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REMOTE WELDING OF STAINLESS STEEL CONTAINERS

E. E. Pierce

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REMOTE WELDING OF STAINLESS STEEL CONTAINERS

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REMOTE WELDING OF STAINLESS STEEL CONTAINERS

E. E. Pierce

ABSTRACT

Equipment for sealing stainless steel cylinders containing radioactive materials by remotely operated—shielded-arc welding has been fabricated and successfully operated. The equipment consists of two portable units. One of the units, including a rotating chuck and electrode positioner, is operated in a cell equipped with model 8 master-slave manipulators. The power supply unit and control panel are of conventional design and are operated outside the cell. Containers varying in size from ¼ in. to 3 in. in diameter by 11 in. long may be sealed either by a side weld or an end weld.

INTRODUCTION

Radioactive sources, fabricated for commercial use, must have a dependable seal to prevent leakage of radioactive material from the capsule. Gasketing and soldering, the present methods of sealing, are satisfactory for most uses. However, requests for radioactive sources for use in high-temperature regions or in corrosive liquid media made it necessary to develop equipment for sealing sources by welding.

The Heliarc nonconsumable electrode process involving no deposition of filler metal is used for the following reasons:

1. The cell, which is equipped with model 8 master-slave manipulators,[1] is available for source fabrication and is used for several different operations resulting in frequent changes of equipment. Therefore, it is desirable that the remote portion of the device be portable, easily decontaminated, and simple to operate.

2. Because of the protection from the atmosphere, the Heliarc welds are stronger, more ductile, and more corrosion resistant than welds made with ordinary arc-welding processes.

3. The use of a flux is avoided, and thereby the possibility of the flux penetrating the container and causing corrosion is eliminated.

4. Type 316 stainless steel, which was selected for the source containers because of its weldability and its resistance to corrosion from chloride salts and the atmosphere,[2] presents no unusual metallurgical problems to the Heliarc process.

EQUIPMENT

Power Supply Unit

The welder consists of the following components: a standard power supply unit (Fig. 1), which is a Miller electric welding machine, model SR-200-A; a control unit, model SR-32-A; and an amperage control.

The model SR-200-A is a portable d-c welder, 220/440 v, with the following three welding ranges:

Range	Current (amp)
Low	5–95
Middle	10–180
High	37–335

The model SR-32-A control panel provides for automatic flow of water to cool the electrode and for a supply of argon to prevent oxidation during welding. It has a high-frequency stabilizer for arc initiation.

The current is regulated by either a foot control, model RFC-23, or a motorized control, model RMC-23. To prevent the formation of craters and pinholes, the control permits the current to be gradually decreased after the weld has been completed.

[1] E. Lamb, *Fourth Annual Symposium on Hot Laboratories and Equipment Held in Washington, D. C., Sept. 29-30, 1955*, p 312, TID-5280.

[2] H. H. Uhlig, *The Corrosion Handbook*, p 172, Wiley, New York, 1948.

