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Fabrication, Optimization, and Evaluation of a Massive Volume Air Sampler of Sized Particulate Matter

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FABRICATION, OPTIMIZATION, AND EVALUATION OF A MASSIVE VOLUME AIR SAMPLER OF SIZED RESPIRABLE PARTICULATE MATTER

by

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ABSTRACT

This project was initiated with the overall objective of designing and fabricating (two) improved and thoroughly tested (Mark II) massive volume air samplers of respirable particulates. The samplers are to collect large masses of particulate aerosols in three size ranges. Collections are obtained using air flow of about 18 m^3/min through two large impactor stages and an over-designed electrostatic precipitator stage. In a prior program two prototype (Mark I) samplers were designed and fabricated and operated in the field on a nearly continuous basis for over a year by personnel of the United States Environmental Protection Agency.

Incidences of component breakdown, electrical failures, and operating difficulties encountered in the prototype samplers were reported. Improvements were made in the new design and fabrication, principally through the use of stainless steel, Teflon, and Teflon-coated structural components for better strength and durability. Automatic power shutoffs, failure indicator, flow gages, and timers were installed to insure better unattended operation. A more durable and voltage-adjustable high-voltage power pack was incorporated for the electrostatic precipitator.

The redesigned samplers were experimentally tested for reproducibility, sharpness of cutoff stages, and collection efficiencies; details of these test procedures and results are given in the text.

A significant and novel advance in the second generation (Mark II) samplers was the use of a conductive Teflon-clad substrate to replace the more reactive pure aluminum plate surfaces incorporated in the electrostatic collector section.

The 50% cutoffs found for the three stages, 3.5, 1.7 and below 1.7 μm, closely fit the Atmospheric Conference of Governmental Industrial Hygienists respirable size curve. The reproducibility between the two samplers operating in parallel was better than 5%; efficiencies up to 99% can be obtained by use of a higher ionizing voltage with the resultant generation of a small amount of ozone.

This report was submitted in fulfillment of Contract No. 68-02-2281 by Battelle's Columbus Laboratories under the sponsorship of the U.S. Environmental Protection Agency. It covers the period December 15, 1975, to November 14, 1976, and work was completed as of November 14, 1976.

For a description and discussion of the Mark I prototype sampler, EPA publication # 600/4-78-009 may be consulted.

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FIGURES

Note:

Drawing No. 6352-A-030 supercedes drawing No. 6352-A-034.

TABLES

SECTION 1

INTRODUCTION

Currently, considerable attention is being given to the direct effects of air pollution on health. Previously, effects of chronic exposure have not been readily recognized, and attention has been focused on the subject only when disastrous episodes such as Donora, Meuse Valley, London, New York, Tokyo-Yokohama, etc. occurred under extraordinary meteorological conditions that reduced the effective volume of air in which the pollutants were diluted.

In the last decade, however, it has no longer become necessary to raise the question as to whether air pollutants produce chronic and acute adverse human health effects. Each year the evidence demonstrating health effects becomes more and more impressive. The problem now appears to be one of determining the amount of pollution which is safe and tolerable rather than questioning if pollutants are harmful.

The current Community Health and Environmental Surveillance System (CHESS) studies relate community health to changing environmental quality. These studies are designed to measure simultaneously environmental quality and sensitive health indicators in different communities. Communities studied represent various exposures to common air pollutants, with the communities selected to obtain data on the predominant effects of particulate matter, sulfur oxides (SO_x), and nitrogen oxides (NO_x) alone, as well as in various combinations to determine interaction effects.

One of the most severe limitations of the CHESS study is achievement of comprehensive characterization of the particulate insult that produces the physiological response. Also, in part, a limitation on characterization has been imposed by lack of adequate amounts of valid sample for testing particulate pollutant levels. The collection of adequate masses of particulates requires that large volumes of air be sampled, which entails long time period efforts with conventional high-volume samplers. However, since short-term episodic changes in pollutant levels are also of concern in health studies, the availability of a sampler capable of processing massive volumes of air in a comparatively short time period has distinct advantages. In addition to processing large volumes of air, the sampler described here was designed to overcome several other deficiencies or problems encountered with the use of previous available samplers — notably the capability to collect particulates in three size ranges on inert substrates without acquiring contamination from the substrate surfaces. Working under a previous Environmental Protection Agency (EPA) program, two prototype Massive Respirable Particulate Air Samplers were designed and fabricated to fulfill the need for collection of large masses of particulates, sized into respirable-nonrespirable size ranges, and readily recoverable from the collecting surfaces with minimal substrate contamination and interaction. The samplers can collect the respirable particulate fraction of ambient aerosols in quantities to provide both for detailed chemical characterization and for toxicity screening. These prototype samplers were immediately pressed into operational use at the EPA background catalyst study site in Los Angeles in September 1975 and have been operated on a continual basis by EPA technician-level personnel since that time.

Since delivery of these prototype samplers, the Battelle-Columbus project personnel responsible for their design and fabrication have maintained close contact with EPA personnel involved in the current and future applications of the pollutant collection capabilities of these samplers. During this period several deficiencies have been observed in the performance of these samplers when operated by untrained technicians in the field 24 hours a day for well over a year. While these deficiencies have been taken care of in the field, the remedial actions have given insight into design and materials changes that would provide for better durability and ease of sampler operation in future sampler construction. Besides these largely materials and assembly improvements, several other optimization features have suggested themselves and/or have been recommended by EPA personnel. Operational and performance aspects, including collection efficiency, precision, accuracy and reproducibility, sharpness of cutoff stages, gas/substrate and gas/particle interaction were not investigated in sufficient depth for total acceptance and use of the Massive Respirable Particulate Air Samplers in future pollutant studies and health assessment programs. This program, defined together with the EPA Project Officer and described in the following sections, was designed to improve the operational characteristics of the prototype samplers and to obtain the needed performance measurement data.

OBJECTIVE AND SCOPE OF WORK

The primary objective of this program was to further develop, design, and fabricate a second generation (Mark II) Massive Respirable Particulate Air Sampler for the collection of airborne suspended particulate matter for use in determining the composition and toxicity effects of the collections respirable to humans, particularly the sulfur (S), nitrogen (N), and polycyclic organic compounds.

SECTION 2

SUMMARY

An improved, Mark II, three-stage Massive Respirable Particulate Air Sampler was designed to provide for the rapid collection of gram quantities of ambient aerosols in three cutoff size ranges, namely, >3.5, 3.5 to 1.7, and <1.7 μm. The latter two ranges generally are regarded as the sizes respirable by humans. Two samplers were fabricated, test evaluated, and delivered to EPA for subsequent use in particulate burden-health effects studies. The samplers are unique in their capability to provide respirable-sized particulates in sufficient masses for both bioassay screening and, when indicated, detailed chemical characterization of the collections.

The sampler design utilizes two impactor stages (Teflon-coated steel) followed by a high-efficiency electrostatic precipitator (55 steel plates coated with conductive Teflon) to effect the three-stage size separation. (A scalping stage before the first impactor removes the very large [>20 μm diameter] particles.) A flow rate of 17.3 m^3/min (as compared to a nominal 1.1 m^3/min High-Volume sampler [Hi-Vol] flow) is obtained which, with a particulate loading of 100 μg/m^3, gives a total 24-hour collection of about 2.5 g. The collection efficiency of the sampler has been determined to be better than 90% for submicrometer particles, and the precision between two side-by-side samplers better than 5%.

The collection stages are modular in design with duplicate modules supplied for each sampler. In field operation, the impactor stages are removed for sample recovery, and duplicate clean stages installed for nearly continuous collection. The "loaded" stages can be taken to a clean area and the sample recovered by use of a brush or Teflon-coated scraper. Also, the

entire precipitator plate assembly can be removed when particulate loaded, and a cleaned plate assembly installed. The precipitator assembly similarly can be taken to a clean area for recovery. The use of Teflon-coated collection surfaces minimizes any extraneous contamination and gas-substrate reactivity.

SECTION 3

CONCLUSIONS

The redesigned and fabricated Mark II samplers have been thoroughly tested in all collection aspects except for possible gas-particulate reactivity. More thorough testing of reactivity can be performed at the EPA laboratories. The durability of the Mark II samplers has been improved by the use of stronger and less corrosive stainless steel components and of Teflon which has superior dielectric properties and introduces less contamination into the collections. When malfunctions do occur in the Mark II samplers, they are manifested by a warning light, indicator gages, and power shutoff.

As pointed out in the Discussion section, the adoption of a conductive Teflon to coat the surfaces of the electrostatic plates represents a technical breakthrough. Such a use had not previously been attempted, and its adoption greatly improved the hitherto tedious and time-consuming particulate recovery operation. A further benefit is the reduced substrate contamination as compared to that from the aluminum plate surfaces.

The reproducibility between samplers, particle size cutoff stage points, and overall collection efficiencies have all been found to be sufficiently valid for use of the samplers in the field to collect samples for detailed chemical and toxicological characterization.

