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O T T A W A January 24th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1583.

(Subsequent to Reports of Investigations Nos.
1532 and 1540, November 13th and 25th, 1943.)

Examination of Welds Cut from Compressed Air Reservoirs C. Mk. 1A (E. Leonard & Sons, London, Ontario).

(Copy No. 10.)

Bureau of Mines
Division of Metallic Minerals

Ore Dressing and Metallurgical Laboratories

CANADA
DEPARTMENT OF MINES AND RESOURCES
Mines and Geology Branch

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Introduction:

The above-mentioned previous investigations revealed that the welds contained numerous serious defects. The defects found were photographed and reproduced in reports. The probable causes, and recommendations for the elimination of these defects, were given.

The present investigation covers the examination of samples submitted on January 4th, 1944, by Mr. Ian McMillan, Inspector of Carriages, Inspection Board of United Kingdom and Canada, Ottawa. In his covering letter* Mr. McMillan gives the following information:

> "The various defects found have been brought to the attention of the manufacturer. As a result of this, and using your information as a guide, he has now presented various samples which represent his best endeavour to produce a satisfactory welded reservoir. These samples are handed to you with the request for your opinion on them."

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* File No. ARM:5448, 4/9/15 E. Leonard.

Object of Investigation:

(1) To examine the welding of the samples and evaluate the suitability of the procedure employed.

(2) To make recommendations to improve the welding practice, if this is necessary.

PROCEDURE:

(1) All six samples were given a thorough visual examination and were photographed "as received". The samples were lettered for purposes of identification. Samples identified as A and B consisted of one piece comprising approximately one-half of the end of a reservoir.

Figure 1 shows the outside of weld of Sample A, and Figure 2 the outside of weld of Sample B. Figure 3 shows the inside of weld of Sample A, and Figure 4 the inside of weld of Sample B. Figures 5 and 6 illustrate the appearance of the insides of welds of Samples D, E, F, and G. In all cases the white retangles show the locations from which macro samples were machined.

(2) All samples were subjected to an x-ray examination at the National Research Council, Ottawa. Figures 7 to 11 are reproductions of the exographs. In examining these reproductions, it should be borne in mind that there is an inevitable loss of sensitivity in the reproduction process and that the colours are the reverse of the exograph itself.

(3) Macro samples were machined from the areas showing typical defects. Figures 12 to 15 show the cross-sections of these samples after polishing and etching.

DISCUSSION:

A visual examination of the samples indicated the presence of the following defects: high piled-up welds, lack of penetration, lack of fusion, shrinkage cavities, improper alignment of plate edges to be welded, improper edge preparation, gas inclusions, and faulty welding sequence.

The presence of these defects was confirmed by the radiographic and macro examinations. As explained in previous reports, these defects act as stress raisers and as such seriously impair the impact and tensile strengths of the welds. The probable causes of the defects, together with recommendations for their elimination, have already been given and there would seem to be no useful purpose served by their repetition in this report.

While it is true that there has been some improvement in the welding of these samples over the material previously examined, it is our opinion that the welding is still unsatisfactory. The defects found point to the continued use of an unsatisfactory welding technique, in spite of the fact that it has been shown to be productive of serious defects.

CONCLUSIONS:

1. The following welding defects were found: high piled-up welds, lack of penetration, lack of fusion, shrinkage cavities, improper alignment of plate edges to be welded, improper edge preparation, gas inclusions, and faulty welding sequence.

2. It is apparent that recommendations previously submitted for the improvement of the welding technique have not been followed.

3. The examination shows that there has been some improvement over material previously examined, but the welding is still unsatisfactory for this reservoir.

(Continued on next page)

(Conclusions, cont'd) -

4. No useful purpose can be served by repetitive examinations of material welded with continued indifference to good welding practice. The entire assembly should be re-examined at the manufacturer's plant and the operations completely revised.

