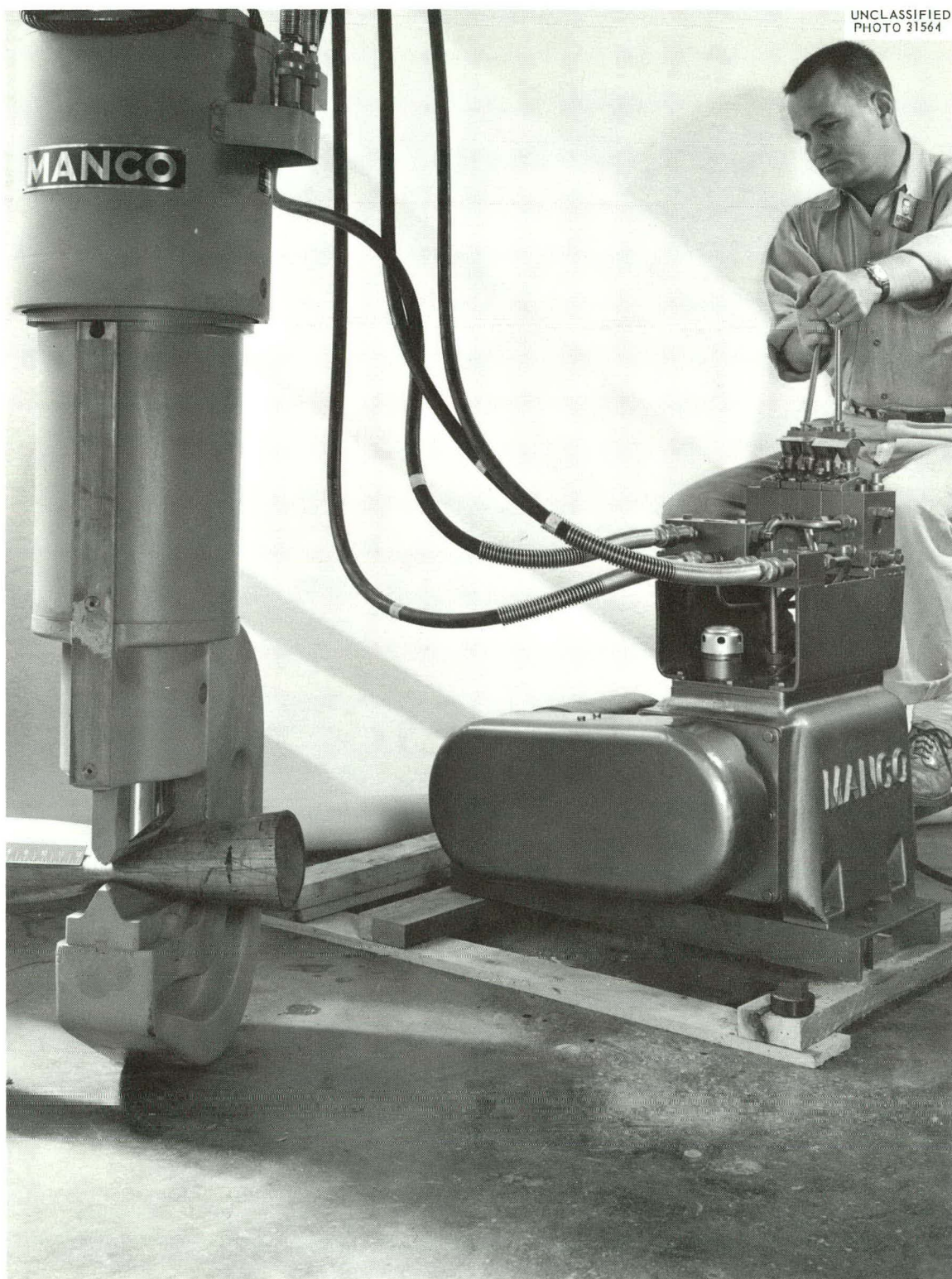


Fig. 4. The Shear Rotated on Its Own Axis to Demonstrate the Wrist Motion.

shear was made available for planned emergency removal of the Maritime test loop from the ORR. The shear has been used to develop a combined pinch sealing and shearing blade for use on ORR-GCR loop No. 2.