SECTION 4

RECOMMENDATIONS

The design, fabrication, and test evaluation efforts have resulted in a three-stage sampling system novel in capability to collect large masses of particulates in respirable and nonrespirable particle size fractions. Until the advent of these Massive Respirable Particulate Air Samplers, efforts to relate health effects to particulate burdens have been hampered due to insufficient sample size for detailed chemical and bioassay-type analyses. Of especial interest in assessing health effects are the chemical forms of sulfur species present in a given environmental burden. With an insufficient sample size, determinations often have been limited to total sulfur and/or sulfate ($SO_4^=$) values without measuring for reduced sulfur or organosulfur species. Even when larger masses of samples have been obtained over relatively long periods, these usually have not been fractionated into respirable and nonrespirable sizes and are not as meaningful as they could be, since studies have shown heavy metals, organic species, reduced sulfur compounds, and certain nitrogen compounds to be concentrated in the smaller particle sizes.

A recommended use of the samplers to characterize atmospheric burdens for health effects assessments very briefly is:

- Locate the samplers where other monitoring information is being obtained simultaneously, viz., hydrocarbon (HC), sulfur dioxide (SO_2), and ozone (O_3).
- "Screen" the particulate fraction collections by bioassays and broad-base analytical techniques such as spark source mass spectrography, ion chromatography, solvent separation followed by flame detection infrared (FDIR).
- Determine quantitatively those fractions or chemical species indicated by the bioassays and/or the analytical screening to be potentially toxic or hazardous.

SECTION 5

EXPERIMENTAL PLAN

An experimental work plan was designed to meet the overall objectives of the program and to encompass the efforts delineated in the scope of work. This plan was amplified near the end of the contract period to provide for the experimental trial of conductive Teflon coating on the electrostatic precipitator plates and, if experimentally sound, the subsequent incorporation of such a coating into the final sampler fabrication.

WORK PLAN

- Review of Prototype Air Sampler

    Analysis of design and operational performance
    Determination of impaction slot characteristics

- Formulation of Modifications
- Fabrication of Two Mark II Samplers
- Evaluation of Full-Scale Samplers

    Laboratory aerosol tests
    Ambient aerosol field tests

- Final Modifications, Based on Field Test Evaluations
- Preparation of Revised Drawings, Parts and Costs Lists, Operational Instructions, and Preventive Maintenance Guide

The work plan was followed in detail as described in the following sections. A visit was made to the site where the prototype "Mark I" samplers had been in continual operation for over a year, and operational problems were identified and reviewed with site personnel. These observations served as the basis for most of the material and fabrication changes incorporated into the Mark II samplers. Spare sets of the impactor and precipitator assemblies were returned from the prototype operation to Battelle's Columbus Laboratories for additional calibration and collection efficiency testing prior to making modifications for optimum performance in the Mark II samplers.

EXPERIMENTAL WORK - LABORATORY EVALUATIONS

Fabrication Changes for Long-Term Operational Performance

The initial sampler design was based on assumed 2- to 4-week sampling periods at selected sites by personnel knowledgeable in the operational characteristics of the samplers. Actual continuous operation over many months by relatively untrained operators demonstrated that many design and fabrication changes were needed to improve the functional capability of the sampler for particulate collection and to facilitate recovery (removal) of the particulates from the three sampler-collection stages. A major change for the Mark II sampler was the redesign of the electrostatic precipitator plate holders. Although the dielectric used for the prototype sampler performed adequately under laboratory atmospheric conditions, it was found to absorb moisture in the field which caused excessive voltage drain in the high-voltage section. This problem was eliminated by the use of Teflon as a construction material for the plate holder assembly. Another major field operational problem was the physical breakdown of the high-voltage ionizing wires. These would break on extended use and fall across the precipitator plates, causing parts of this assembly to malfunction. Unless observed and repaired immediately, this would result in incomplete collection of the finer size particulates. This problem has been minimized by the use of soldered wire clip holders for the ionizing wires, which lessens their stress-corrosion failure, and by automatic shutoff of the sampler when the high voltage drops below a preset minimum.

Other design and fabrication changes were made to better evaluate sampler performance, improve safety of operation, and facilitate sample recovery. These changes include:

- The precipitator section was enclosed within a stainless steel frame to improve durability and strength. This permits it to be lifted and removed by use of attached handles.
- High voltage to the precipitator plates is now supplied through a contact in the back. This contact is broken when the precipitator section is removed to minimize possible electrical shock hazard.
- The impactor plates are notched so that they can be inserted only in the correct sequence and alignment.
- The impactor plate housing frame was redesigned for easier assembly.
- The samplers now have a running-hour-meter to record total sampling time.
- The electrical circuit has a minimum voltage relay such that the sampler is completely shut down in case of a high-voltage malfunction to the precipitator plates.
- The sampler is equipped with two high-voltage power supplies, one for the ionizing wires and another for the precipitator plate voltage.
- The sampler is equipped with a red light to indicate failure and a voltmeter to assist the operator in maintaining proper operation.
- The electrostatic collector plates are coated with conductive Teflon, which facilitates particulate recovery and minimizes substrate contamination.

Calibration of the Mark II Impaction Slots

The original prototype of the Massive Respirable Particulate Air Sampler was taken to the Los Angeles Catalyst Study (LACS) sampling site before it was thoroughly calibrated. The designed cutoff sizes for the two impaction stages of the Mark I samplers were 3.5 μm for Stage 1 and 1.7 μm for Stage 2. The actual cutoff sizes of the original samplers are given later in this discussion.

In order to obtain the impaction characteristics of the long slots, a miniature impactor was made that would accommodate either one or two slot impaction jets of the same size to be used in the full-scale sampler. This impactor was designed so that the jet-to-slot spacing could be varied over a wide range. Particulates that did not impact on the impaction stage were collected on a 142-mm glass fiber back-up filter.

The impaction efficiency curves for the impactor jets were determined using monodispersed aerosols of dibutyl phthalate containing a highly fluorescent dye. The aerosols were generated using a Bergman-Liu generator, and the particles were passed through a heated duct to insure complete evaporation of the diluting solvent (ethanol). The particle size distribution of the particles was continuously monitored by cascade impactor sampling on coated slides which were examined under the microscope.

Figure 1 shows the impaction characteristics of the first stage of the Mark II Massive Respirable Particulate Air Sampler. The impaction slot is oval (2.5 by 4.8 mm), and the distance between the jet and the impaction target is 12.7 mm. The width of the impaction target is 6.3 mm. Several combinations of these parameters were varied, and this set of conditions produced the closest approximation of the Atmospheric Conference of Governmental Industrial Hygienists (ACGIH) respirable curve. The total air flow for this condition was 17.3 m^3/min. The jet-to-target distance could have been reduced, but this would have required a reduced target size, resulting in very frequent cleaning of the collection surface. The slot width of the first stage of the Mark II sampler is 25% narrower than the Mark I. This change reduces the velocity component for impaction of a given particle size and necessitates more slots for a given volume flow rate. A reduced jet velocity minimizes blowoff of collected particulates, especially when the deposit is thick.

Figure 2 shows the impaction characteristics for the second stage of the sampler (Mark II). The impaction slot is rectangular (25.4 x 1.2 mm), and the jet-to-target distance is 3.2 mm with a 12.7 mm target width.

Figure 3 shows a comparison of the ACGIH curve and the collection efficiency of the first stage of the Mark II sampler. This plot shows a

