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ABSOLUTE GLOVEBOX VENTILATION FILTRATION SYSTEM WITH UNIQUE FILTER REPLACEMENT FEATURE

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ABSTRACT - RESUME

A glovebox ventilation system was designed for a new plutonium-238 processing facility that provided 1) downdraft ventilation, 2) a leak tight seal around the High Efficiency Particulate Air (HEPA) filters, and 3) a method for changing the filters internally without risk of contaminating the laboratory.

A 6.25 in. diameter tube, long enough to contain two HEPA filters in series, is welded to the bottom of the glovebox for the exhaust. A similar 6.25 in. diameter tube is welded to the upper back panel of the glovebox for supply air. The locations of the supply and exhaust tubes provide the downdraft flow required. A double-lipped gasket made of low durometer silicone rubber attached to the top of each filter is designed to provide a helium leak tight seal with the exhaust tube even with imperfect tubes. A flanged opening to the exhaust tube is provided at the back of the glovebox. The filter change is made by inserting a new filter through this opening into the exhaust tube. As this new filter is pushed forward, the first filter which has accumulated the airborne particulates is ejected into the glovebox, the second filter moves into the top position, and the new filter becomes the second filter in series.

This glovebox ventilation filtration system has operated successfully for five years.

SYSTÈME ABSOLU DE VENTILATION ET FILTRATION BOÎTE À GANTS AVEC DISPOSITIF UNIQUE DE REMPLACEMENT DU FILTRE

On a élaboré un système de ventilation boîte à gants (glovebox) pour un nouveau procédé de fabrication du plutonium-238, système qui pourvoie 1) une ventilation à courant d'air de haut en bas, 2) une valve étanche autour des filtres d'air de haute efficacité (High Efficiency Particulate Air filters - HEPA), et 3) une méthode de remplacer les filtres à l'interieur du système sans courir le risque de contaminer le laboratoire.

Un tuyau de 15.87 cm de diamètre, assez long pour contenir deux filtres HEPA en série, est soudé au bas de la boîte à gants pour l'échappement. Un tuyau similaire d'un diamètre de 15.87 cm est soudé

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au haut du panneau postérieur de la boîte à gants pour l'alimentation en air. L'emplacement des tuyaux d'alimentation et d'échappement assure le courant d'air de haut en bas requis. Une garniture à deux levres en caoutchouc silicone à basse dureté, attachée au haut de chaque filtre, a le rôle de pourvoir le tuyau d'échappement d'une valve étanche qui empêche la fuite de l'hélium même si les tuyaux auraient des imperfections. Une ouverture à rebord du tuyau d'échappement est pratiquée à l'arrière de la boîte à gants. Le changement du filtre se fait en inserant un nouveau filtre à travers cette fente dans le tuyau d'échappement. Pendant que ce nouveau filtre est poussé en avant, le premier filtre qui a accumulé les impuretés dont l'air est chargé (airborne particulates) est éjecté dans la boîte à gants, le deuxième filtre avance dans la position la plus haute, et le nouveau filtre devient le second en série.

Ce systeme de ventilation filtration boîte à gants a fonctionné avec succès pandant cinq ans.

INTRODUCTION

Mound Laboratory has been operated for the U. S. Atomic Energy Commission by Monsanto Research Corporation since the laboratory was built in 1948. Over the years many radionuclides have been processed including ^{228}Th, ^{229}Th, ^{230}Th, ^{208}Po, ^{209}Po, ^{210}Po, ^{237}Np, ^{231}Pa, ^{227}Ac, ^{241}Am, ^{226}Ra, ^{239}Pu, and ^{238}Pu.

In the early days the High Efficiency Particulate Air (HEPA) filters were usually installed in the exhaust duct external to the glovebox. There was a high potential for contamination of the laboratory when these filters had to be changed. This problem became acute with the processing of hundreds of grams of ^{238}Pu oxide because of the large quantity of airborne particulates, the serious biological effect of ^{238}Pu on the body, and the relatively long half-life (~88 years).