#### Description of Equipment

The Model MC-125-DA shear developed for ORNL is of the open-C-frame type with the 7-in. cutting blades capable of opening to 5 in. The shear is operated by an 8-in. double-acting hydraulic piston directly coupled to the moving jaw. Rotation about the principal axis is obtained by a hydraulic radial-vane motor mounted within the upper body. This arrangement provides a wrist rotation of 140 deg on each side of the center line for a total of 280 deg, with the shear mounted at any angle. At the upper end of the tool, a bolting circle has been provided for mounting, and four quickly detachable 1/2-in. hydraulic connections are used for the flexible driving-fluid lines. A schematic drawing of the equipment is shown in Fig. 5.

The same hydraulic supply system is used for rotation and for cutting. The pump is a motor-driven hydraulic unit with built-in relief valves, oil reservoirs, screens, control valves, and starter. The operating valves are mounted on top of the pump so that remote shearing is accomplished by placing the pump at a viewing station outside the test cell and running the hydraulic lines along or through the C-frame to the shear. The maximum pump pressure is 8800 psi.

A method for mounting the shear on a C-frame to permit the necessary maneuverability is shown in Fig. 6. Horizontal and transverse motions within the limits of the cell opening are obtained by direct crane horizontal travel. Vertical motion is obtained by normal crane lift. Limited radial movement about the vertical axis through the cell opening is possible by radial movement of the upper end of the C-frame while restraining the pivot point. The entire suspension is self-balancing. The crane mounting shown is designed to carry the shear in a vertical position. In case it is desired to mount the shear in the horizontal plane, it is necessary to remove the complete suspension from the cell, disconnect the 90-deg