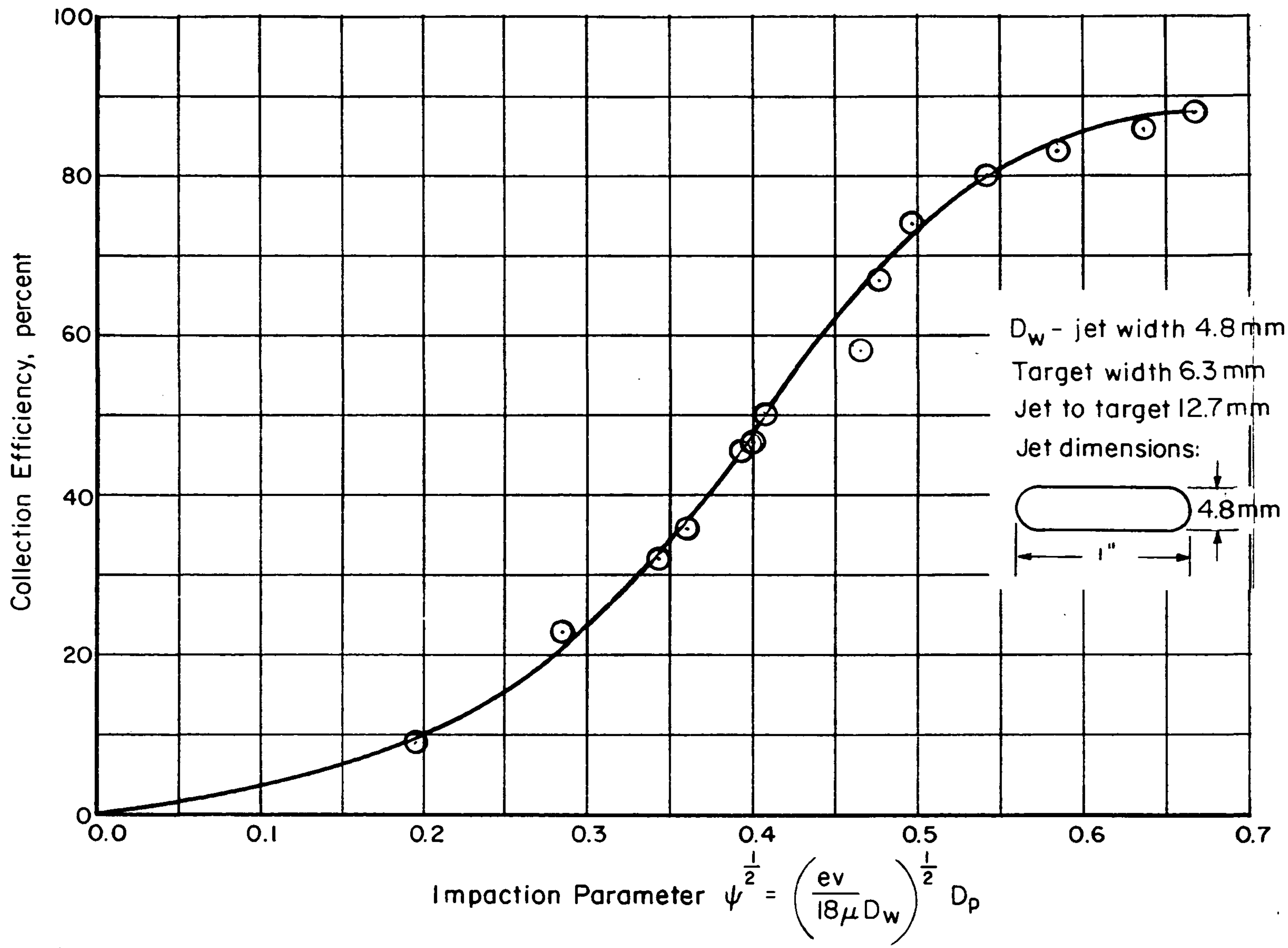

FIGURE 1. IMPACTION CHARACTERISTICS OF THE FIRST STAGE OF THE MASSIVE VOLUME SAMPLER (MARK II)

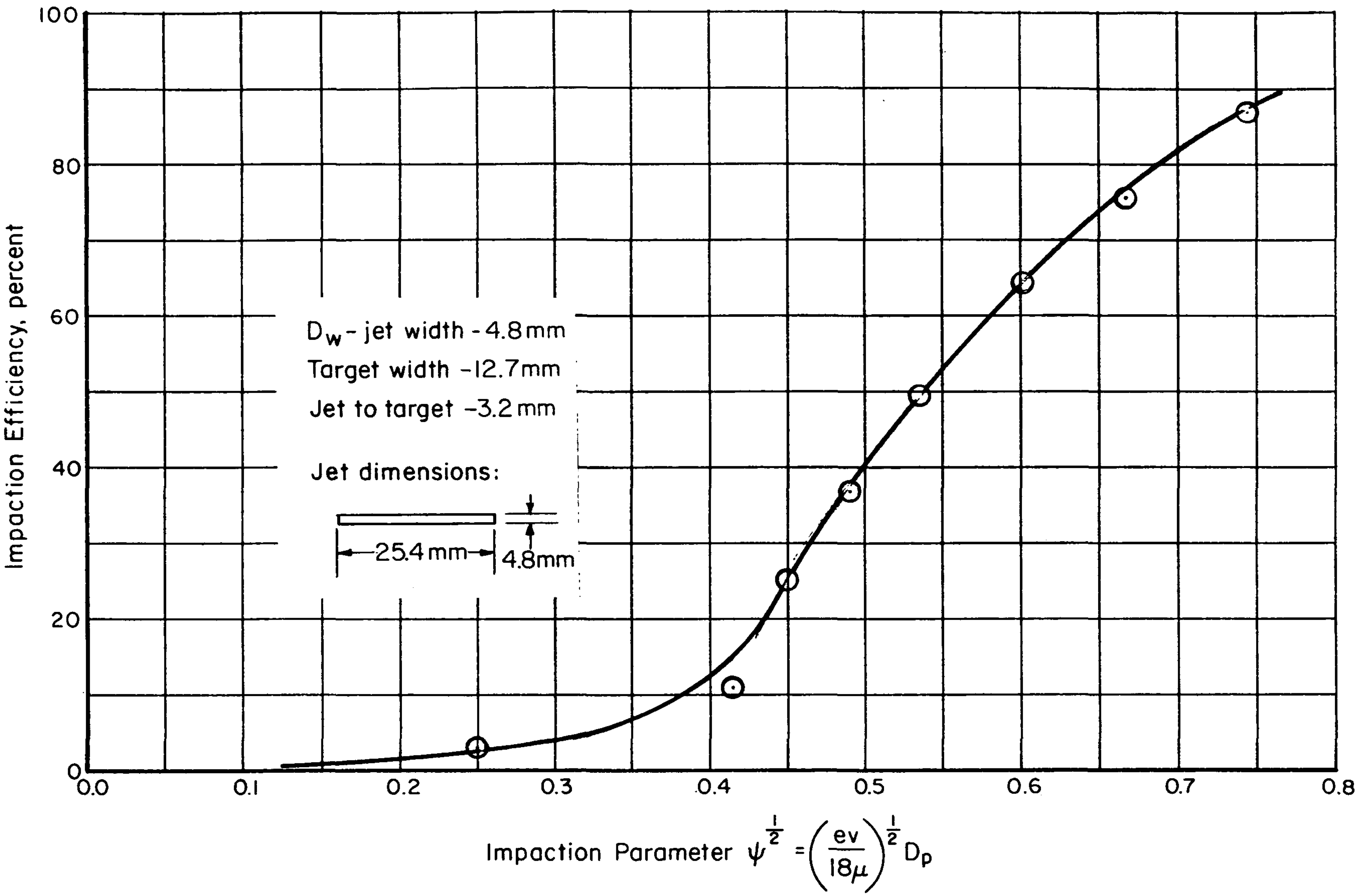

FIGURE 2. IMPACTION CHARACTERISTICS OF THE SECOND STAGE OF THE MASSIVE VOLUME SAMPLER (MARK II)

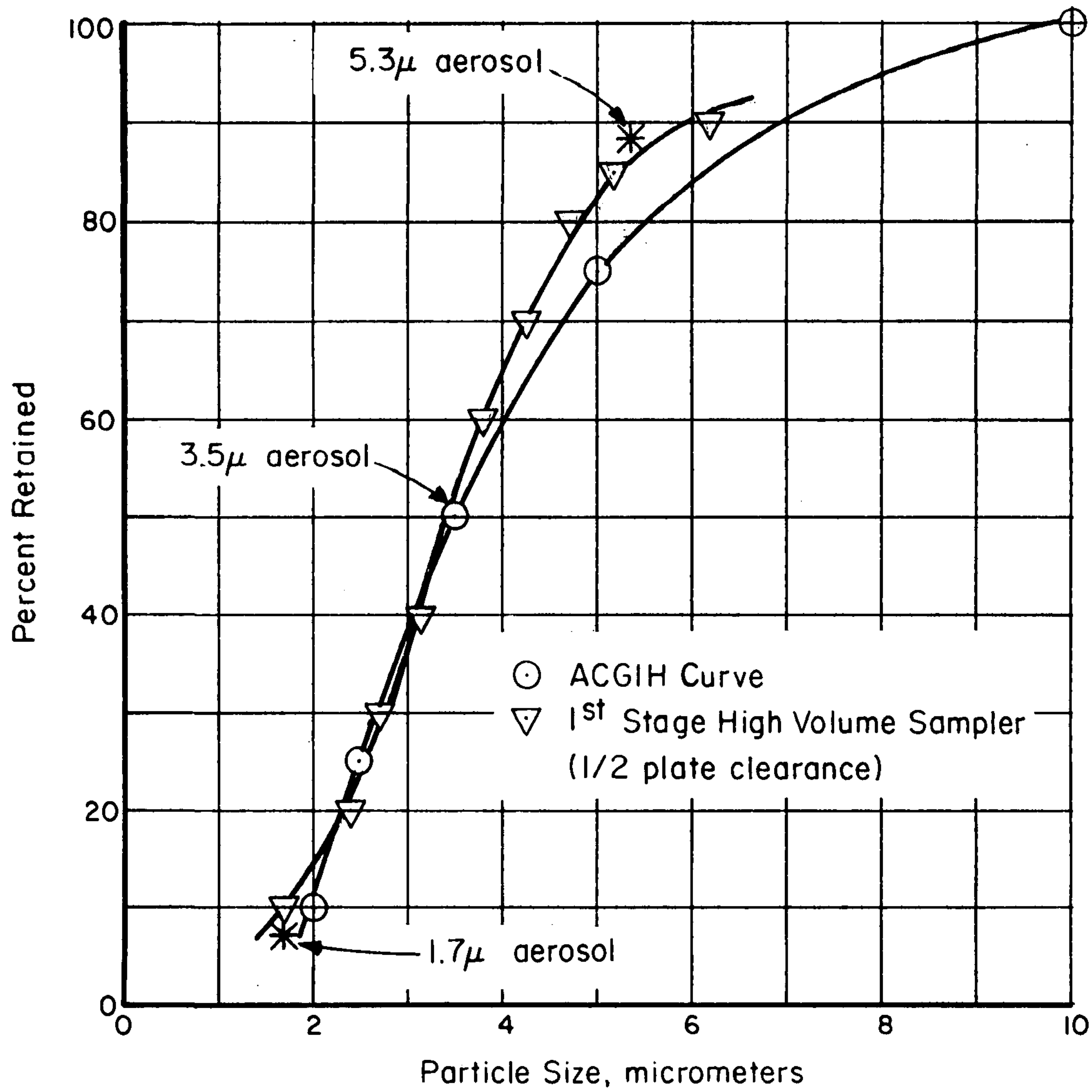

FIGURE 3. COMPARISON OF ACGIH CURVE AND COLLECTION EFFICIENCY OF THE FIRST STAGE OF MASSIVE VOLUME SAMPLER (MARK II)