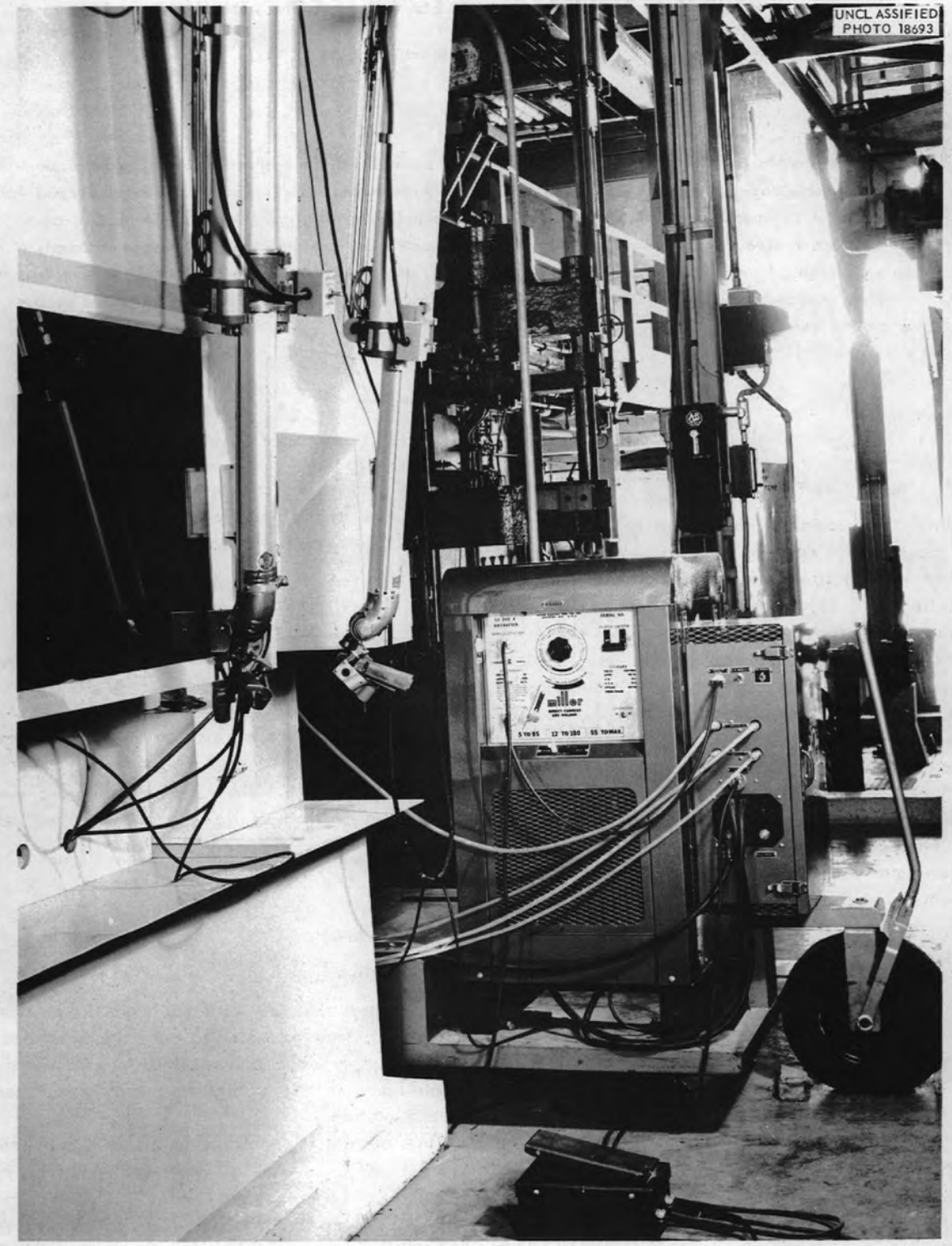

Fig. 1. Miller Welding Machine, Model SR-200-A, Control Panel Model SR-32-A, and Remote Control Switch.

Remotely Operated Assembly

The remotely operated portion of the welding device consists of a two-piece stainless steel frame, a motor-driven electrode assembly, and a motorized container holder.

The frame is constructed of stainless steel angles welded to form two sections. One section supports the electrode assembly and the container holder and is hinged to the other section, which serves as a base. This permits the welding of containers in either a horizontal position, Fig. 2, or a vertical position, Fig. 3. The base section is $36 \times 27\frac{3}{4}$ in., with lifting rings at each corner. The support section in a vertical position is 29 in. high; the assembly weighs approximately 100 lb.

The standard electrode holder used is a Machine Heliweld Holder No. 2302-2190 manufactured by Air Reduction Co., Inc. It is mounted on a movable arm that may be rotated from a vertical position to a horizontal position for making side welds on containers (Fig. 4). The 2% thoriated electrode is $\frac{1}{16}$ in. in diameter and has a needle-sharp point. The motor-driven electrode assembly consists of two reversible Bodine motors mounted on rack-and-pinion drives. These motors are used to position the electrode holder. Switches, located near the operating face of the cell, control the motors. In case of motor failure, extension handles, provided on the motor shafts, can be operated remotely by model 8 manipulators.