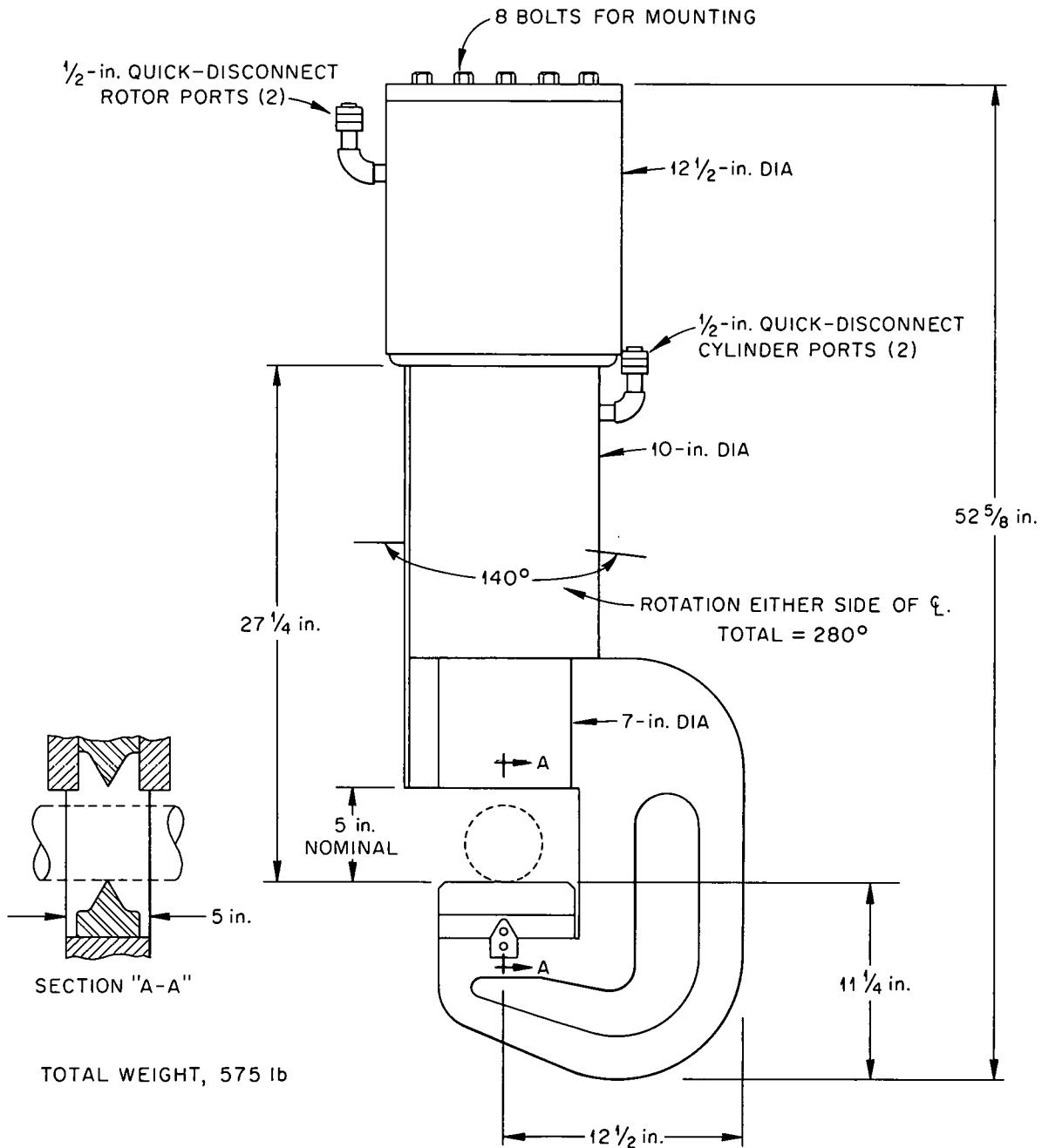


Fig. 5. Schematic Drawing of the MC-125-DA Shear.