very close similarity for the two curves. The cutoff size of 3.5 μm and the smaller particle sizes lie on both curves. Although there is some deviation from the ACGIH curve for the larger sizes, it is minimal considering that the ACGIH is only a theoretical approximation of the lung deposition characteristics. This curve also shows the collection efficiency data obtained for three different sizes of monodispersed aerosols (1.7, 3.5, and 5.3 μm) which were used to challenge the completely assembled Mark II sampler head mounted in a wind tunnel. These data show that there is no interaction between slots and that the impaction data for the full-scale sampler can be predicted from single slot data.

The collection efficiency of the impaction slots for the prototype sampler (Mark I) was determined at the same time that the new impaction slots were calibrated. Figure 4 shows the impaction characteristics for the impaction slot used in the prototype Mark I sampler (6.3 x 25.4 mm oval slot). The curve also shows the effect of reducing the target width (the narrower the width, the more inefficient the sampler becomes in obtaining sharpness of cutoff). The total flow through the Mark I sampler was previously reported as 26.0 m^3/min. However, an error was found in the integration data obtained with the hot-wire anemometer. The true flow is actually 19.5 m^3/min. At this flow rate the cutoff size for the first stage is 3.6 μm, and for the second stage 2.1 μm.

Reproducibility Tests with Fluorescent Aerosols

After showing that identical data could be obtained with the full-scale sampler as compared to single slots, the sampler was challenged with a fluorescent dye aerosol dissolved in Freon contained in a conventional aerosol can. The particle size of various formulations was varied by changing propellant concentrations and by adding small quantities of nonvolatile dibutyl phthalate. Table 1 shows the reproducibility of the two new Mark II samplers when they were used to sample the fluorescent aerosols. Three different aerosol formulations, having mass median diameters of 2.1, 2.4, and 5.1 μm, and two samplers (A and B) were used.

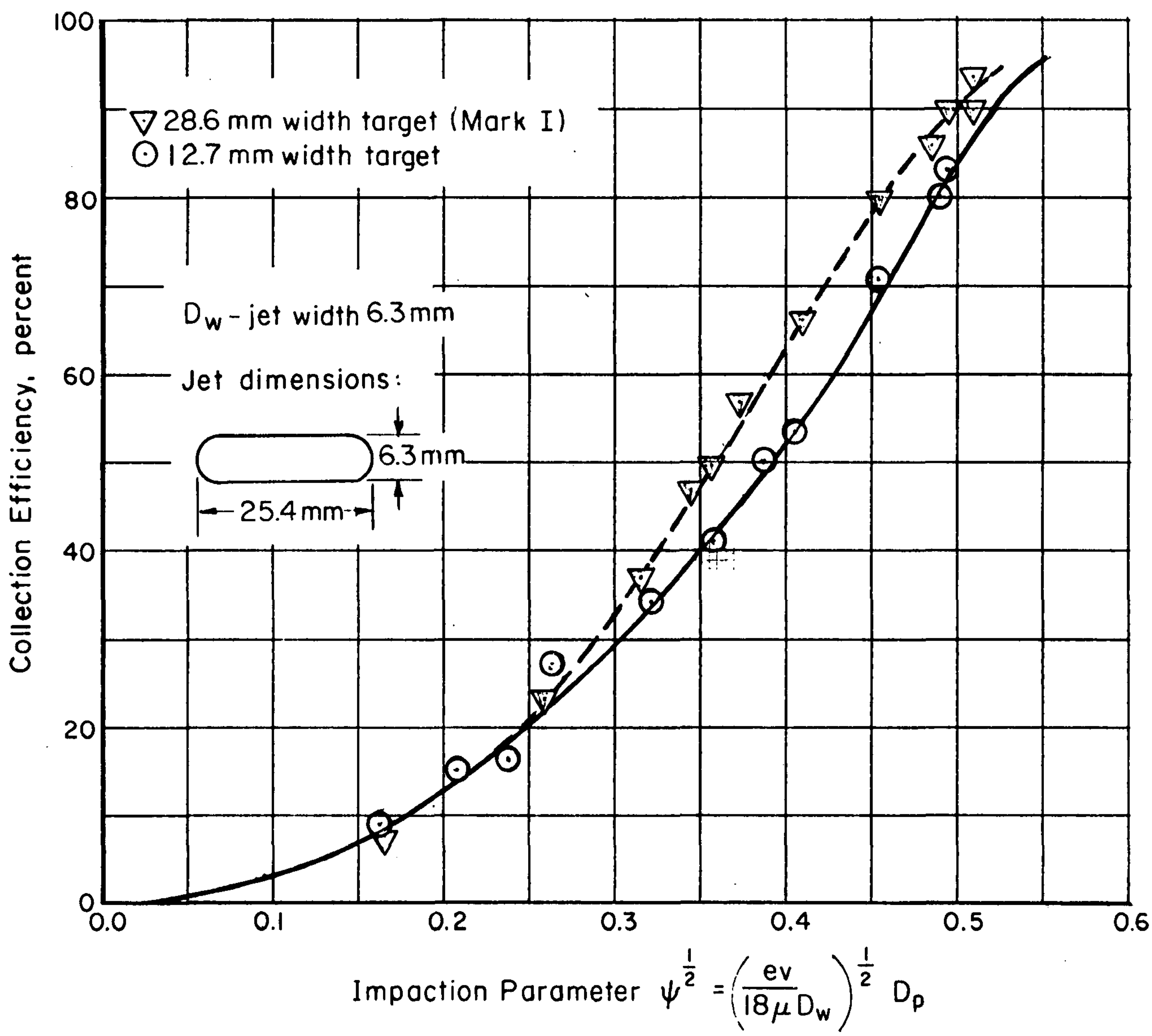

FIGURE 4. IMPACTION EFFICIENCY CURVES FOR 6.3 mm WIDE JETS

TABLE 1. REPRODUCIBILITY TESTS USING HETEROGENEOUS FLUORESCENT AEROSOLS DISPENSED WITH CONVENTIONAL AEROSOL PACKAGES

Test	1	2	3	4	5	6
Can	F	F	E	E	A	A
Sampler	A	B	A	B	A	B
MMD μm	2.1	2.1	2.4	2.4	5.1	5.1
Grams Dispensed	17.6	17.5	18.3	17.9	7.9	8.0
Total Fluorescence Units Collected	693 614	683 417	1 411 875	1 440 875	319 830	321 359
Units Collected per Gram Dispensed	39 410	39 052	77 151	80 495	40 485	40 170
Percent Collected						
Stage 1	16.52	14.54	26.56	27.76	54.72	54.73
Stage 2	51.90	50.17	51.35	51.18	29.46	29.86
Precipitator	28.76	30.79	18.77	17.80	14.44	14.14
Backup filter	2.82	2.48	3.32	3.25	1.37	1.27
Overall Collection Efficiency, %	97.2	97.5	96.7	96.7	98.6	98.7

The aerosols were sprayed into a wind tunnel containing the massive volume sampler heads and a special cascade impactor. A high volume filter sampled the effluent from the Massive Respirable Particulate Air Samplers in order to obtain the overall collection efficiency.

FIELD REPRODUCIBILITY, EFFICIENCY, AND GAS-PARTICULATE REACTIVITY TESTS AND RESULTS OF MARK II SAMPLERS

Reproducibility Tests Using Ambient Aerosols

In order to check the reproducibility of the two samplers in the field with ambient aerosols, they were positioned outside the laboratories about 6 m apart. Because of building obstruction and possible variance in meteorological conditions, the sampler positions were interchanged daily in order to minimize sample bias. The samplers were operated for 14 days. Table 2 shows the weights of particulates removed from each collection surface. The alcohol scrub was used to recover any particulate residue left on Stage 3 after the normal scrape recovery. These results show that the two samplers have virtually identical collection characteristics.

