REPLACEMENT OF QUAD CITIES NUCLEAR POWER STATION SBGT SYSTEM CHARCOAL ADSORBER TRAYS

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ABSTRACT

Quad-Cities is a two-unit BWR which went on-line in the early 70's. The Standby Gas Treatment Systems (SBGTS) are dual-train units with each train rated at 4000 cfm. This equipment was designed, installed, tested and made operational prior to the implementation of Reg. Guide 1.52, ANSI/ASME N509, and ANSI/ASME N510.

This "pre-Reg Guide 1.52" system was based on a "side-load" style Type II tray with the unusual feature of having two sealing surfaces at 90 degree angles from each other; the "inside" sealing surface mated to the inlet face of the mounting frame to prevent bypass leakage and an "outer" sealing surface to prevent in-leakage from outside the housing. The "outer" surface` also served as the "door" or "cover" plate for the unit. Achieving a seal was further complicated in that the "clamping" mechanism is "shared" in sets of three filters (to "seal" to the mounting frame). However, *each* filter was captured and "sealed" to the system skin individually. In addition, two trays in each train were modified to serve as "sample canister" holders. Therefore, obtaining surveillance carbon samples required "breaking" the seal (for 3 filters) and necessitated a halide leak test after resealing. This unconventional system design caused many problems. To get both sealing surfaces to seat well often caused the trays to twist out of shape. Often only one of the sealing surfaces really sealed well. If the outside sealed well then there was a likelihood of bypass leakage and, conversely, if the inside sealed well there was a strong possibility of in leakage. In the 1980's this tray design became obsolete and could no longer be purchased. In 1991 it was decided that we would find a replacement tray.

NUCON designed a side-loading Type II tray that would seal only on the inside then designed a door to go over the trays and become the outside sealing surface. The new trays met the seismic qualification with no need for new supports and with little change to the clamping mechanism. The new trays were installed and tested in 1994 and no problems have been reported since.

1 INTRODUCTION

Quad-Cities is a two-unit Boiling Water Reactor whose Standby Gas Treatment Systems (SBGTS) are Barneby-Cheney (B-C) dual-train units with each train rated at 4000 cfm. As Quad Cities start-up date was the early 1970's, the SBGTS were designed, installed and operational prior to the implementation of Reg Guide 1.52, ASME N509, and ASME N510. Each SBGTS train contains a 2" deep charcoal adsorber bed which is designed to remove 90% of the methyl iodides after a design basis accident. One train is designed to run for 30 days post-accident and the other train is a backup.

Prior to 1994, the SBGTS charcoal adsorber units consisted of 12 Barneby-Cheney Type II side-loading trays (Model FC). Each tray contained a 2" bed of Potassium Iodide impregnated carbon. This design has the unique feature of having two sealing surfaces at 90 degree angles. The inside sealing surface was used to prevent bypass leakage around the trays in the air flow direction. The outer sealing surface was to prevent inleakage from outside the train. There was no door on the charcoal adsorber unit. The trays acted as both a tray and a door at the same time. It is this unique sealing surface that caused most of our problems.

Some of the problems with this design were:

A) If both sealing surfaces were tight it often warped the trays making it more difficult to repair or refurbish them.

B) If the outside surface sealed, then the inside surface usually did not and that meant failure of the halide bypass leakage test.

C) If the inside surface sealed well, then the outside surface "hissed" because it was not sealed and had inleakage.

D) In the 1980's the Barneby-Cheney Type II tray design became obsolete and replacement trays could no longer be obtained.

E) Because of the warpage problem many of the trays that we sent back to be filled and refurbished had to be scrapped because they were beyond repair. This situation left us with fewer and fewer spares as time went on.

2 OPTIONAL SOLUTIONS

Quad Cities considered several options to solve the charcoal adsorber tray problems. Among the options were: living with the existing tray design, replacing the entire SBGTS system, or replacing the trays with a new design. Living with the existing tray design would not last long at the rate we were losing trays because of the warping and the age of the trays. In 1991 we had just a few more than a full set of spare trays. We could borrow some spare trays from our sister station, Dresden, but they were facing the same problems we were. If we wanted to exercise this option in the future it would involve paying a large sum of money to a contractor to build some replacement trays for us. Once the trays were built they would have to be "blessed" by Stores and Quality Verification so they could be used in a safety related application. If we were successful in getting the trays made and blessed we were still faced with the same sealing problems as before. The station decided the time and money could be better spent elsewhere.

Replacing the entire SBGTS system was also considered. This option would bring the Standby Gas Treatment System up to the new standards for nuclear air treatment filtration systems in Regulatory Guide 1.52 and ANSI/ASME N509 and N510. The first cost estimates came in at $1 million per train. There would be additional costs for engineering, seismic calculations, and labor. Replacement of the entire train was not considered cost effective and was eliminated as an option.

The remaining option was to replace the existing trays with a new design. In 1991, NUCON sent a sketch of a new tray design that would work in our application with little or no change to the structure of the train. The cost estimate for the new tray design was approximately $20k per train. Since there were to be no major changes to the existing SBGTS train housing, engineering and seismic calculations would be minimized.