The motorized container holder consists of a 5-in. chuck mounted on a Graham model 20 W 30 variable-speed drive with a speed range of 0 to 40 rpm. The chuck is chromium-plated to prevent corrosion.

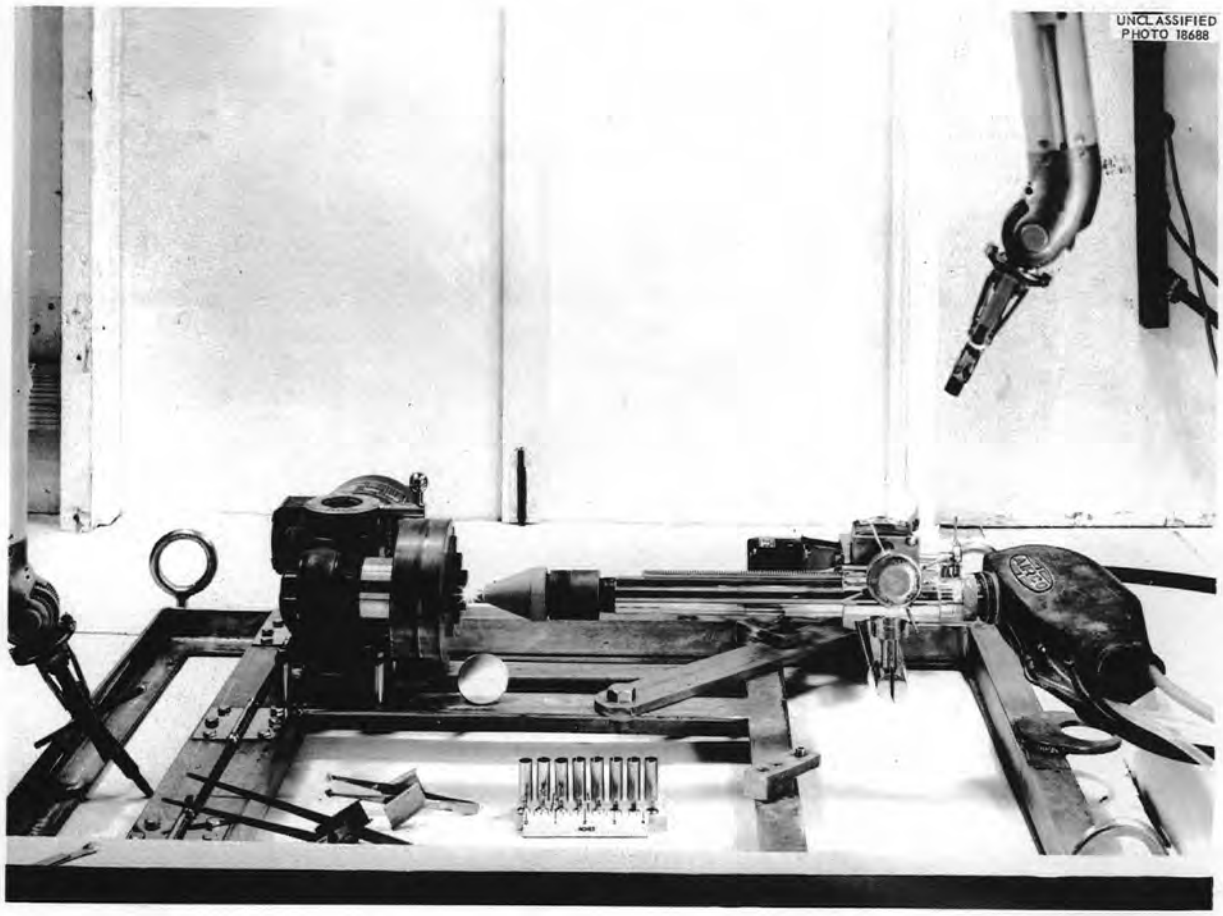

Fig. 2. Remote Welding Device Inside a Manipulator Cell with Containers and Electrode in Horizontal Position.