TABLE 2. REPRODUCIBILITY OF THE MARK II SAMPLERS IN THE COLLECTION OF AMBIENT AEROSOLS

	Sampler A	Sampler B
1st Impactor Stage (3.5 to 20 μm)	1.177 g	1.074 g
2nd Impactor Stage (1.7 to 3.5 μm)	0.996 g	0.995 g
3rd ESP Stage (<1.7 μm)	9.110 g	9.073 g
Alcohol Scrub of Precipitator Plates	0.800 g	0.860 g
Total	12.083 g	12.002 g

Cyclone Comparison of Massive Respirable Particulate Air Sampler with Miniature Cyclones and High-Volume Sampler Equipped with Andersen-2000 Impactor Head

A 14-d test was run in which a comparison was made among the respirable fractions of particulates collected by the Massive Respirable Particulate Air Sampler, two miniature cyclones, and a high-volume sampler equipped with an

Andersen-2000 impaction head. The sampling rate for the Hi-Vol-Andersen sampler was 1.1 m^3/min. The operating voltage of the precipitator action of the Massive Respirable Particulate Air Sampler was 7600 V (positive corona), which is about 78% efficient for submicrometer particles.

Table 3 shows the comparative collection rates for the three types of samplers. These results indicate that the concentration of the respirable fraction obtained by the cyclones and the Hi-Vol-Andersen sampler is about 39 $\mu g/m^3$, while the Massive Respirable Particulate Air Sampler gave a concentration of 32 $\mu g/m^3$. Correcting for operation at the low-ionizing voltage yields a concentration of 40 $\mu g/m^3$ (see Table 4).

TABLE 3. COMPARATIVE COLLECTION RATE FOR THREE TYPES OF RESPIRABLE AEROSOL SAMPLERS

Sampler	High Volume (Andersen)	Miniature Cyclones a	Miniature Cyclones b	Massive Respirable Particulate Air (Mark II)
Sampling Rate	1.13 m^3/min	8.72 l/min	8.26 l/min	17.3 m^3/min
Sample Weight collected <3.5 (mg)	895.9	6.37	6.48	11,210
Volume of Air Sampled (m^3)	22,780	175.8	166.5	348,800
Concentration of respirable particulates ($\mu g/m^3$)	39	36	39	32*

*80% of sample collected on precipitator plates; correcting for low collection efficiency at operating voltage, the respirable concentration would be 36 $\mu g/m^3$.

Massive Respirable Particulate Air Sampler Collection Efficiency of Submicrometer Aerosols

The collection efficiency of the Massive Respirable Particulate Air Sampler for submicrometer aerosols was determined using the Minnesota Aerosol

TABLE 4. COLLECTION EFFICIENCY OF PARTICLES SMALLER THAN 0.42 μm AT DIFFERENT OPERATING CONDITIONS FOR THE MASSIVE RESPIRABLE PARTICULATE AIR SAMPLER

Test	Sampler Exit Concentration* μg/m	Corona Sign	Corona Voltage	Plate Voltage	Ozone† Concentration Above Background, ppm	Collection Efficiency, Percent
1	2.88	Positive	7800	7800	0	66.0
2	2.48	Negative	7800	7800	0.025	80.4
3	2.39	Negative	7800	7800	0.025	81.1
4	1.37	Negative	9500	7800	0.050	89.2
5	1.95	Negative	11 500	7800	0.120	84.6
6	1.22	Negative	13 000	7800	0.220	90.4

*Ambient aerosol concentration 12.7 $\mu m/m^3$.
†Ambient background ozone concentration 0.05 ppm.

Analyzing System. The instrument was used to determine the concentration of ambient aerosols in the size range from 0.028 to 0.42 μm. These measurements were made at the sampler inlet and outlet for various operating conditions.

Table 4 lists the collection efficiency for the total integrated mass of particles in the above size range. The table also lists the ozone generation rate for the different operating voltages.

The raw data show that for a given operating condition the efficiency was fairly consistent and did not drop off as the particle size decreased.

Evaluation of Gas-Substrate and Gas-Particle Reactivity

Considerable evidence (1-5) exists on artifact particulate formulation with the use of certain filter substances for aerosol collection. High efficiency filters have large surface areas on which monolayers of gases can adsorb and undergo chemical reactions to form artifact sulfate and nitrate salts. This problem is much less severe when quartz, pH neutral glass, or Teflon filters are substituted for the more commonly used alkaline glass filters, but some interaction has still been found. It was not anticipated that similar reactivity would occur in the Massive Respirable Particulate Air Sampler precipitator collections, but efforts were made to ascertain any reactivity. The electrostatic precipitator collector stage of the Massive Respirable Particulate Air Sampler employs 55 aluminum sheets measuring approximately 43 x 28 cm charged with a high electrostatic voltage. (Note: After completing the substrate and gas-particle interaction studies described below, the aluminum collection surfaces were coated with a conductive Teflon surface. Therefore, the results of the studies using aluminum substrates may not apply to the more chemically inert Teflon substrate surfaces.)

To evaluate substrate and gas-particle reactivity, a series of experiments were made wherein the two assembled samplers were set up side by side with one sampling ambient air spiked with well-above (10X) ambient concentrations of SO_2, NO_2, and O_3, while the other sampled ambient air only. These experiments were performed sequentially; i.e., the SO_2 spike and nonspike experiments were run followed by the O_3 and then the NO_2 spike. Two-day runs were made for each study.

In these experiments it was planned to evaluate reactivity by two methods: (a) using a calibrated gas analyzer to monitor at the exit of the samplers, alternating measurements between the spike gas flow sampler and the nonspike gas flow sampler; and (b) removal and chemical analyses of particulates collected on each sampler. These experimental trials were largely unsuccessful due to erratic operation of both the gas-measuring monitors and the spike gas flow system, as well as the very small masses of particulates collected during the experimental trials. The SO_2 spike experiment indicated minimal reactivity, but the error bars were too large for positive results as can be seen in Table 5.

TABLE 5. 24-h AVERAGES OF REACTIVITY OF GASES SAMPLED AS MEASURED THROUGH SAMPLERS (results in ppb)

Reactant Gas	SO_2
Sampler "A" Spike, Addition to Ambient	$750^{\pm 75}$
Sampler "B", Measured Ambient Concentration at Exit	$48^{\pm 13}$
Sampler "A", Measured Spike and Ambient Concentration at Exit	$775^{\pm 28}$
Sampler "A", Concentration over Ambient	$727^{\pm 41}$

The SO_2 spike experiments followed by $SO_4^{=}$ determinations of the collected particulates show nominally equal (0.49 versus 0.61%) $SO_4^{=}$ contents in the particulates recovered from the electrostatic stages of the two samplers. However, the finding of only about 0.5% ambient air sulfate appears unusual even in view of the fact that during the period of these experiments (mid-March 1976) there was considerable rainfall which would tend to clean the atmosphere. Another factor casting doubt on the evaluation of these data is the small amount of total mass collected in the series of 2-d spike experiments. An average of only ∿0.5 g of particulate was recovered from the precipitator stages during the experiments, due to the very low atmospheric particulate loading during the rainy 2-d collection periods. Rigorous scraping of the precipitator plates was required for recovery of the collected particulate with the result that a disproportionately high amount of aluminum and aluminum oxide subsurfaces was included in the particulate samples used for the chemical determinations. (This problem of difficult removal and metal, metal-oxide contamination and possible chemical reaction was resolved with the use of Teflon-coated plates.)

The NO_2 and O_3 gas spike-measurement data were too erratic for valid interpretation. The experiments did emphasize the difficulty in recovering small masses of particulates from the precipitator plates, and attention was given to resolving this problem with the resultant adoption of coating the plates with conductive Teflon. This provides a very smooth surface in contrast to the previously used aluminum surface which eventually becomes oxidized, somewhat porous, and irregular, making complete recovery difficult.

Feasibility of Coating Precipitator Plates with Teflon

The original Mark I samplers utilized 55 high-purity aluminum plates for high-efficiency collection of the small size range particles in the electrostatic precipitator section of the sampler. These plates, which are removable for sample recovery, are 43 x 28 cm in size. One of the major problems with the Mark I sampler has been the time and effort required to recover the small particles from all this surface area. Razor blade scraping has been the quickest way, but this introduces contamination from the razor blade and from the aluminum substrate. Several suggestions were made to apply nonmetallic polymer-type coatings to the plates. However, most of the people familiar with electrostatics believed that these would be inefficient since the surface would not be conductive. Experimental trials were made using thin Teflon-coated surfaces, but these proved to be nonconductive and were judged inefficient. Subsequent to these trials, proprietary discussions with people at E.I. duPont de Nemours and Co. revealed the availability of Teflon containing graphite that was reported to be fairly conductive. A few gallons of this product were located, and several plates were coated and evaluated in the sampler. This trial showed that each graphite fiber acted as a needle electrode and caused the complete plate to ionize. Further investigation revealed another formulation containing a high percentage of carbon black which made it a better conductor. It was tried and appeared to be satisfactory.

After several unsuccessful trials to obtain a suitable way to adhere the carbon-impregnated Teflon to the plates, a suitable application mode was found, and one set of coated precipitator plates was obtained. Comparisons were made with a set of uncoated plates. For these tests the Massive Respirable Particulate Air Sampler head was placed in a wind tunnel and challenged with fluorescent aerosols identical to those used in the reproducibility tests.

Table 6 lists the results for two different aerosol formulations. The quantity of particulates obtained on the different collection surfaces was determined by washing the dye off of all surfaces with absolute ethanol, and the concentrations of dye were measured by a fluorophotometer. This table shows that the collection efficiency of the sampler was the same regardless of the type of precipitator plates.