3 MODIFICATION PROBLEMS AND SOLUTIONS

Among the problems encountered during the design process were seismic issues, fabrication, tray installation and bolting. The first considerations were the seismic issues. Typically, when a design change is done, the structural engineer will go back to the original seismic calculation, review the assumptions and identify the differences between the original and the new design. In this case the documentation for the original seismic calculation for Standby Gas Treatment Systems was minimal and did not give the structural engineer enough to work with. The structural engineer had to start by literally redoing the original seismic calculation and then proceed from there. This extra calculation added cost to the original cost estimate and the time-line for the tray replacement. In addition, several Standby Gas Treatment System supports were removed and redone during the early 80's because of an NRC Information Notice. Finding documentation for these changes further complicated seismic calculations. After much research and discussion with NUCON the seismic calculations were complete and only required a few bolts to be added to the existing Standby Gas Treatment supports.

The second major problem was the fine details of the fabrication of the trays. Things that needed to be considered in the tray design were how to stop the trays from going in too far, where to put the sample canisters to allow for ease of removal, and how to fit two doors on each side of the system housing yet allow for enough of a flange for clamping the door so as to seal properly. Because the old tray design was a tray and door in one, the outer lip acted as a stop so the tray did not go in too far thus properly aligning itself with the corresponding mounting frame air slot. There was no "stop" inside the train and the trays had to match the internal air flow path or there would be air flow blockage. The new tray design, with no outer lip or stop, would go in too far. It was decided to put a small stop lip on one side of the tray to prevent that. Another important issue was where to put the sample canisters to allow for ease in removal for testing and still have canisters exposed to representative air flow. In the old tray design the sample canisters were an integral part of a modified version of the trays with two installed per train. To remove the sample canister, the tray had to be completely removed from the train, the sample canister unbolted and a cover plate (blank-off) put in its' place. When the tray was removed the internal tray gasket usually had to be replaced as well because the neoprene had "set." And, due to the shared clamping design, the seal of two adjacent trays was disturbed. This practice involved a lot of time and extra maintenance. The new sample canister tray was designed with the sample canisters on the outside in the air flow stream of the tray. The sample canisters were under the same superficial air flow conditions as the rest of the carbon in the tray. To remove a sample canister one housing door is removed, a canister unscrewed and a plug put in its place. So as not to diminish air flow, a replacement canister can be installed provided it is tagged or marked so it is not used for subsequent testing. This was a much simpler operation than the old tray design.

The third issue was the design of the doors. There were to be two doors on each side, with each door covering three trays. A tab with a hole in it was put at the top of each door to prevent the door from slipping down. The tab hole went in the first bolt on each side of the three tray bolting arrangement. Between the two doors on each side is an area that measures approximately 2". In that space we needed to fit a bolt, two door lips and a clamp for the doors. The doors were designed with a curled up lip that measured a mere ¼".

Another problem encountered during the tray design was tray installation and bolting. The individual trays would be secured mostly by the internal spring clamp. This clamp would ensure that the trays were pushed up and sealed internally. However, taking into account external vibration we needed to put a small clamp on the outside of the trays. This clamp had to be put between the tray slots so as to not interfere with the door clamping. The space between the tray slots measures approximately 1". The tray clamping was accomplished by two pieces of metal, a washer and nut. The bottom clamp had a long slot in it to allow it to slide along the bolt while the top clamp kept the bottom piece in place and the washer and nut secured the whole system. This clamp was used for two trays.

The internal clamping mechanism of the charcoal adsorber unit was a spring clamp that pushed the trays into the internal sealing surface. The clamp is activated by a swing arm on the outside the train. This arm generally swings toward the trays when it is engaged and away from the trays when not engaged. Because of the door on the new tray design, this arm had to be extended.

Early in the design process there were discussions on modifying the internal clamping mechanism to clamp each tray individually, rather than three at a time. The individual clamp would eliminate two concerns; namely, the possibility of an uneven internal sealing surface and concern whether two of the trays seal but the third one does not. This individual clamp idea was dropped because of the station's position on the ASME N509 and N510 standards. The major concern was that if the clamp was modified then it and the entire charcoal adsorber area would have to be brought up to current standards.

The next step in the design process was to plan the replacement. Planning the replacement required a SBGTLCO. The Technical Specifications allow a 7 day LCO, but station policy allows you to plan only 2/3 of the LCO time. A 4 day time frame was planned to include OOS, removal of old trays, cutting off the old clamping and bolts, welding on new bolts, installing new trays, installing new clamping, installing the new door and door clamping, the return to service, DOP and Freon testing and finally a 10 hour operability run.

The "A" SBGT train was taken out of service on February 28, 1994 and returned to service after successful completion of the DOP and Freon testing on March 3, 1994. The replacement and testing was completed in approximately 4 days. The "B" SBGT train was taken out of service on March 7, 1994 and returned to service after successful completion of the DOP and Freon testing on March 9, 1994. The "B" SBGT replacement was completed in approximately 3 ½ days with the lessons learned from doing the "A" SBGT.

Since 1994 when the trays were replaced, we have not entered a non-planned LCO for SBGT. The trays have been successful at reducing the failure of the Freon bypass leakage test and eliminating the inleakage around the charcoal adsorber unit.

4 PROJECT TIME LINE

4.1 7/31/91 - Started looking into tray replacement after reviewing history and rejecting other ideas. Talked with NUCON. They had rough proposal for a new tray.

4.2 7/15/91 - Mod request for Charcoal Tray replacement submitted.

4.3 1992 - Convinced station of need to do modification. Other SBGT design basis issues came up involving the heater such as the fact that the station could no longer take credit for the use of a heater. These other issues distracted my work on the tray replacement and we changed our testing standard to 30 C, 95% RH instead of 130 C, 70% RH.

4.4 1/13/93 - Explored the option of delaying the SBGT testing until June 93 in hopes of replacing the charcoal adsorber trays. Bechtel is looking into the seismic issues that came up.