HISTORY OF PRIMARY FILTER INSTALLATIONS

The standard installation of the HEPA filters in 1958 was external to the glovebox in the exhaust duct (Figure 1). The filter was made with a wooden frame 8 x 8 x 5-7/8 in. and gasketed on both

sides. It was mounted in a metal frame and taped to the duct. In some instances the metal frame had a removable cover plate and was screwed into the exhaust duct. It was difficult to remove this filter without contaminating the laboratory with the bagging technique employed. In the first case, the entire assembly was removed and replaced; in the latter case, only the filter was replaced.

An attempt was made to eliminate the problem by building a tight housing permanently installed in the exhaust duct (Figure 2). It was fitted with two gasketed doors and contained the same 8 x 8 x 5-7 8 in. wooden-framed filter. The filter was changed by bagging around one door and inserting a new filter from the opposite side so that the dirty filter was ejected into the bag. This was an improvement but did not completely eliminate the occasional release of contamination. Around 1962, I designed a filter that could be mounted inside the glovebox. It was made with a cylindrical metal housing and fitted with a 2 in. diameter threaded nipple at each end (Figure 3). All new gloveboxes had a 2 in. coupling welded to the glovebox and the filter was screwed into place through a glove port. Older boxes were retrofitted with a special adapter to accommodate this new filter.

This internal filter was a vast improvement over the old external installation but had two drawbacks: 1) it was sometimes difficult to unscrew, especially if there was an atmosphere which corroded the threads; and 2) airborne contamination within the glovebox could enter the exhaust duct during the filter change.

CRITERIA FOR NEW PLUTONIUM FACILITY

In 1967, as the Project Manager for a new plutonium processing facility to be built at Mound Laboratory, I was requested by our Health Physics Department to provide a primary filter that would be easier to change and would eliminate all possibility of release either to the building or to the exhaust system. In addition, series flow (no forced supply) and downdraft ventilation within the glovebox were requested.

Since one of the basic concepts of the design of this plutonium facility was the installation of gloveboxes in straight lines, with maintenance from the rear from an access corridor (Figure 4), the design of the filter system was planned for replacement of the filters from this corridor.

DESIGN AND OPERATION OF NEW FILTRATION SYSTEM

What evolved in order to meet the criteria established is a glovebox ventilation system that is described as follows: A 6.25 in. diameter tube (22.00 in. long) with a flanged cover is welded to the bottom of the glovebox for the exhaust, and a similar tube, without the flange, is welded to the upper back panel for the supply (Figure 4). This arrangement provided the downdraft air flow. A closeup is shown in Figure 5. The new filter is a cylinder 5-1/4 in. in diameter and 6 in. long of (Kraft) paper and open at both ends (Figure 6). The filter is rated at 30 ft^3/min at 1 in. differential pressure. The gasket, attached at one end of the filter with a silicone rubber cement, has a double lip and is made of a soft (25 Durometer shore A) molded silicone rubber. Three wooden spacers are

glued to the opposite end of the filter to prevent the filter from being inserted in a cocked position.

When inserted into the tube the gasket forms a lip seal to the wall (Figure 7). The diameter of the gasket is larger than the biggest tube yet allows for the compression in the smallest tube. This was necessary because of the large variation in tube diameters (0.130 in.) and the out-of-roundness of some of the tubes.

Figure 8 shows the tube without filters and with the flanged cover removed. There is room for two filters plus free space for a third filter during filter change.

Filters are changed by removing the flanged cover, inserting the third filter, and pushing forward. The first, or dirty filter, is pushed into the glovebox and thus, even during filter change, there are always at least two filters in series.

During the development of this filter and gaskets, tests for sealing were made with a helium leak detector although in the final assembly of the filters in the gloveboxes they were required to pass a DOP (dioctyl phthalate) test only.

Since March 1968, when the plutonium processing facility became operational, air samples collected from the glovebox exhaust system have confirmed that this filter arrangement provides excellent filtration.