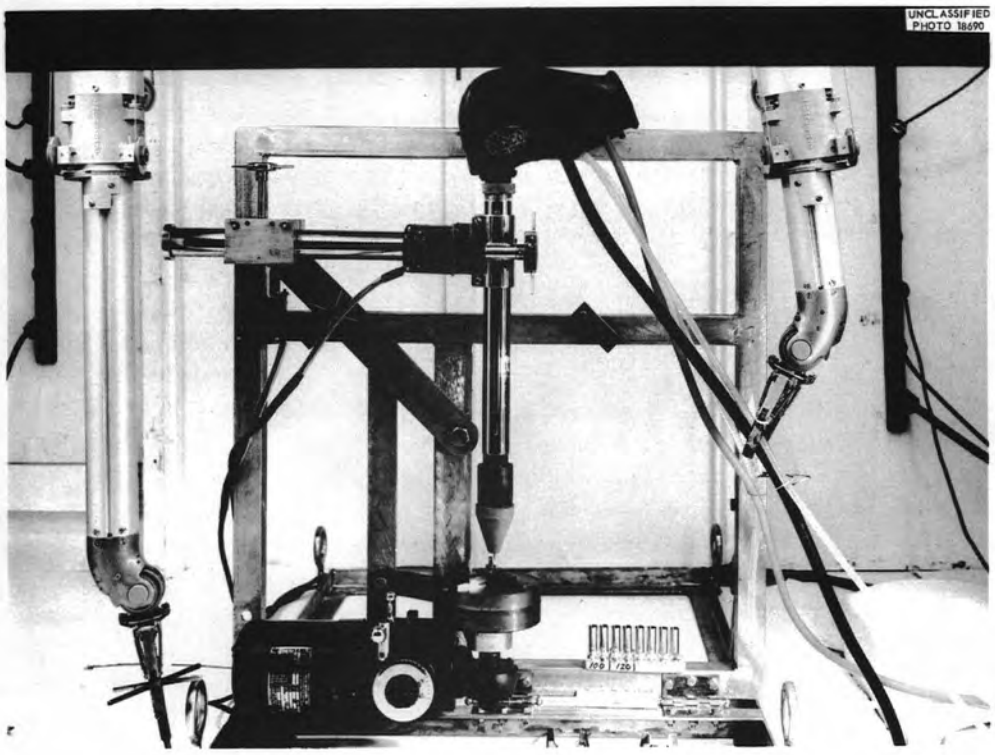

Fig. 3. Remote Welding Device with Containers and Electrode in Vertical Position.