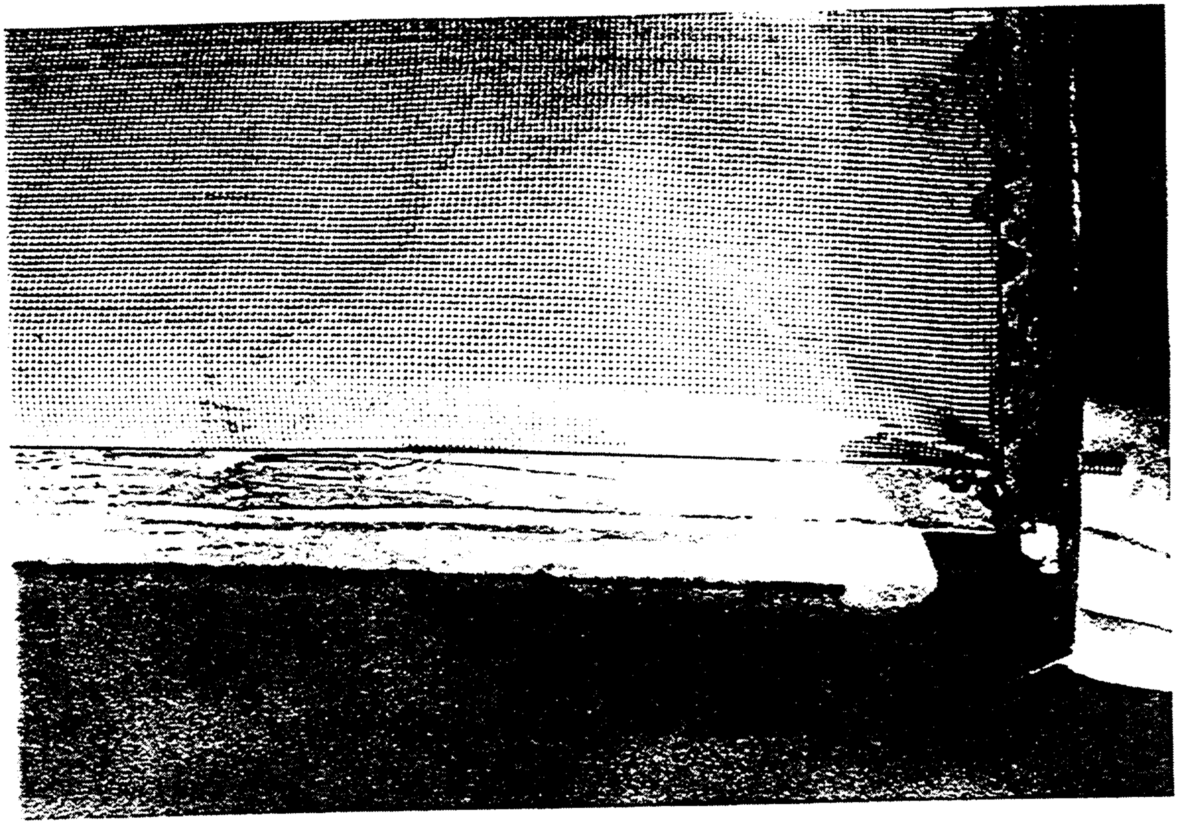
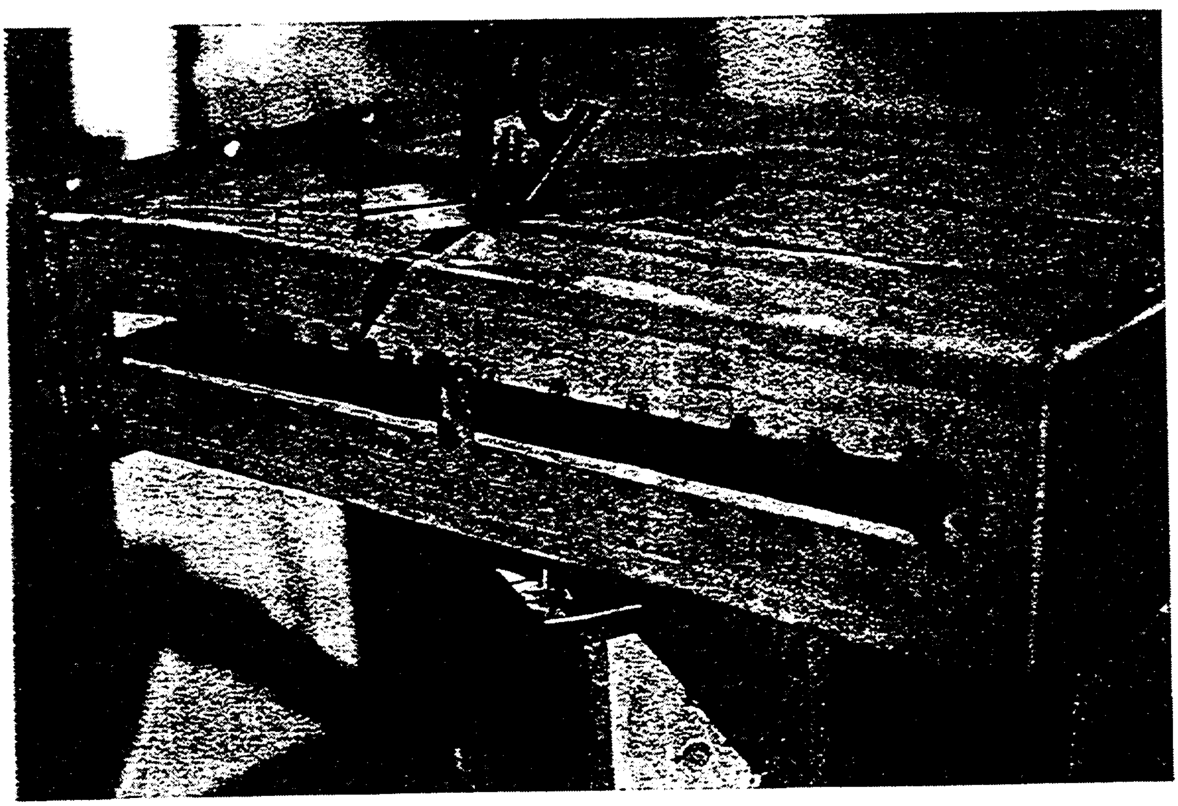