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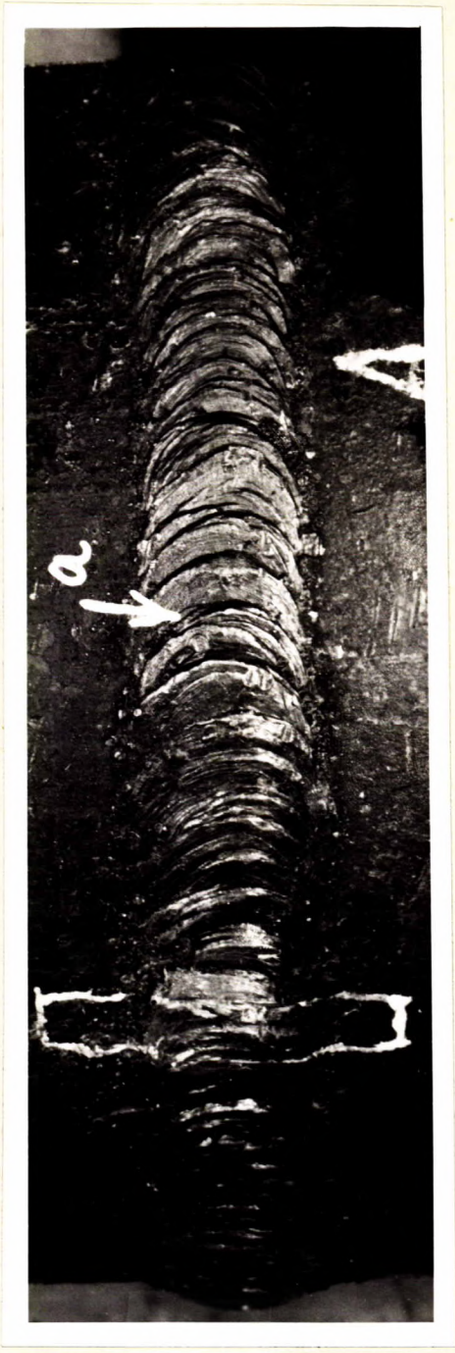

OUTSIDE OF WELD OF SAMPLE A.

Arrow 'a' points to a high spot in the weld. The white rectangle indicates an area from which a macro sample was machined. Note the irregular weave pattern.

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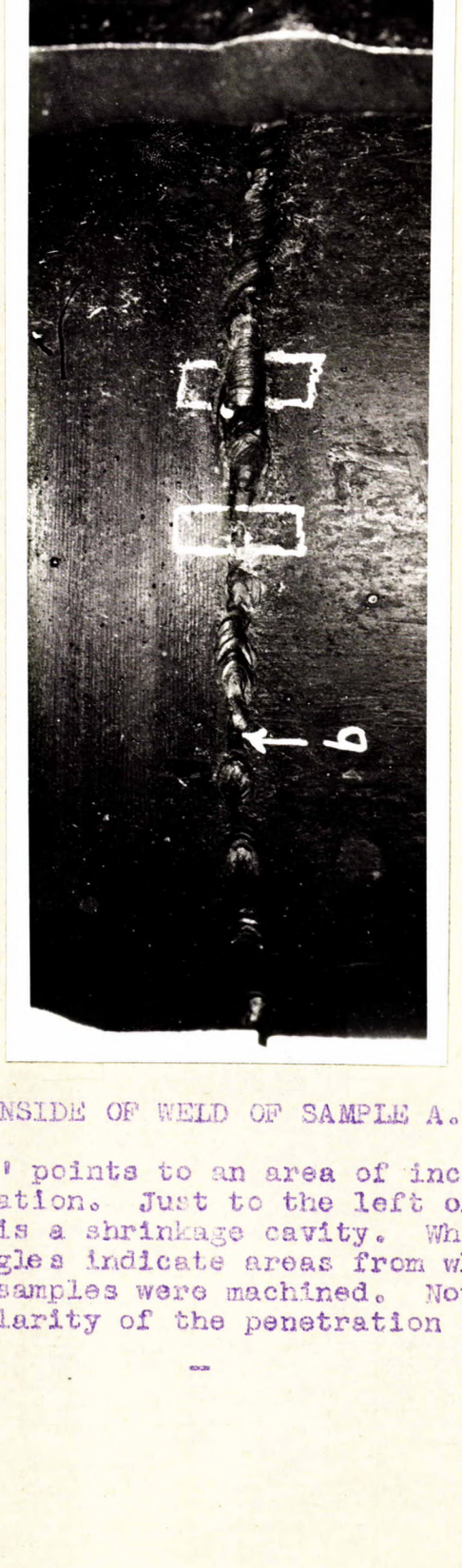
Figure 2.

OUTSIDE OF WELD OF SAMPLE B.

Arrow 'a' points to a high spot in the weld. The white rectangle indicates an area from which a macro sample was machined. Note the irregular weave pattern.