Figure 5 is a particle size distribution plot of the second set of fluorescent aerosol generated by Can "E" as obtained by a special Battelle cascade impactor. This plot shows that the mass median diameter of the aerosol is 2.8 μm. The plot also shows the two data points obtained with the Massive Respirable Particulate Air Samplers. Twenty-eight percent of the aerosol mass was collected on Stage 1 (3.5 μm), and the distribution shows that about 32% was larger than that size. This is very good agreement considering that some of the material, removed by the scalping inlet stage, was not analyzed. The second data point for the 1.7 μm fell exactly on the distribution curve.

TABLE 6. COMPARISON OF COLLECTION EFFICIENCY OF TEFLON-COATED ELECTROSTATIC PRECIPITATOR PLATES WITH UNCOATED ALUMINUM PLATES USING FLUORESCENT AEROSOL

Collection Surface	Teflon Coated: Fluorescent Units	Teflon Coated: Percent of Total	Uncoated Aluminum: Fluorescent Units	Uncoated Aluminum: Percent of Total
Test 1 - Can E				
Stage 1	950 000	30.50	1 198 436	32.52
Stage 2	1 670 130	53.61	1 915 246	51.98
Precipitator plates	475 600	15.26	543 850	14.75
Backup filter	19 460	0.62	27 168	0.73
	3 115 190		3 684 702	
Test 2 - Can F				
Stage 1	161 059	12.12	247 450	14.51
Stage 2	667 500	50.22	880 000	51.6
Precipitator plates	490 200	36.88	564 849	33.12
Backup filter	10 350	0.78	12 900	0.76
	1 329 109		1 705 199	

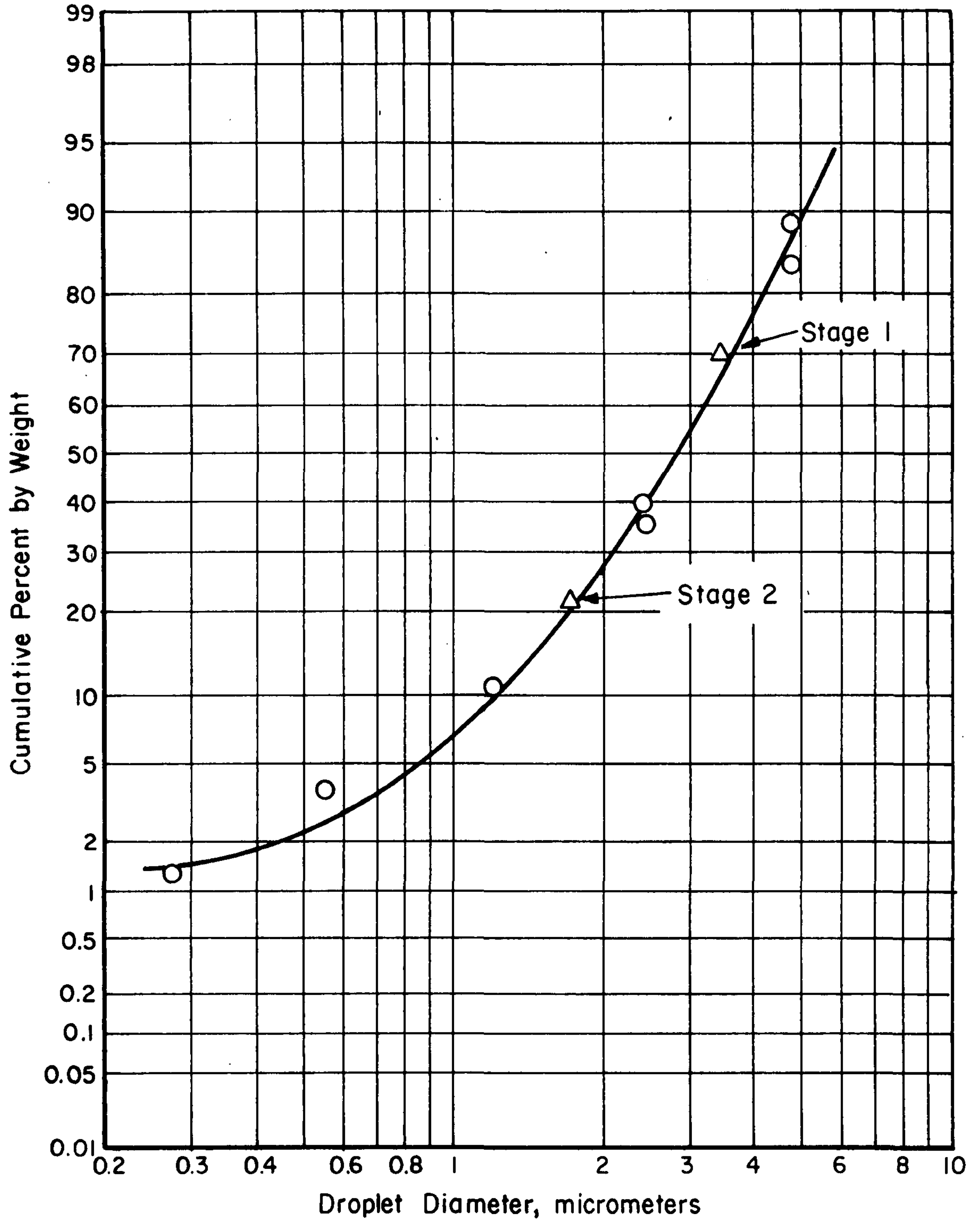

FIGURE 5. PARTICLE SIZE DISTRIBUTION DATA OF FLUORESCENT AEROSOL PACKAGE - CAN "E"

For the above series of tests, a negative voltage was used for both the ionizing wires (10,000 V) and the precipitator plates (6400 V). Table 6 also shows that by using a negative voltage the overall collection efficiency was increased (99.2% as compared to about 97% for all the same conditions using a positive corona).

Measurement of Collection Efficiency of Teflon-Coated Precipitator Plates

The collection efficiency of the Massive Respirable Particulate Air Sampler containing Teflon-coated precipitator plates was determined with the Minnesota Aerosol Analyzing System. Ambient air was sampled, and the particle concentration was measured at the sampler inlet and outlet.

Figure 6 is a plot of the collection efficiency obtained over the particle size range of 0.013 to 0.75 μm. This plot shows that the average collection efficiency for the submicrometer particles is over 90%. For this test the voltage on the precipitator plates was 5500 V, and the ionizing wires carried a negative potential of 10,000 V.