FIGURE 1



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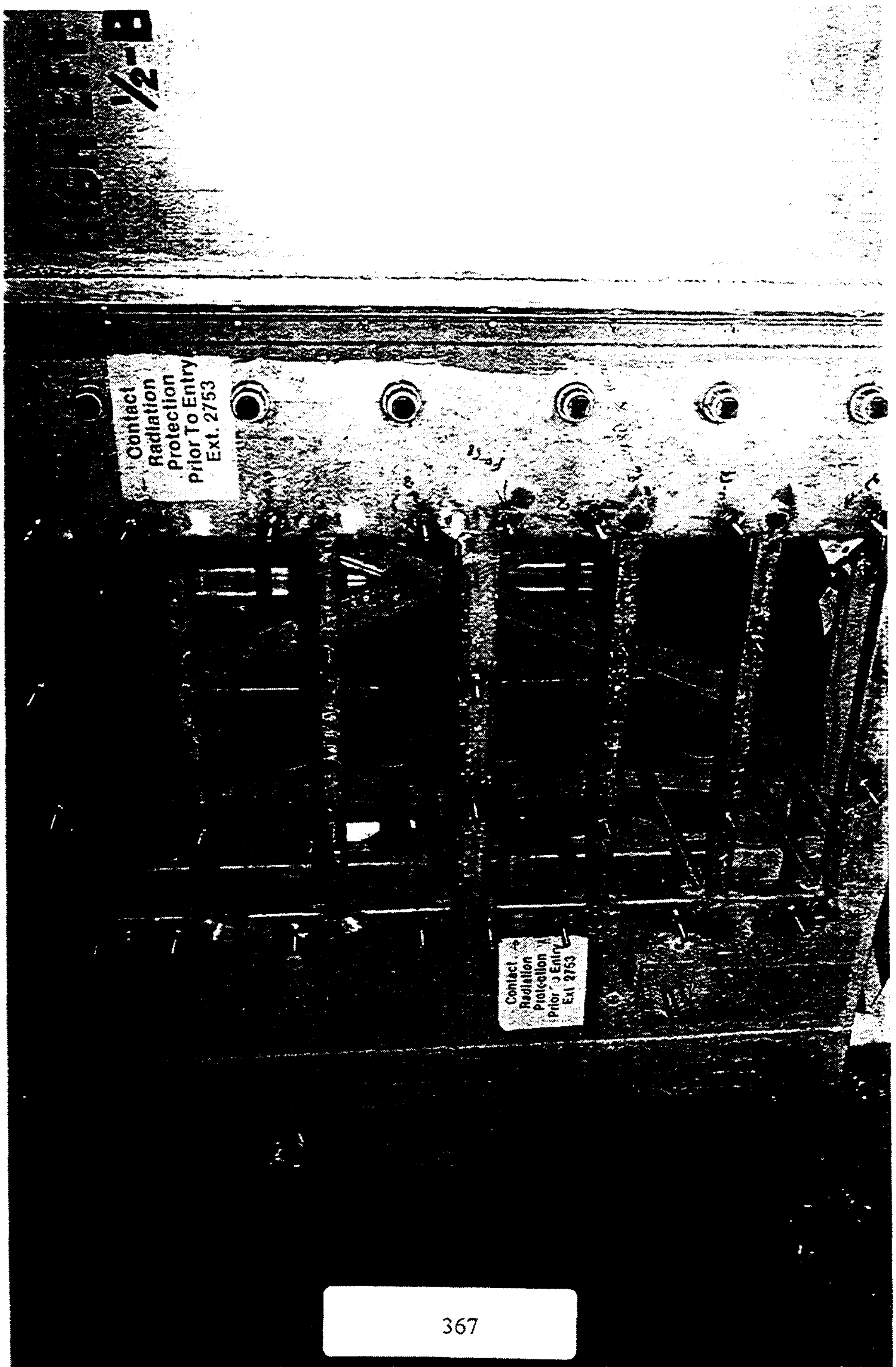