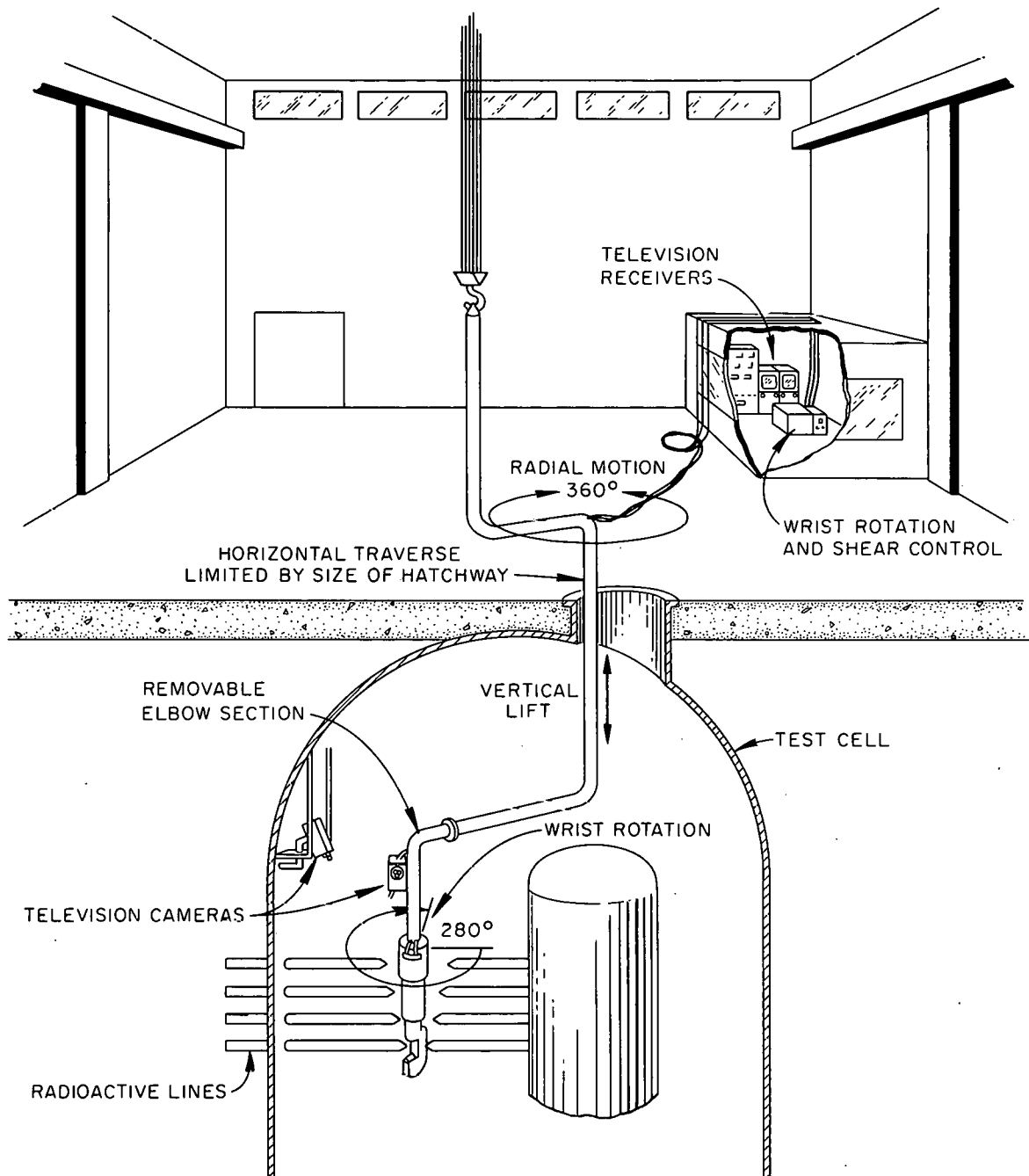


Fig. 6. Diagram of Shear Manipulation.

elbow section, and replace the shear. The television camera would be mounted on the C-frame arm in the same relative position for observing the cutting jaws.

In order to simplify placing the shear over the pipe to be severed in a remote location, a stainless steel slide has been provided along the front edge of the shear that extends down to the upper cutting blade. This is designed to permit the shear to be placed against the pipe at the point to be severed with a light load in the direction of engagement. Upon slowly raising the shear it will slide over the pipe as it comes into alignment. The external surfaces of this tool have been smoothed and painted to minimize contamination. The stainless steel slide is left unpainted.

#### Performance Tests

The shear was tested by the manufacturer, and a certified test report was submitted. The manufacturer severed 3 1/2-in. sched.-40 Inconel pipe and 4-in. sched.-40 steel pipe with hydraulic oil pressures of 4000 and 3500 psi, respectively. Later, the shear was set up at ORNL, and a piece of 4-in. sched.-40 stainless steel pipe was cut as shown in Fig. 7. The time required to perform the cutting stroke is 16 sec, while the return stroke is 12 sec. The full 280-deg wrist rotation requires 8 sec with an oil pressure of 950 psi. Views of the shear rotated on its axis are shown in Figs. 3 and 4. During recent sealing and shearing tests on 2 1/2-in.-IPS pipe, the pump pressure was increased to about 6500 psi.

#### Acknowledgements

The assistance of Earl Hoadley, Chief Engineer of the Manco Manufacturing Company, in the design and construction of the shear is acknowledged, particularly the idea of an internally mounted hydraulic motor to obtain the wrist movement. Charles Henley assisted in the test setup and operation of the shear. The review and helpful suggestions of D. B. Trauger and F. R. McQuilkin are also gratefully acknowledged.