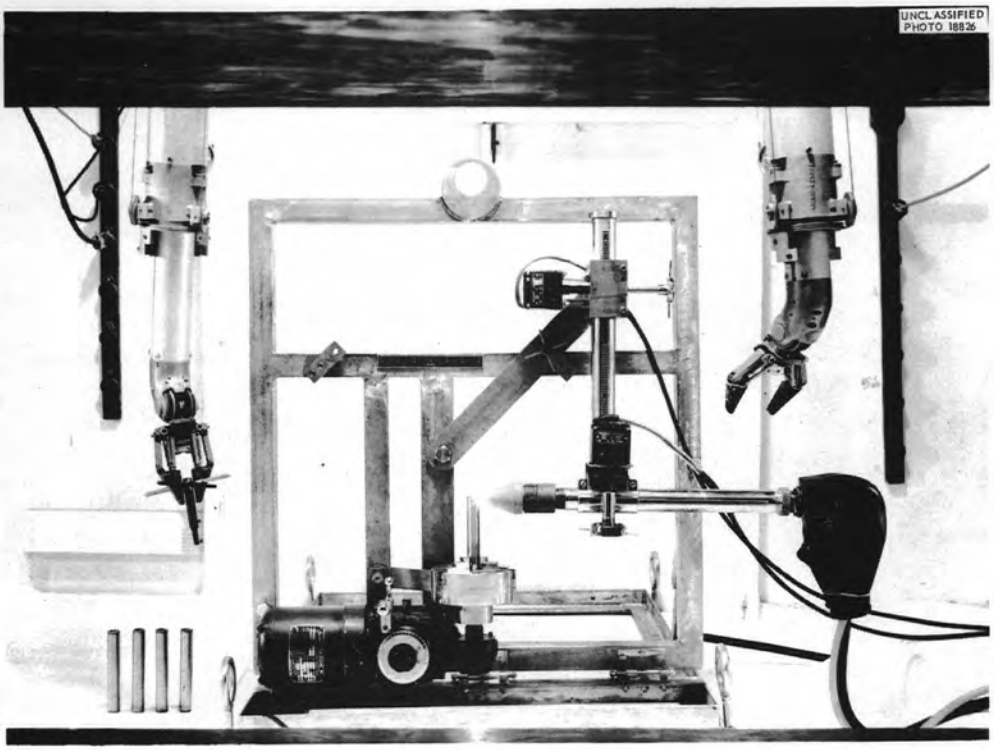

Fig. 4. Remote Welding Device with the Container Vertical and the Electrode Horizontal.

OPERATION

The model 8 manipulators are used to secure the container in the chuck. The speed of the rotator may be adjusted with the manipulators before the welding is started. The current to the rotator is controlled by a switch outside the cell.

The electrode is positioned by two Bodine motors that are controlled by switches located near the operating face of the cell. The motors operate at 6 rpm and are reversible. The positioning of the electrode prior to the welding operation is important and must be closely controlled. The container and electrode are observed through a monocular that has been modified for short-range viewing.

The welding operation is controlled by two switches. One switch starts and stops the rotator. The other switch energizes a motorized control which decreases the current at the end of the welding operation to prevent the formation of craters and pinholes.

Pure tungsten electrodes were received with the welding machine and were used during the first welding experiments. The arc was erratic, and the electrode became overheated, resulting in poor welds. A representative of the Miller Electric Mfg. Co. recommended that tungsten electrodes containing 2% ThO_2 be used. The throium oxide improves the current flow and reduces the temperature of the electrode during the welding operation. Satisfactory welds were obtained with the thoriated electrodes.

Experience has shown that the following conditions are important for successful welding.

1. The surfaces to be welded should be clean.
2. The material inside the containers should be dry.
3. There should be practically no clearance between the surfaces to be welded.
4. The containers should be purged with argon or helium prior to welding.

PERFORMANCE TESTS

Typical stainless steel containers that were filled with a nonradioactive compound and sealed by Heliarc welding are shown in Figs. 5 and 6. Several containers were tested and no leaks were detected. (The containers consist of two parts: one is a cylinder into which a plug is inserted and sealed by welding; the second is a stainless steel jacket into which the first cylinder is placed and sealed by welding a plug fitted with a handling post, shown in Fig. 5, into the top of the jacket. The containers shown in Fig. 6 may be used as a single unit, or multiple units may be arranged in an assembly for use as an irradiation facility.)

Figure 7 is an enlarged photograph of a cross section of a weld made on one of the small containers shown in Fig. 5. The thickness of the concontainer wall is 0.020 in. The curved line in the weld near the top of Fig. 8 is a result of the tapering feature of the welding machines. This reduces the formation of craters and pinholes which may occur when the current is quickly decreased. The container is type 316 stainless steel, and the plug is made of type 410 stainless steel, which is magnetic.

Linear welds up to ½ in. long were made with this equipment by rotating the pieces to be welded on the periphery of a 5½-in.-dia cylindrical holder designed to accomodate 18 containers. Thirty-four sources containing radioactive cobalt have been welded and leak-tested. Thirty-three of these were successful.

Experience gained from operating this equipment indicates that radioactive materials can be sealed in stainless steel containers by remote welding.