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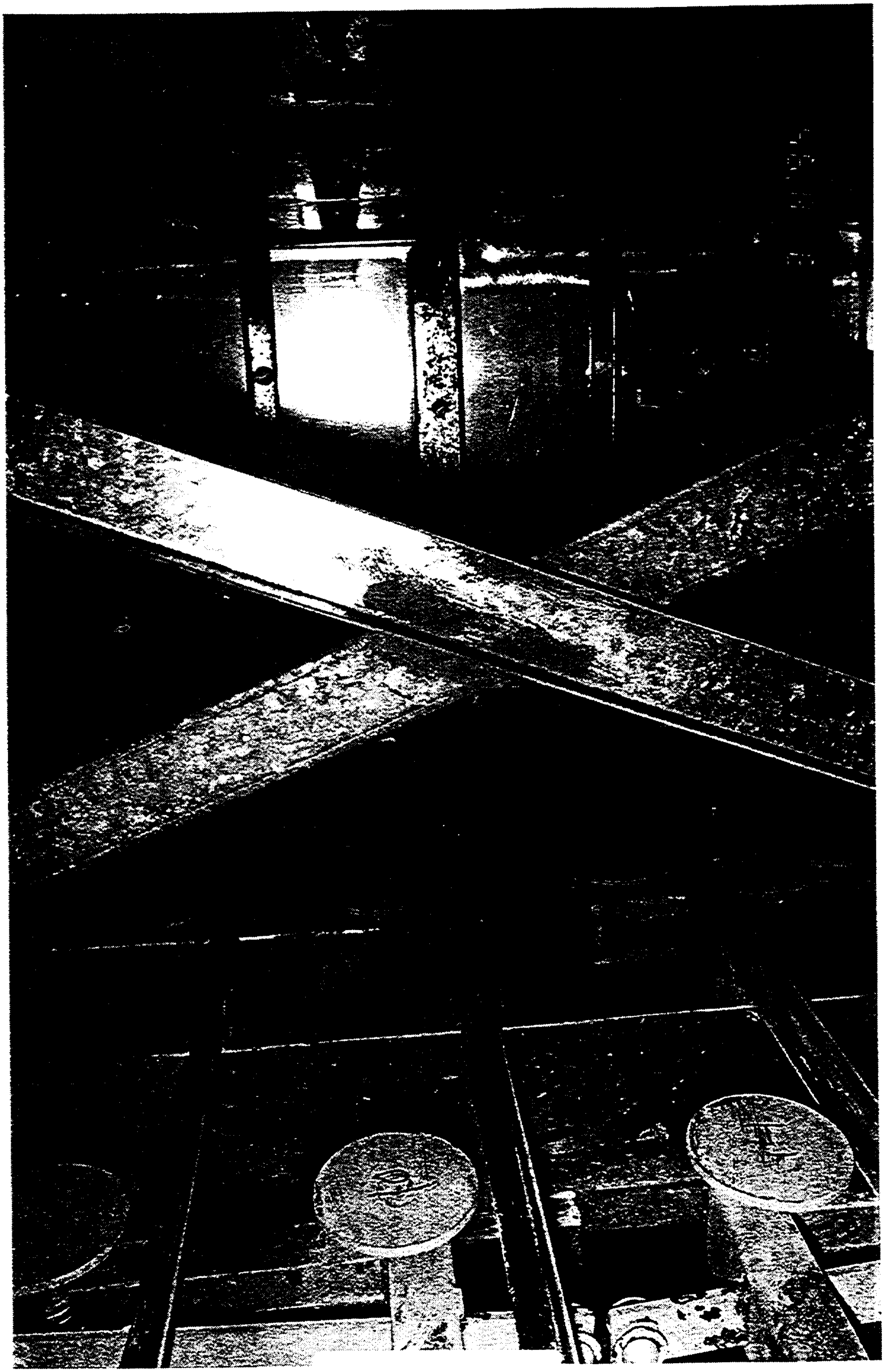

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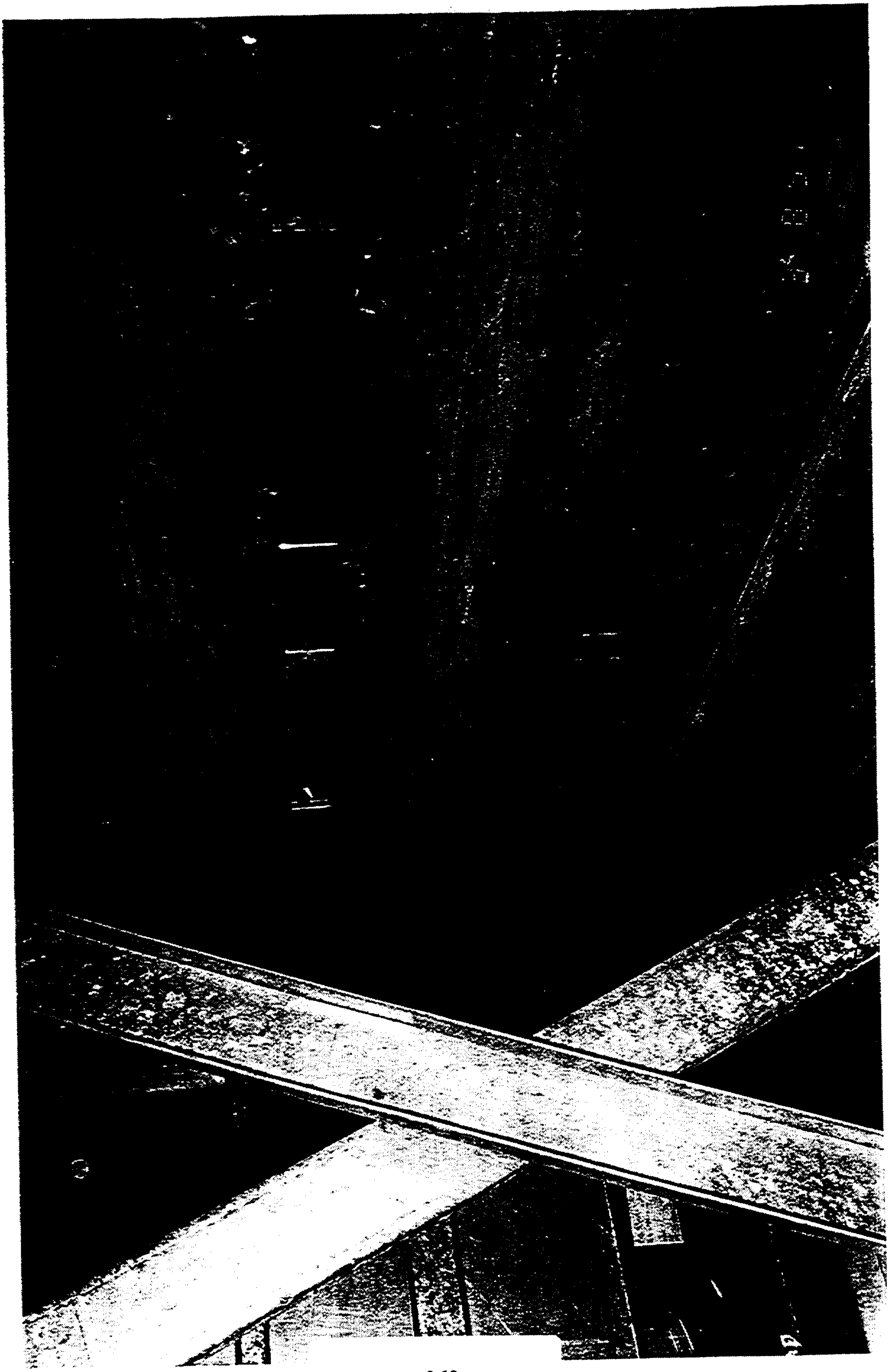