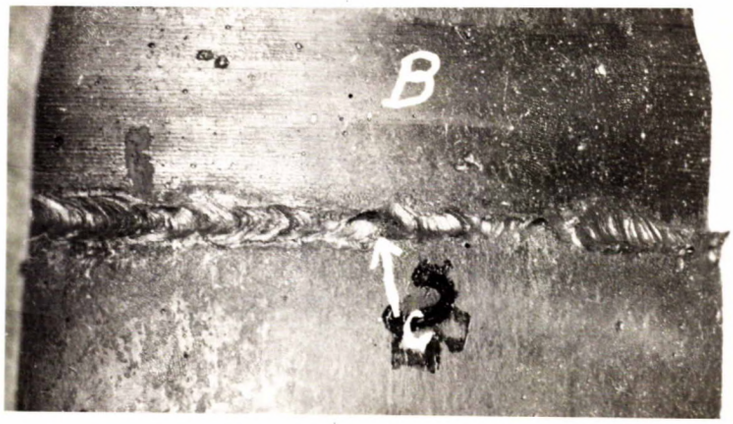
Figure 3.



INSIDE OF WELD OF SAMPLE A.

Arrow 'b' points to an area of incomplete penetration. Just to the left of this arrow is a shrinkage cavity. White rectangles indicate areas from which macro samples were machined. Note the irregularity of the penetration secured.

Figure 4.



INSIDE OF WELD OF SAMPLE B.

Arrow 'c' points to a shrinkage cavity.
Note the irregularity of the penetration secured.

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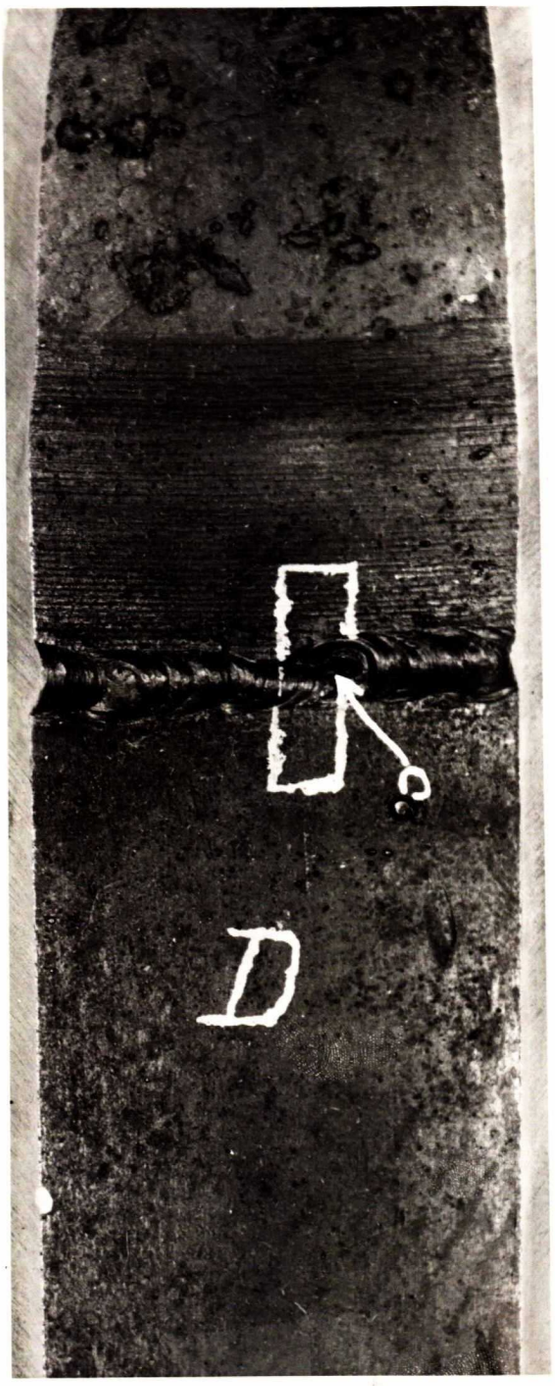
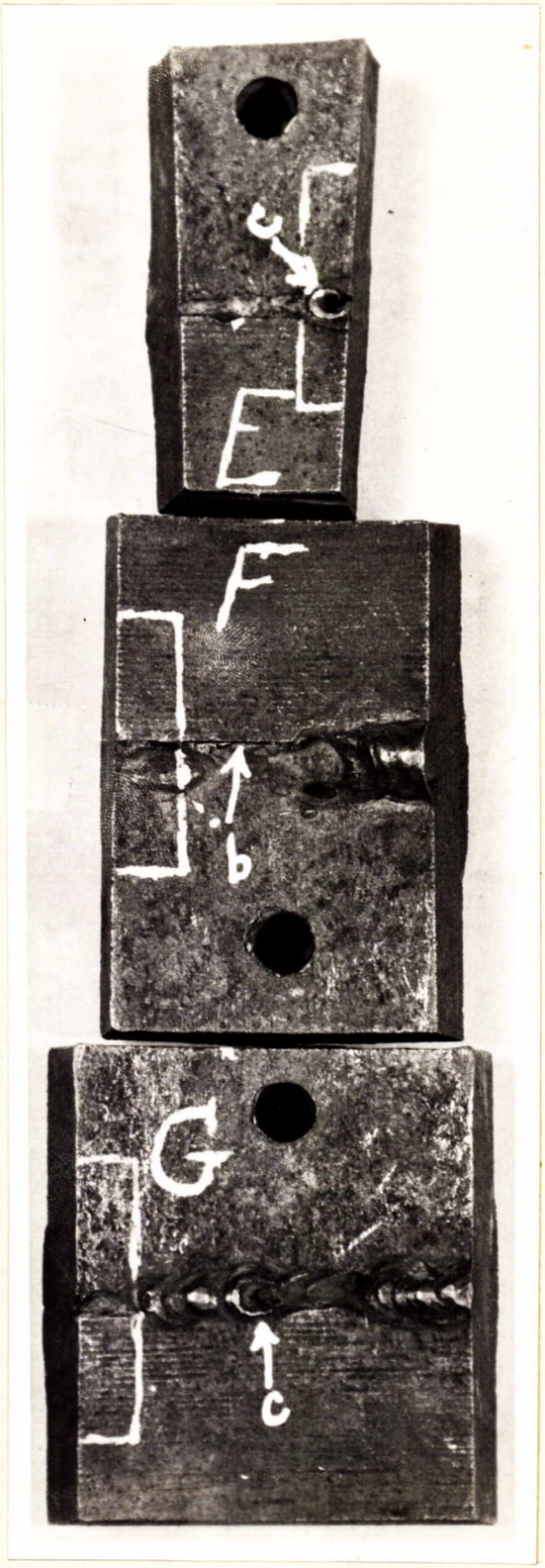
Figure 5.