ACKNOWLEDGMENT

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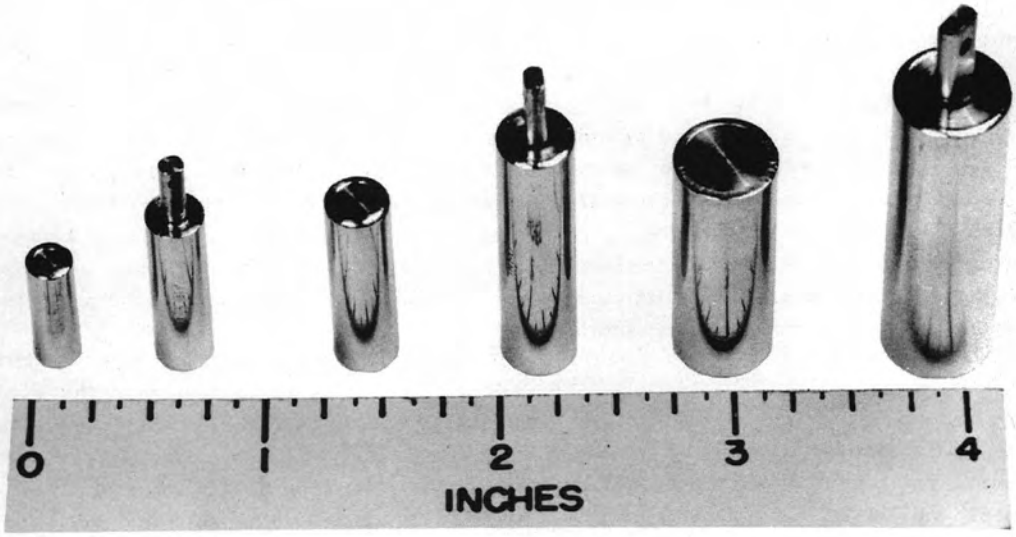

Fig. 5. Containers Sealed by Remote Welding.

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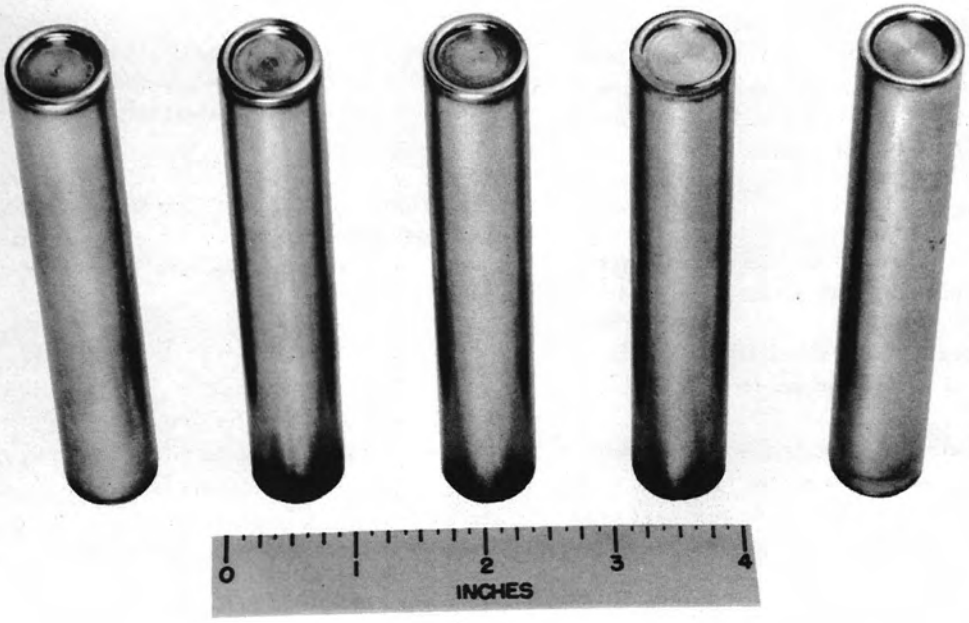

Fig. 6. Containers Sealed by Remote Welding.