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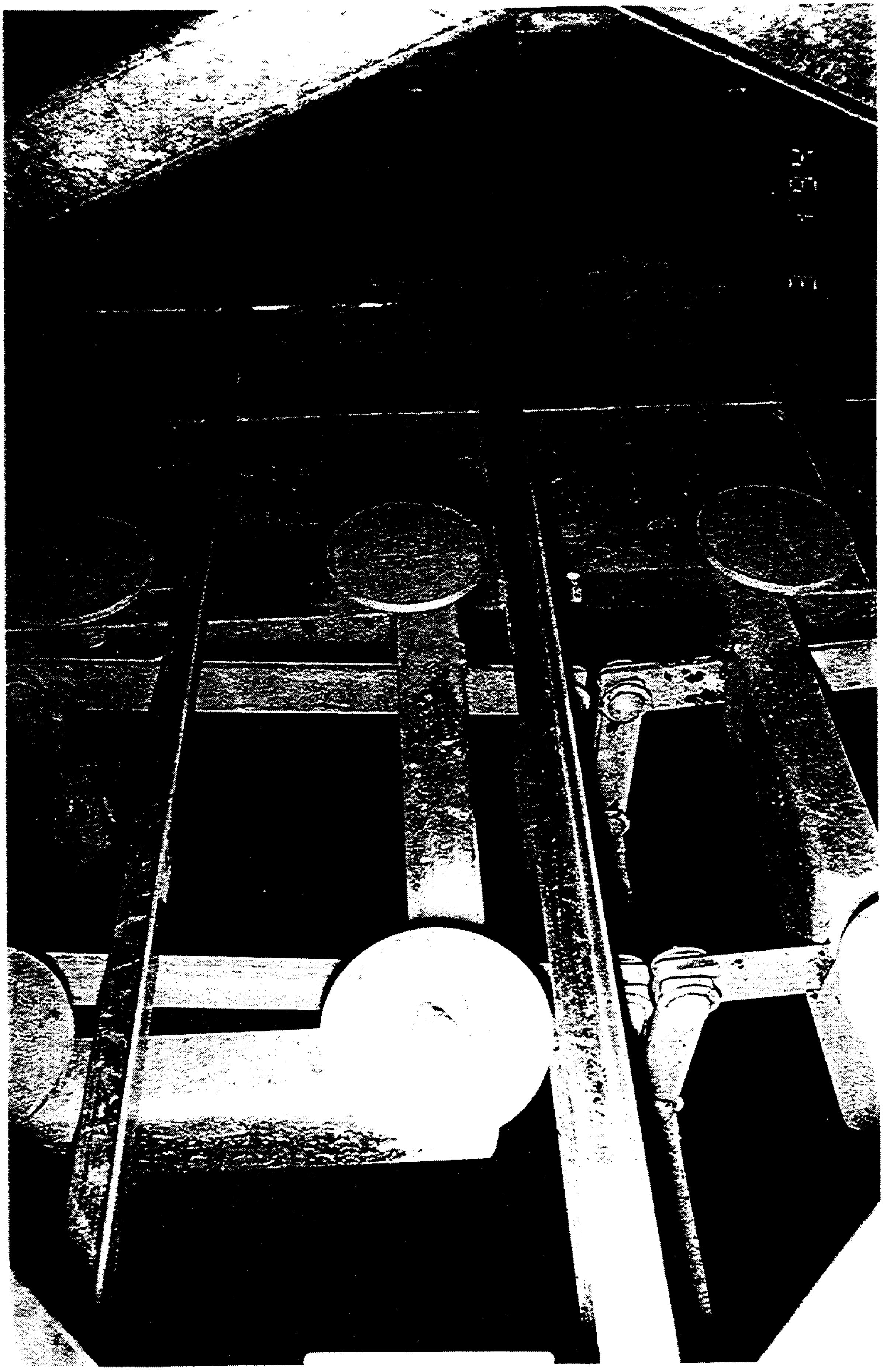