INSIDE OF WELD OF SAMPLE D.

Arrow 'c' points to a shrinkage cavity.
White rectangle indicates area from
which a macro sample was machined.

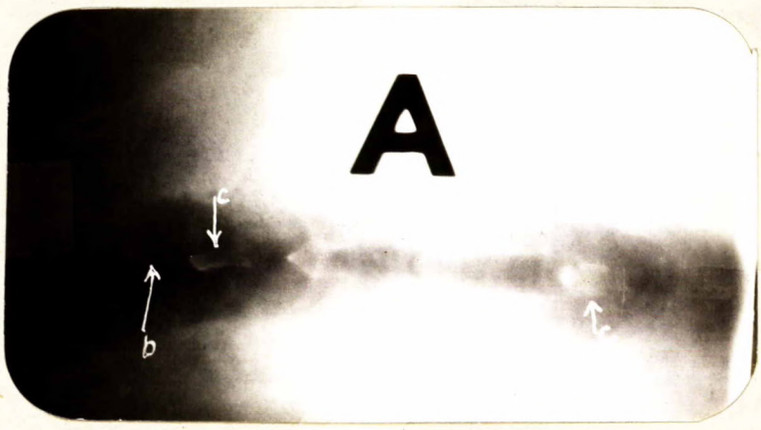
Figure 6.



INSIDES OF WELDS OF SAMPLES E, F, AND G.

Arrows 'c' point to shrinkage cavities. Arrow 'b' points to area of incomplete penetration. White rectangles point to areas from which macro samples were machined.

Figure 7.



REPRODUCTION OF EXOGRAPH OF
WELD A OF SAMPLE A.

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Figure 8.

REPRODUCTION OF EXOGRAPH OF
WELD B OF SAMPLE B.