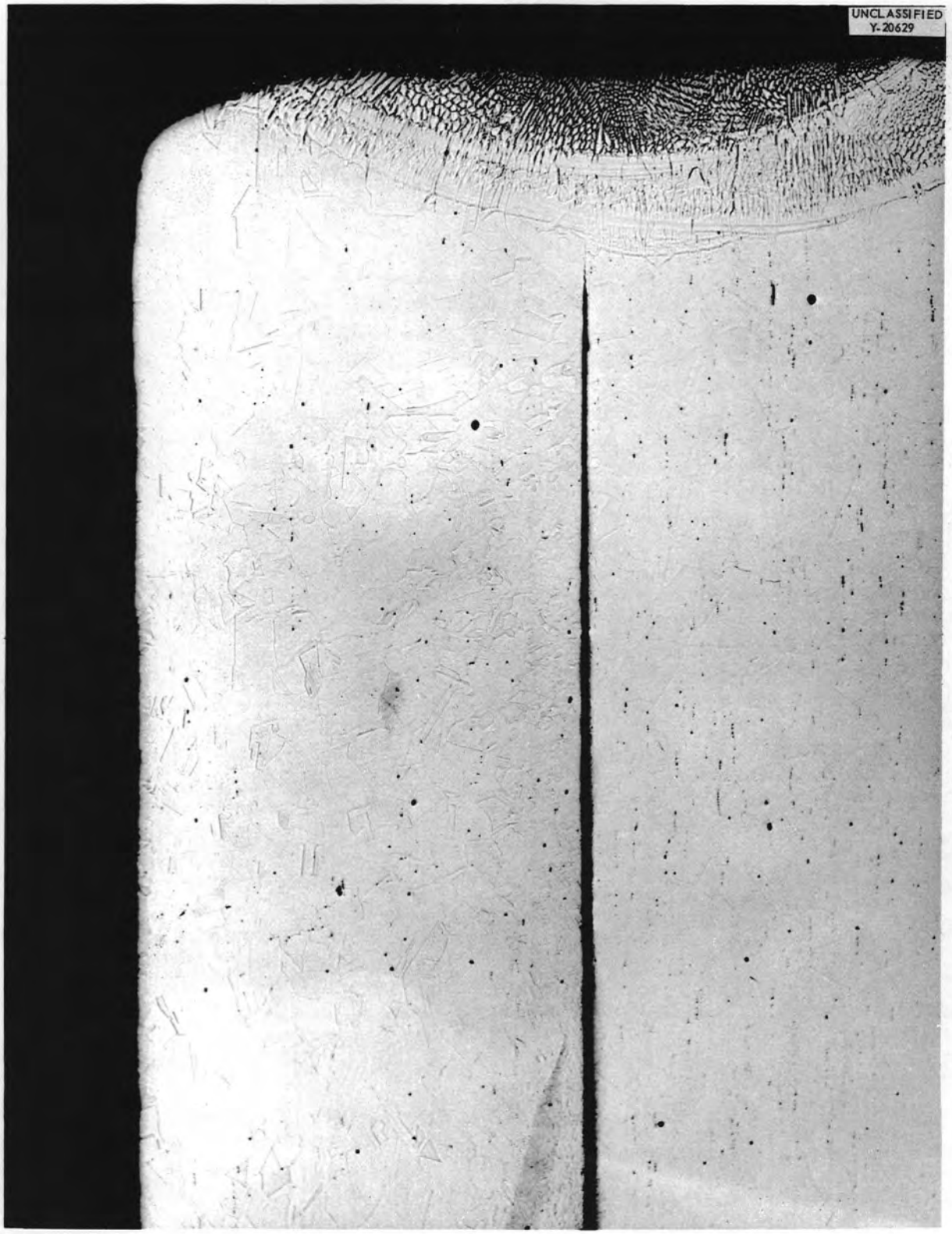

Fig. 7. Cross Section of a Weld on the Inner Container of a Unit. 100X. Reduced 20%.