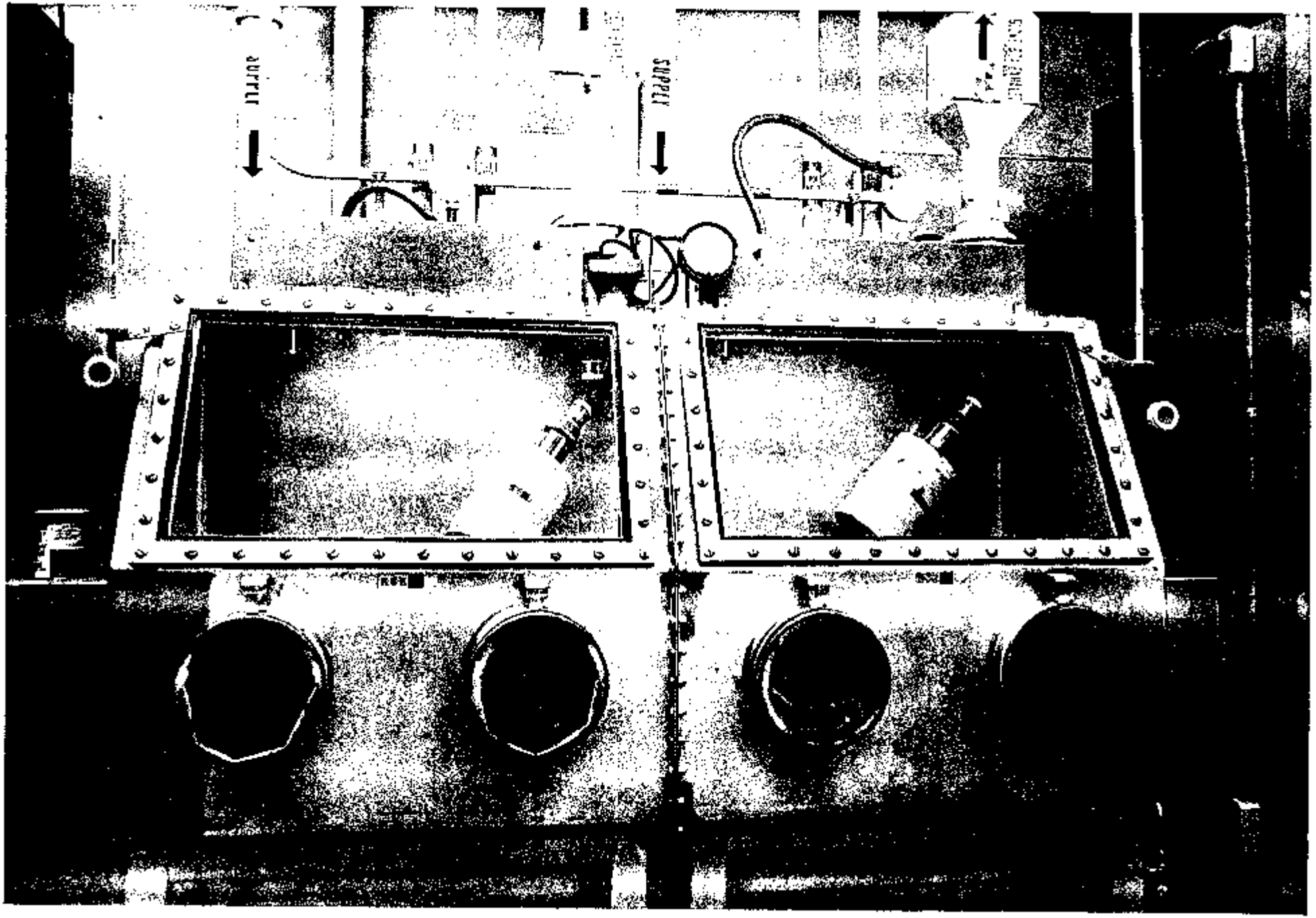

Figure 1 - External Installation of HEPA Filter with Flanged Cover

Figure 2 - External Installation of HEPA Filter with Double Doors

Figure 3 - Internal Canister HEPA Filter

Figure 4 - Access Corridor for Equipment Maintenance and Replacement of HEPA Filters