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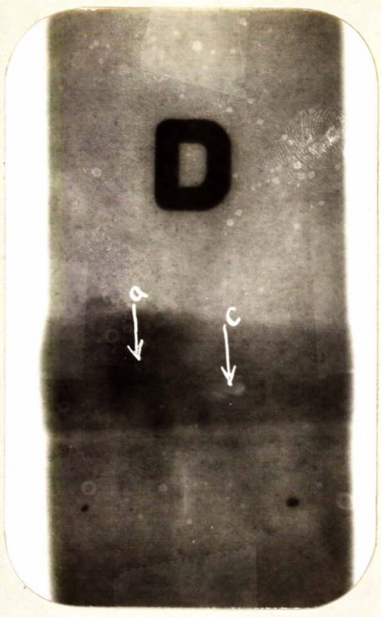
(Legend: a - lack of fusion.
b - incomplete penetration.
c - shrinkage cavity.
e - slag inclusion.)

Figure 9.



REPRODUCTION OF EXOGRAPH OF
WELD OF SAMPLE D.

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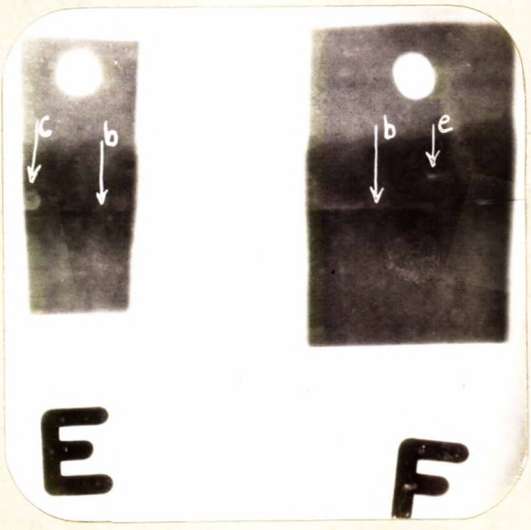
Figure 10.



REPRODUCTIONS OF EXOGRAPHS OF WELDS
OF SAMPLES E AND F.

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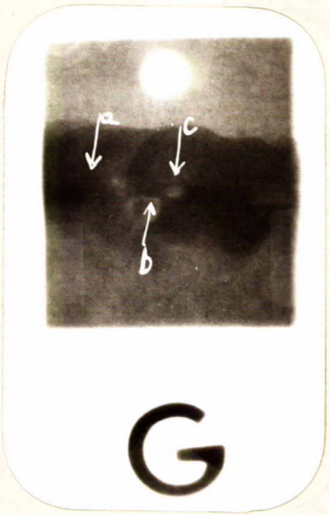
Legend: a = lack of fusion.
b = incomplete penetration.
c = shrinkage cavity.
e = slag inclusion.

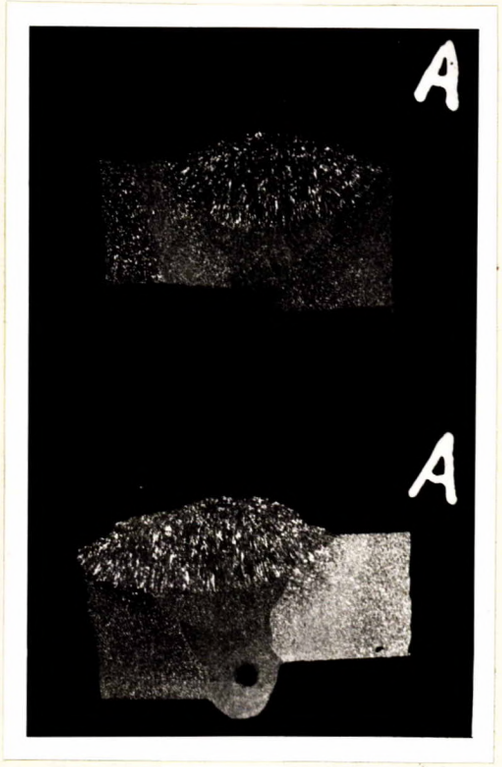
Figure 11.



REPRODUCTION OF EXOGRAPH OF
WELD OF SAMPLE G.

(Legend: a - lack of fusion.
b - incomplete penetration.
c - shrinkage cavity.
e - slag inclusion.)