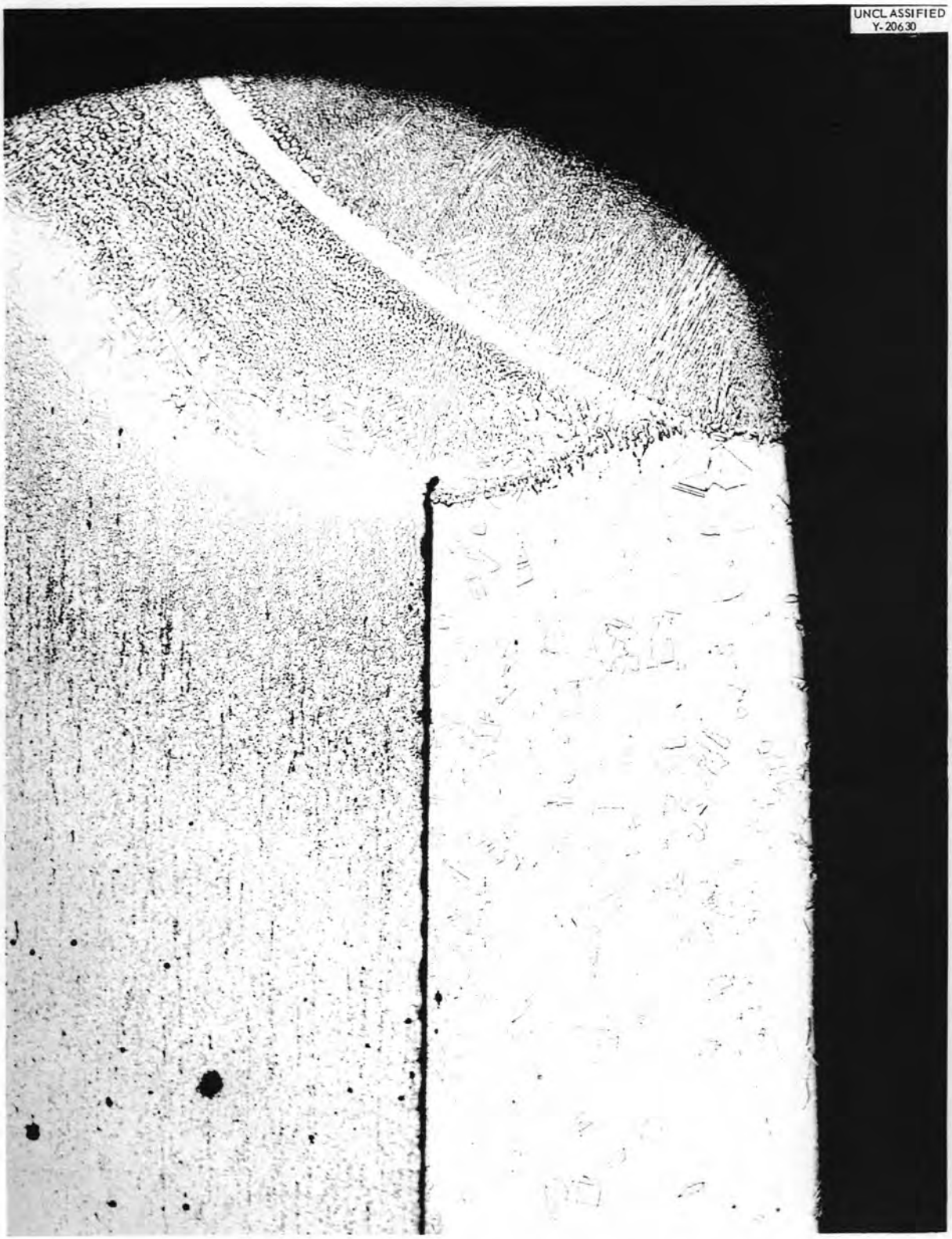

Fig. 8. Weld on the Outer Container of a Teletherapy Source. 100X. Reduced 20%.