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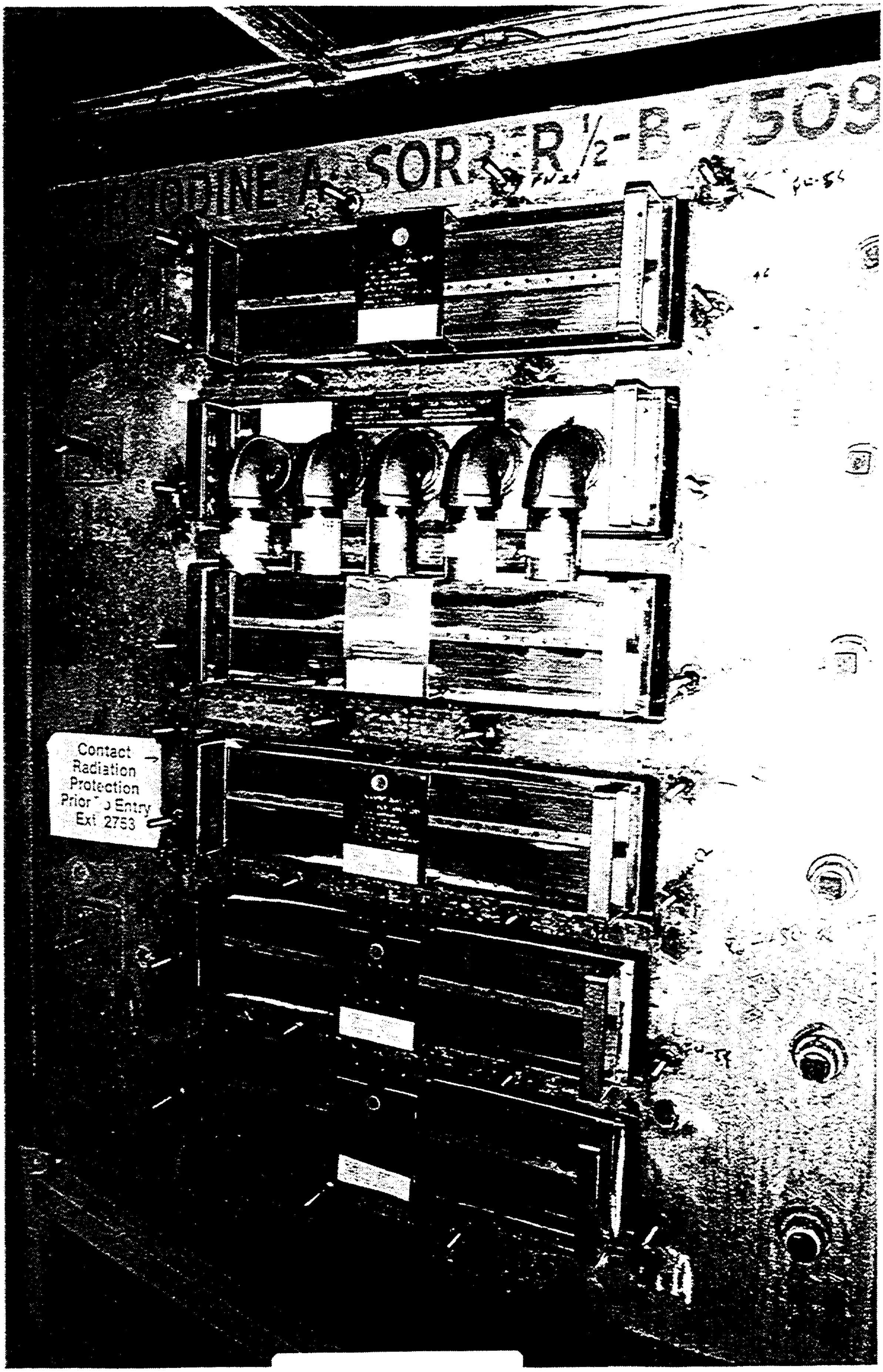
FIGURE 7