Figure 5 - Closeup of Rear of Gloveboxes Showing Exhaust Filter Tubes

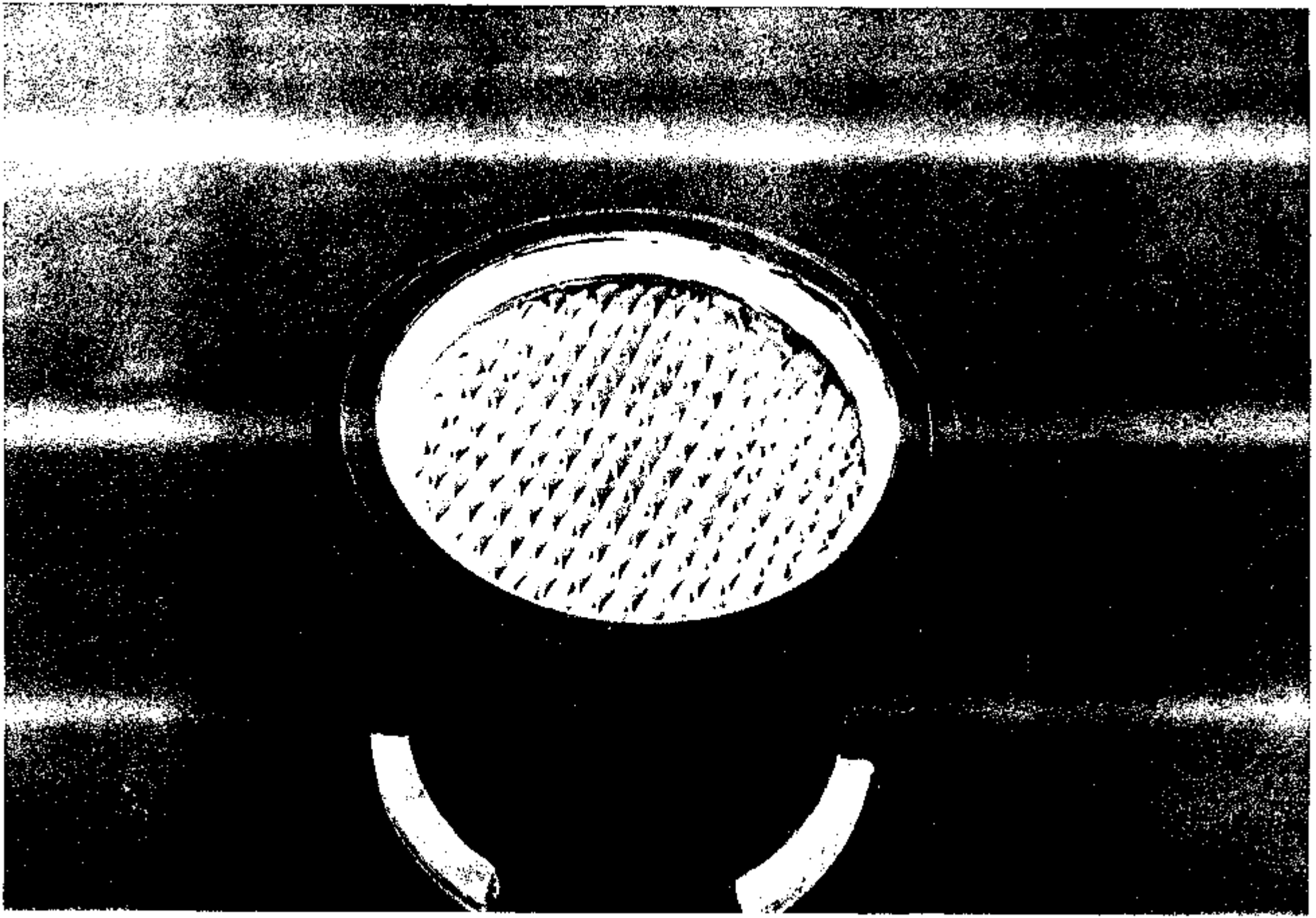