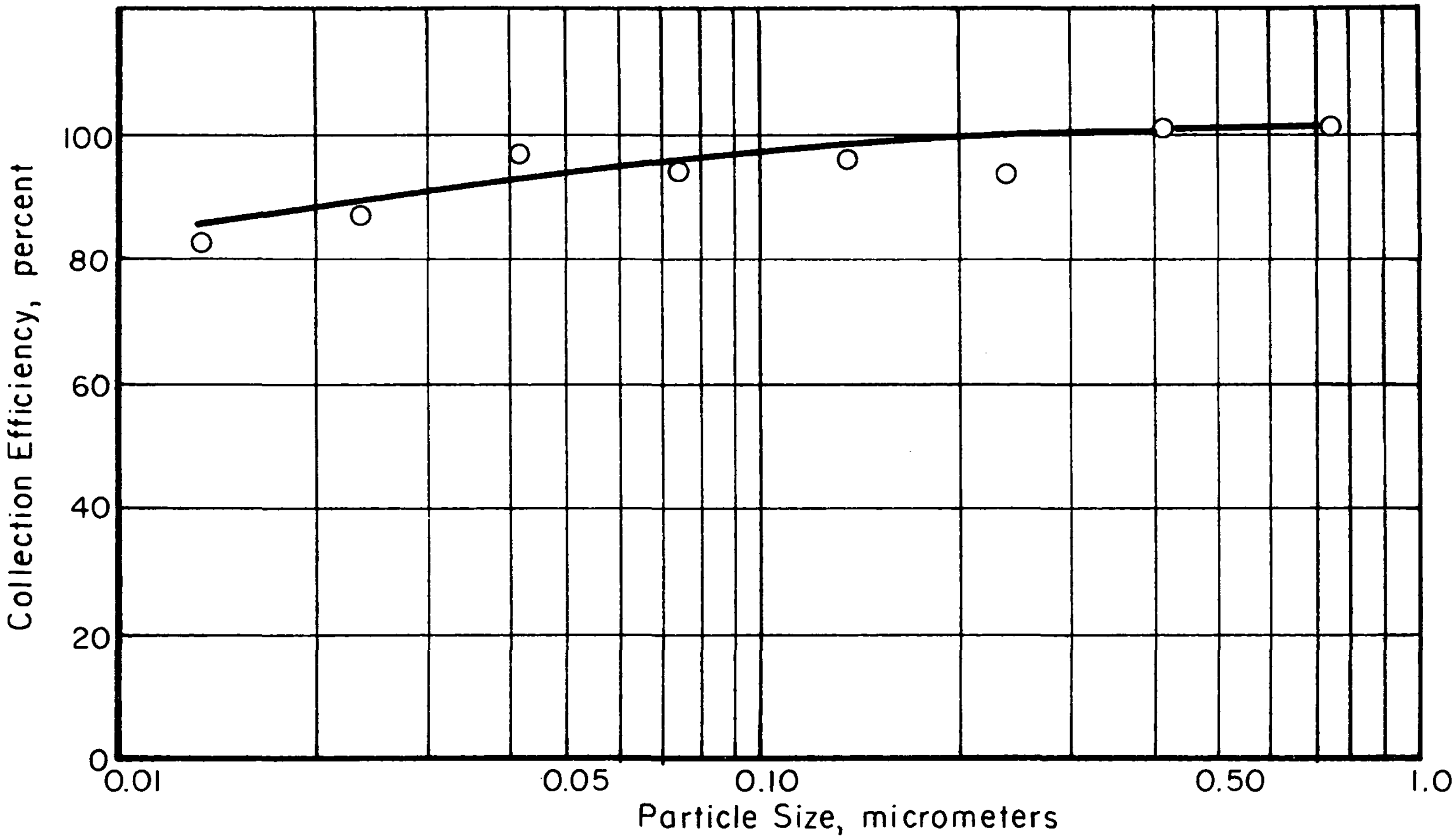

FIGURE 6. COLLECTION EFFICIENCY OF MARK II MASSIVE-VOLUME SAMPLER OBTAINED WITH THE MINNESOTA AEROSOL ANALYZING SYSTEM ON AMBIENT PARTICLES

SECTION 6

DISCUSSION

The Mark II second generation samplers represent substantial improvement over the initially designed and fabricated Mark I prototype samplers. Components that were observed to show wear, distortion, and failure have been strengthened and/or changed. Notable changes were (a) the use of stainless steel for the frames holding the precipitator plates, (b) the use of nonconductive Teflon with its better dielectric properties, (c) the addition of an inplace-shelf to hold the heavy precipitator assembly when it is being changed, (d) the improvement to the ionizing wire holders, and (e) the use of conductive Teflon coating on the precipitator plates to aid in collected sample removal.

Use in the field by relatively untrained operators has been made feasible and safer by:

- The preparation of a more comprehensive and detailed operating instruction and preventive maintenance document.
- The additions of an indicator light, a running-hour-meter, a flow meter and a voltmeter to permit ready observation of proper or improper running conditions.
- The inclusion of a minimum voltage relay to automatically shut down the sampler in the case of voltage malfunction to the precipitator plates.
- The inclusion of notches in the impactor plates so they can be inserted only in the proper sequence and alignment.
- The use of a high-voltage safety contact which is broken when the precipitator section is removed.

An important feature is the addition of a more rugged and versatile high-voltage system with two high-voltage supplies — one for the ionizing wires and one for the precipitator plates — to permit the use of various voltages and either positive or negative corona.

The incorporation of a conductive Teflon coating for the precipitator plates represents an advance over the high-purity aluminum collector surfaces used in the Mark I samplers. After continued use, especially in a relatively corrosive atmosphere such as Los Angeles, the aluminum plate surfaces become oxidized, making particulate recovery increasingly difficult to carry out without excessive inclusion of the oxidized aluminum surface materials. The smoother, more inert Teflon-coated plates enable particulate recovery to be done easier, faster, and relatively contaminant-free.

Experimental tests of the samplers' efficiencies, reproducibility, particle size cutoff stages, and overall operational performances have shown good results as described in the experimental text of this report. The raw data and results of these tests are recorded in Laboratory Notebook No. 32484.

Details of all engineering changes are included in newly prepared drawings, which with an accompanying parts list, including prices and manufacturer, should enable future samplers to be fabricated by equipment manufacturers or job shops. The accompanying Appendixes consists of comprehensive information regarding the Mark II sampler. Appendix A is a description of the sampler and operating procedures. Appendix B contains (1) a list of the revised drawings followed by reproduction of them.

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3. Pierson, W.R., R.H. Hammerle, and W. Brachaizek. Sulfate Formed by Interaction of Sulfur Dioxide with Filters and Aerosol Deposits. Anal. Chem., 48:1808, 1976.

4. Coutant, R.W. Effect of Environmental Variables on Collection of Atmospheric Sulfates. Environ. Sci. Tech., 11:9, 1977.

5. Battelle-Columbus Laboratories. Studies of the Effect of Environmental Variables on the Collection of Atmospheric Nitrate and the Development of a Sampling and Analytical Nitrate Method, Interim Report to the U.S. Environmental Protection Agency, Contract No. 68-02-2213, Columbus, Ohio, January 1977.

APPENDIX A

DESCRIPTION AND OPERATING PROCEDURES FOR THE MARK II MASSIVE RESPIRABLE PARTICULATE AIR SAMPLER

GENERAL DESCRIPTION OF MASSIVE RESPIRABLE PARTICULATE AIR SAMPLER

The Massive Respirable Particulate Air Sampler is designed to pull a very large volume of air, $\sim$25 000 m^3/day, through the sampler system and to collect particulates in three size ranges. The first two size ranges of 3.5 to 20 µm and 1.7 to 3.5 µm are collected by a two-stage impactor system housed in an impactor assembly module, and the third size range, $<$1.7 µm, is collected by a high-efficiency electrostatic precipitator.

Viewing Figure A-1, the air inlet is through the 50.8-mm slot seen near the top of the assembly. A Nylon small mesh screen (not pictured) is wrapped around this air inlet to prevent the entry of small insets. The impactor assembly is in a drawer, closed by snaplocks on either side of the sampler just below the air inlet. The electrostatic assembly is located just below the impactor assembly. It is also closed by snaplocks. The motor and motor housing is in the back of the sample collector. A galvanized duct is usually coupled to the air exhaust outlet to minimize reentrainment of ground dust in the immediate area of the sampler operation. The instrument panel includes a magnehelic flow gage, a running-hour-meter, a voltmeter, and a red indicator light to help insure proper operation.

Of course, the particulate collections should be kept separate when recovered. They should be placed in large opaque containers (Teflon is preferred) according to stages:

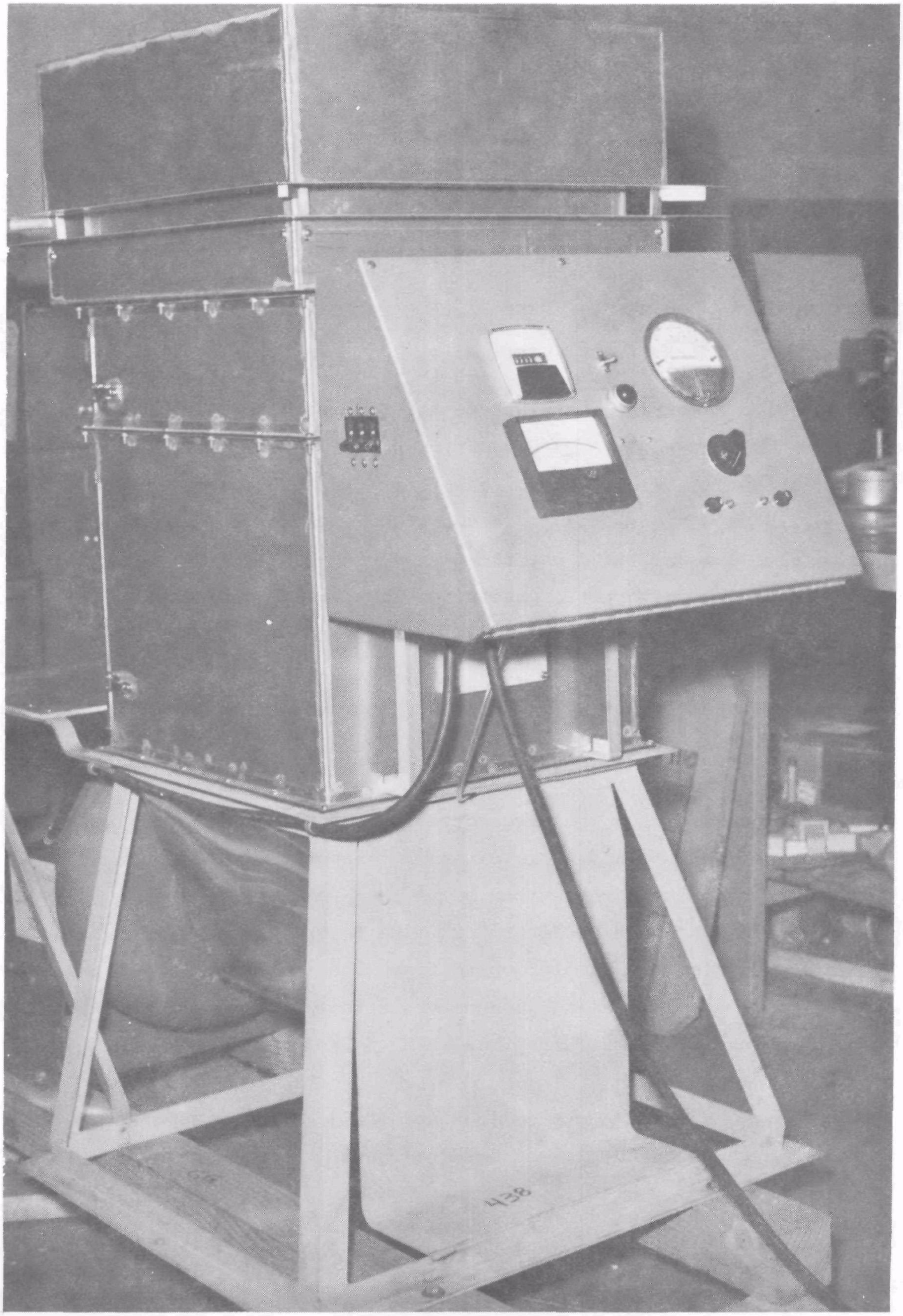

FIGURE A-1. OVERALL PHOTOGRAPH OF MASSIVE-VOLUME AIR SAMPLER (MARK II)

First Stage, Impactor - Size 3.5 to 20 μm

Second Stage, Impactor - Size 1.7 to 3.5 μm

Third Stage, Electrostatic Precipitator - Size <1.7 μm

Refrigeration is recommended to minimize possible chemical interaction.