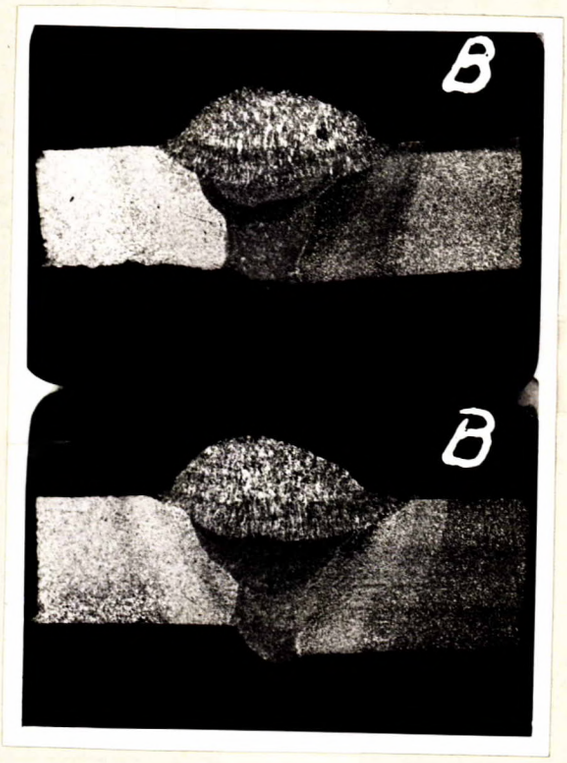
Figure 12.



TWO MACRO SECTIONS OF WEID OF SAMPLE A.

Note gas inclusions and improper alignment of plate edges to be welded. Bottom section shows improper edge preparation.

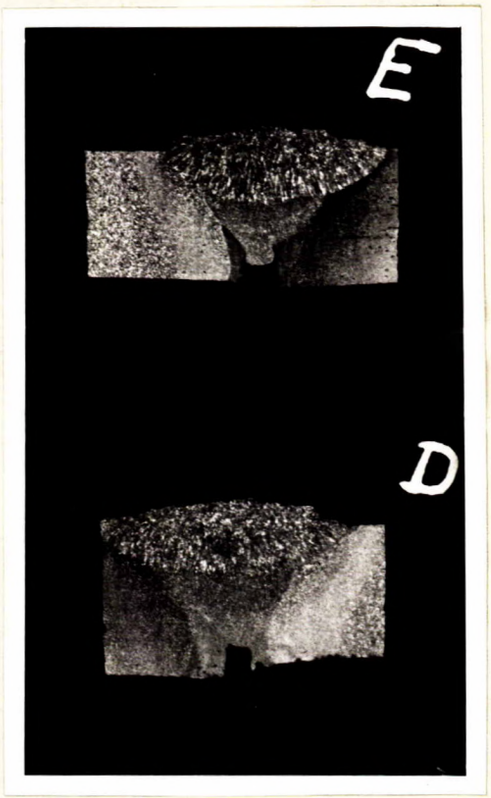
Figure 13.



TWO MACRO SECTIONS OF WELD OF SAMPLE B.

Note high piled-up welds, improper edge alignment, and improper edge preparation.

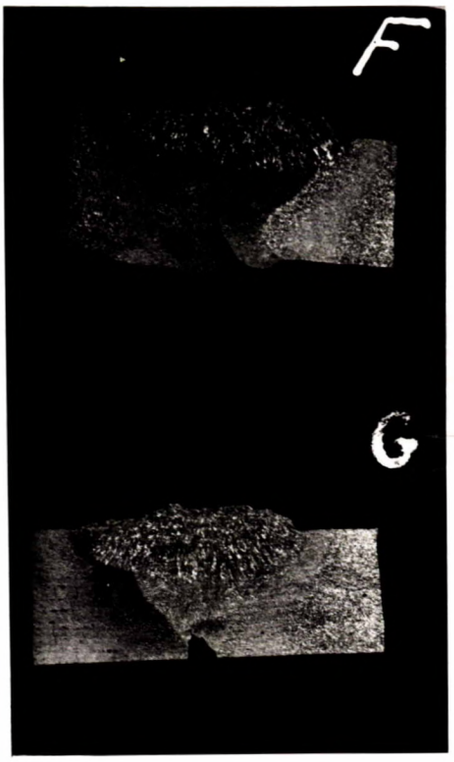
Figure 14.



MACRO SECTIONS OF WELDS OF SAMPLES D AND E.

Note incomplete penetration.

Figure 15.



MACRO SECTIONS OF WELDS OF SAMPLES F AND G.

Note incomplete penetration. Top sample shows lack of fusion along lower scarf face and improper edge alignment. Edge preparation of both incorrect.

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