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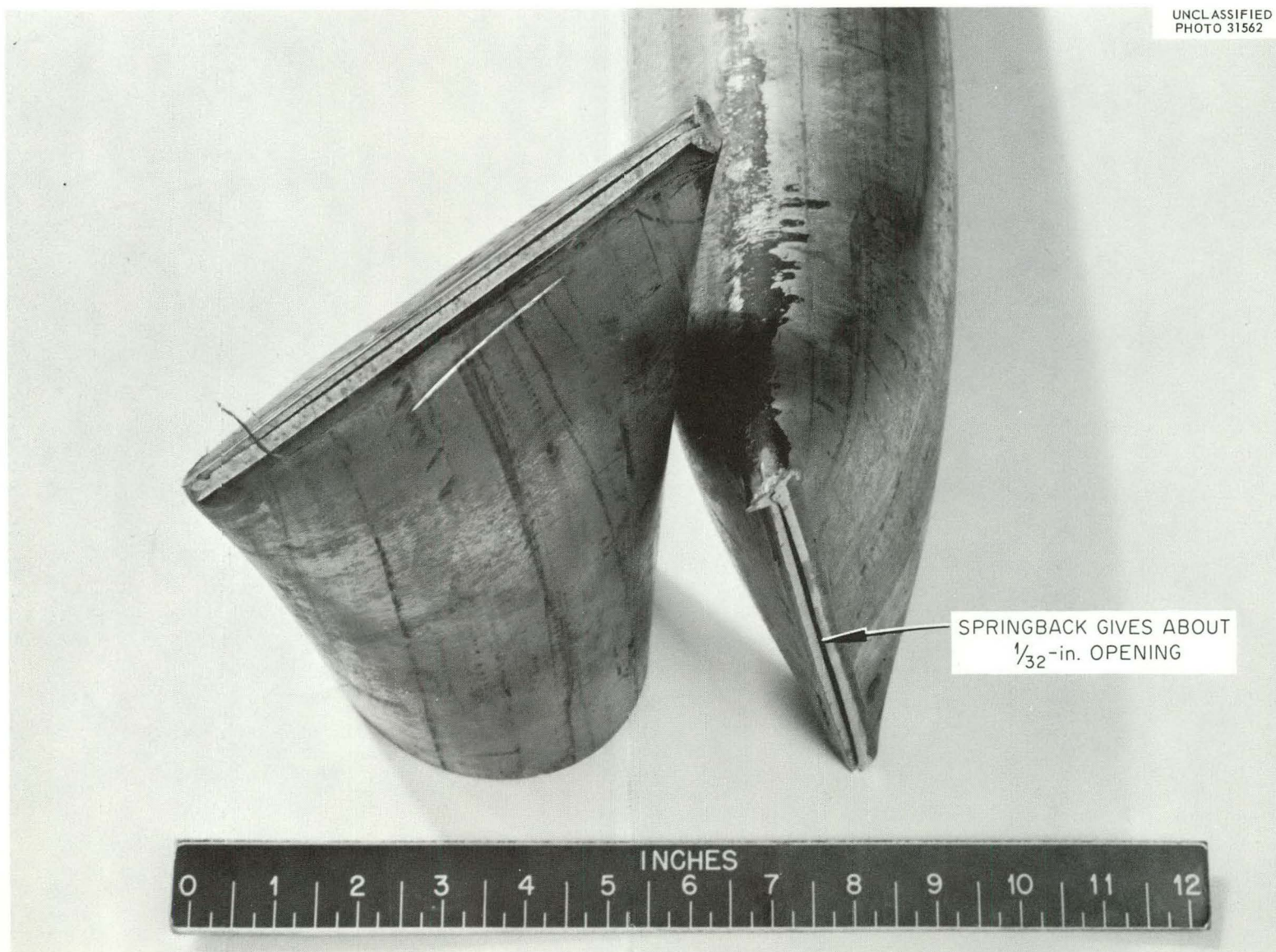


Fig. 7. Cut Section of 4-in. Sched.-40 Stainless Steel Pipe.



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