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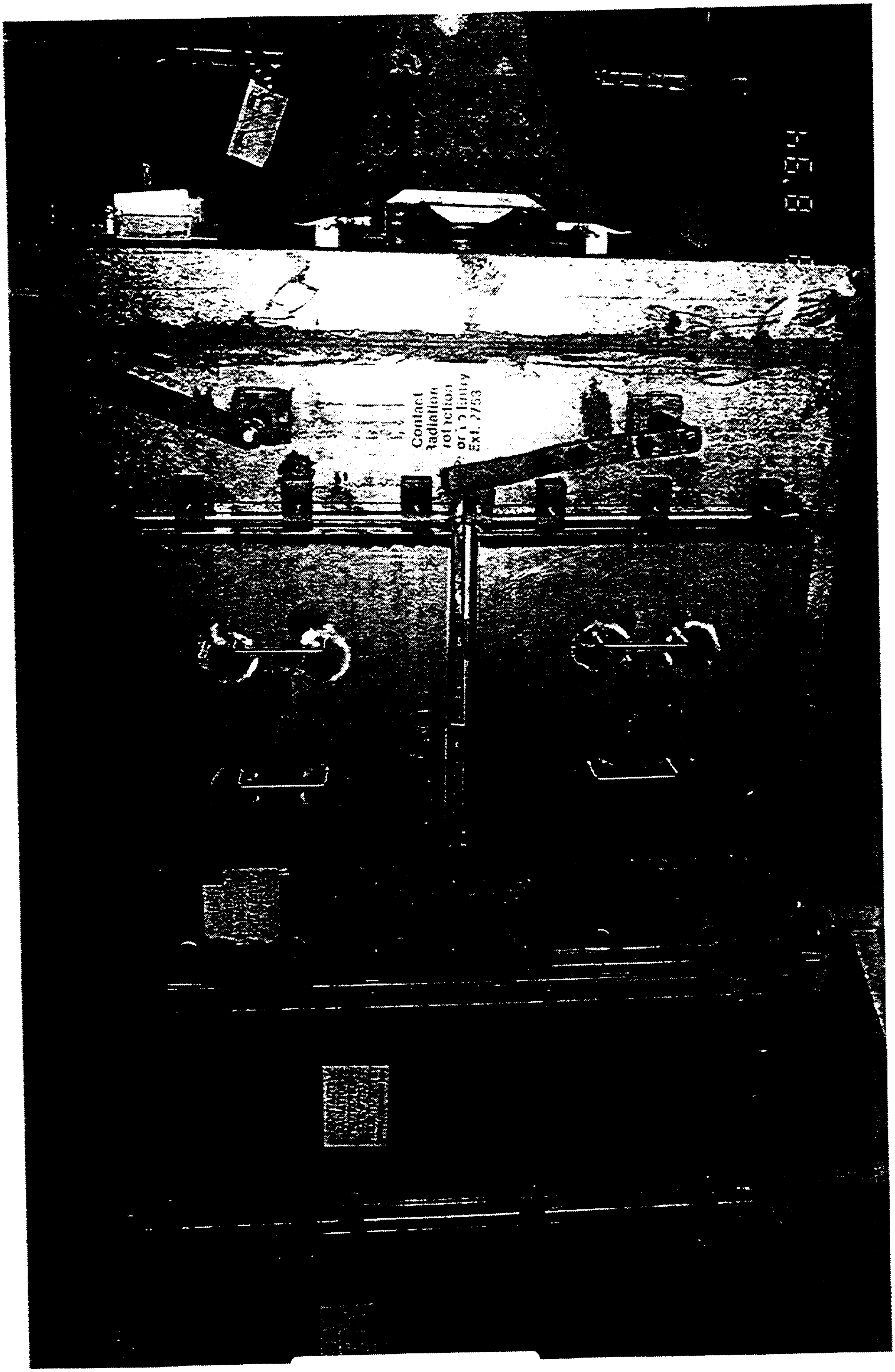
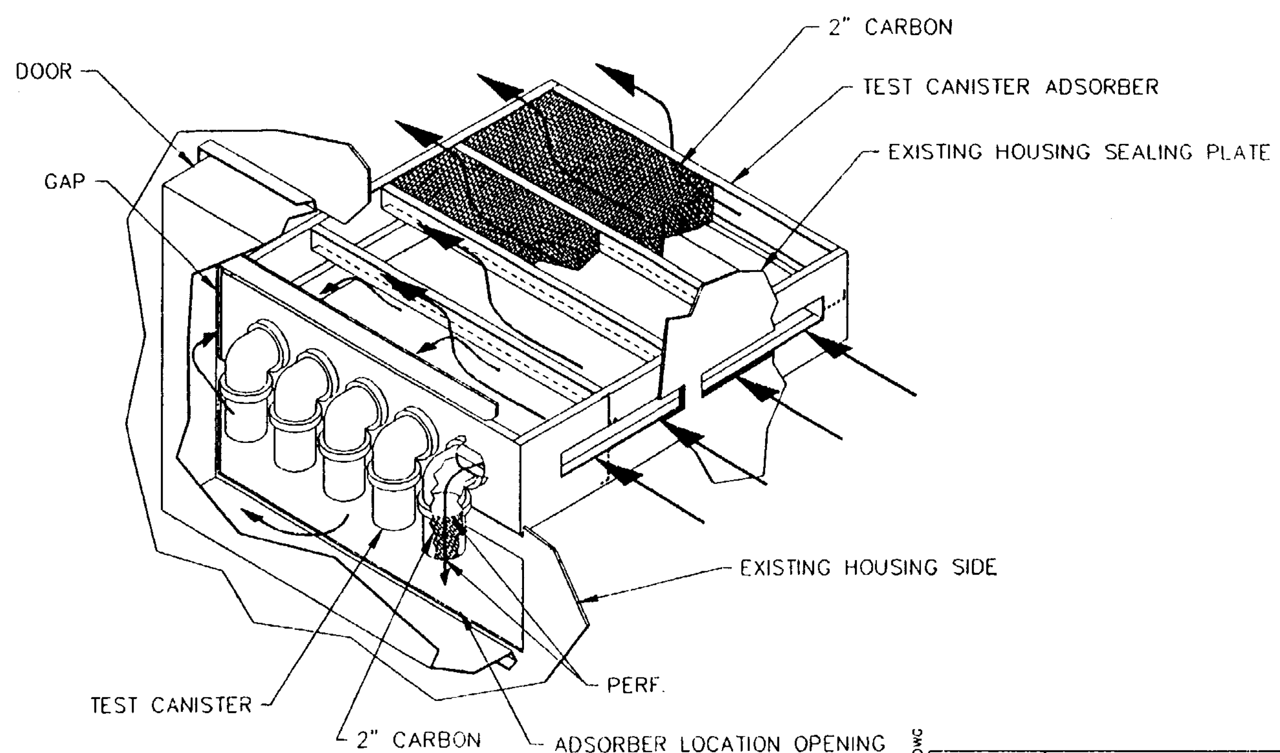


FIGURE 9



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