Figure 6 - Assembly of Filter, Rubber Gasket and Spacers

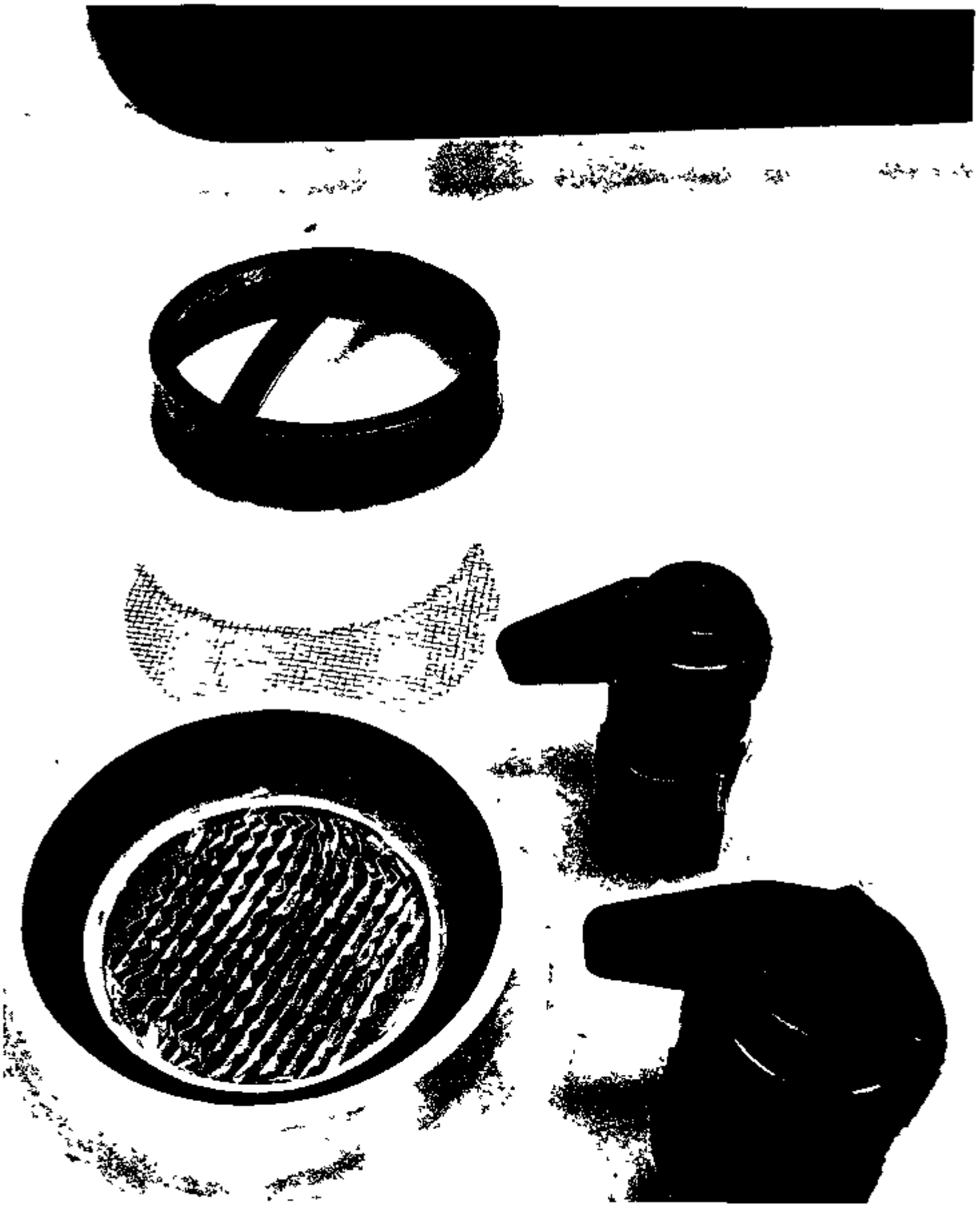

Figure 7 - Filter Sealed in Position and Detail of Roughing Filter

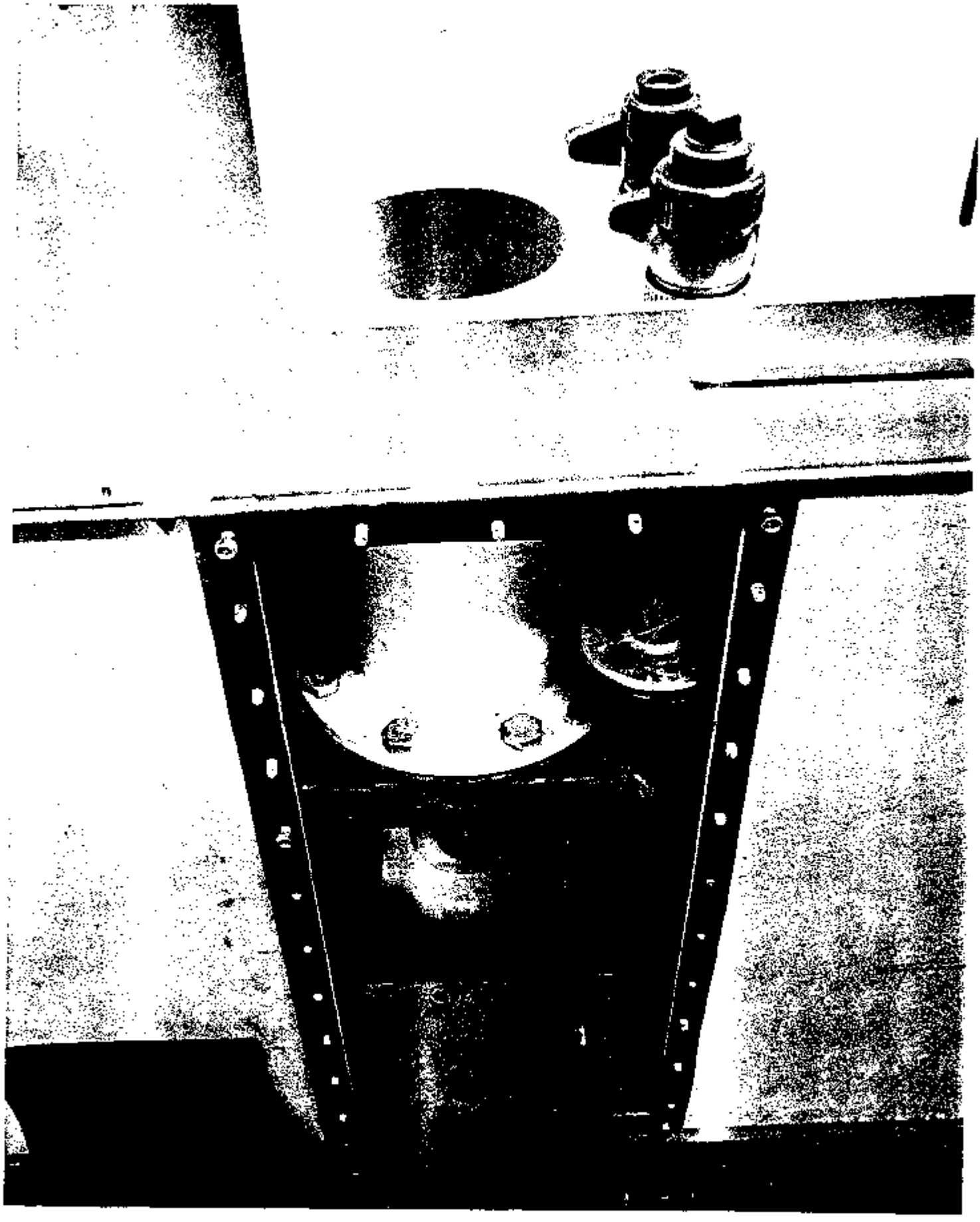

Figure 8 - Empty Filter Tube with Flanged Cover Removed