Two impactor assembly modules and two electrostatic precipitator assemblies are provided with each sampler so that sampling can be nearly continuous; i.e., a cleaned assembly can be put in when the particulate-laden assembly is removed.

In operation the sequence of sample collection is as follows:

- Shut off power to the motor blower and to the electrostatic precipitator, generally every 24-h period.
- Remove the impactor plate assembly from the sampler and take it to a clean area or place in the impactor assembly shipping box.
- Install a second impactor plate assembly having cleaned (particulates removed--not washed) the plates.
- Start up the sampler again.
- In a clean area, remove the collected particulates from the impactor plates and replace the plates in the assembly for reinstallation and collection in the sampler. The objective of this operation (which is repeated every 1 to 3 d) is to prevent excessive particulate buildup on the impaction plates which could be blown off, resulting in improper size fractionation. Do not wash or excessively scrub the particulates from the plates. Repeated collection and removal will result in nearly total recovery over a time period.
- The electrostatic assembly sample recovery should follow the same general procedure as above, except that the assembly will be changed only about twice a month. The recovery of particulates from the 55 plates or about 13.9 m^2 of surface will require a 4- to 8-h effort. Since space and time for contaminant-free sample recovery may not be available at the field site, and since the recovery needs to be done only every 2 to 4 weeks, normally, it is recommended that the electrostatic assembly containing the particulate-loaded plates be placed in the shipping box provided and taken to a well-equipped clean laboratory for particulate recovery, reinstallation of the 55 plates, and reshipment to the field collection site.

OPERATIONAL GUIDE

Setup of Sampler System

It is assumed in this description that no electrical connections have been made and that the impactor plate assembly and electrostatic precipitator assembly are not in place in the sampler.

Step One--

Select a location to provide intake air at the desired vertical level. Keep in mind that the exhaust air flow is of a very high volume and may resuspend particulates which could get into the inlet. A large sheet of plastic spread below the sampler base or an extended exhaust can minimize this problem.

Step Two--

The base on which the sampler and blower motor are placed should be approximately level. The weight of the sampler and blower motor is about 225 kg.

Step Three--

Secure the sampler and blower motor independently to the base to minimize movement during operation. Prior to fastening, be certain that the blower motor housing inlet is in alignment and snugly fitted to the bottom sampler air fitting. The sampler should also be positioned so that the high-velocity blower exhaust is not deflected back into the sampler inlet.

Step Four--

Install impactor plate assembly (Figure A-2). Open the two snap fasteners located near the top of the sampler and raise the door opening. A magnetic latch will hold the door open. Remove the impactor plate assembly from the

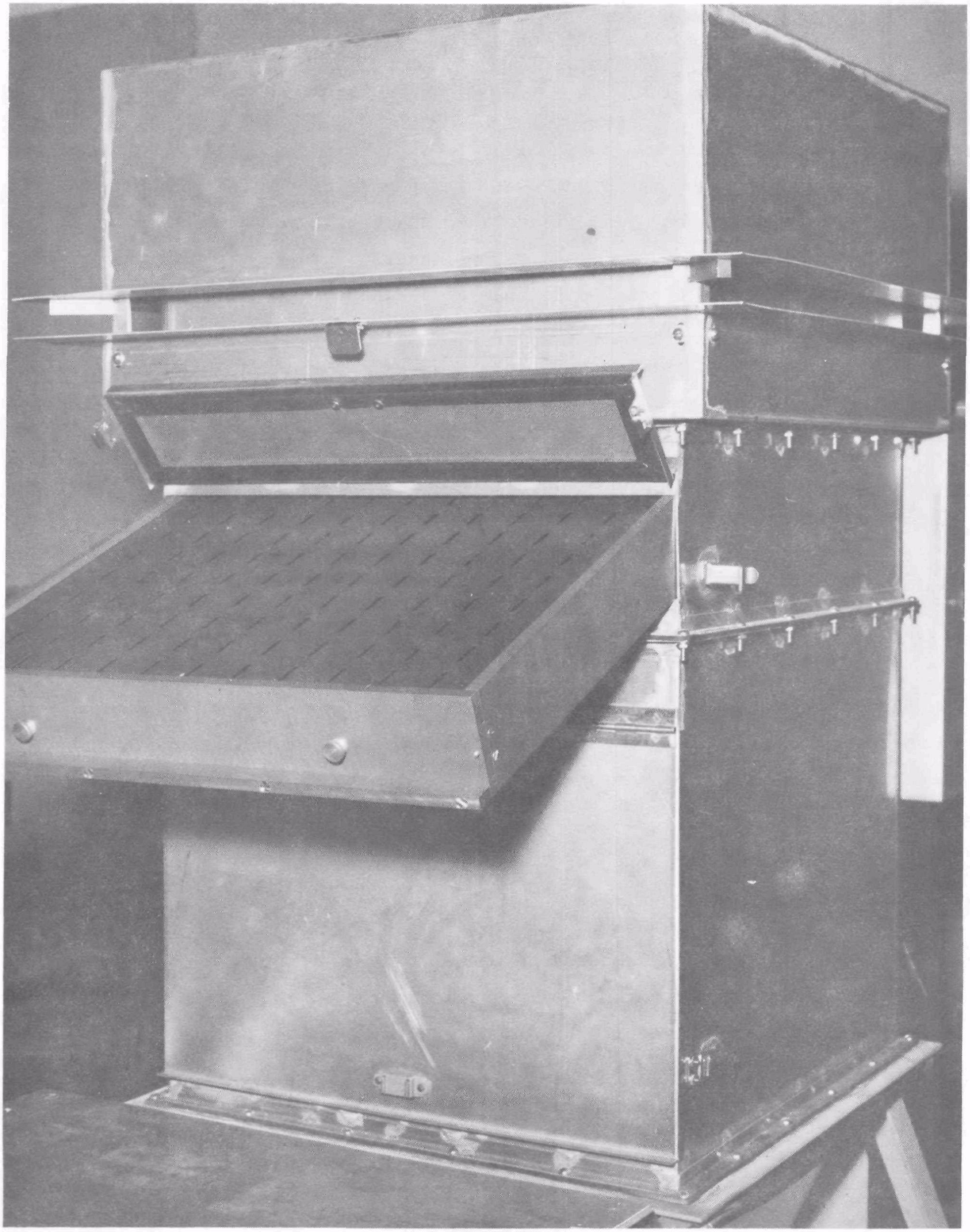

FIGURE A-2. IMPACTOR PLATE ASSEMBLY MODULE, PARTIALLY WITHDRAWN shipping box and carefully slide the impactor assembly (Figure A-2) into the opening. [Note: An impactor plate assembly may be already in place in the sampler. In that case ascertain that it has clean plates and reserve the second assembly for the next collection.]

The impactor plate assembly holder is a rigid box constructed of anodized aluminum. It has a removable end plate which permits the insertion of the impactor plates. The end plate is held in place with two knurled brass screws located in the middle of the plate. The impaction plates are constructed of stainless steel and are notched so that they can be inserted only in the proper sequence and have the proper slot alignment. The plate holder assembly has pins in the back which are spaced about 25.4 mm apart and fit the notches in the impaction plates when they are aligned properly. The proper impaction plate sequence is as follows:

Plate	Position	Slot Width, mm	Purpose
1	Top	4.8	Stage 1 Jets
2	2nd	9.6	Stage 1 Impaction Plates
3	3rd	1.2	Stage 2 Jets
4	Bottom	3.2	Stage 2 Impaction Plates

Be certain that these are placed in the right sequence (see slot width diameters above) and in the correct directions--notches to the rear. Do not force unnecessarily. Be certain of the proper alignment.

Step Five--

Install the electrostatic assembly (Figure A-3) by: (a) similarly opening the two snaplocks located on either side near the bottom of the sampler, (b) opening the electrostatic precipitator door until it is held by the magnetic latch, and (c) carefully sliding the electrostatic assembly into place. (Electrical control to the high-voltage power supply is made by spring contact when the assembly makes contact with the back wall.) After the precipitator is placed completely within the sampler, it will then be possible to close the

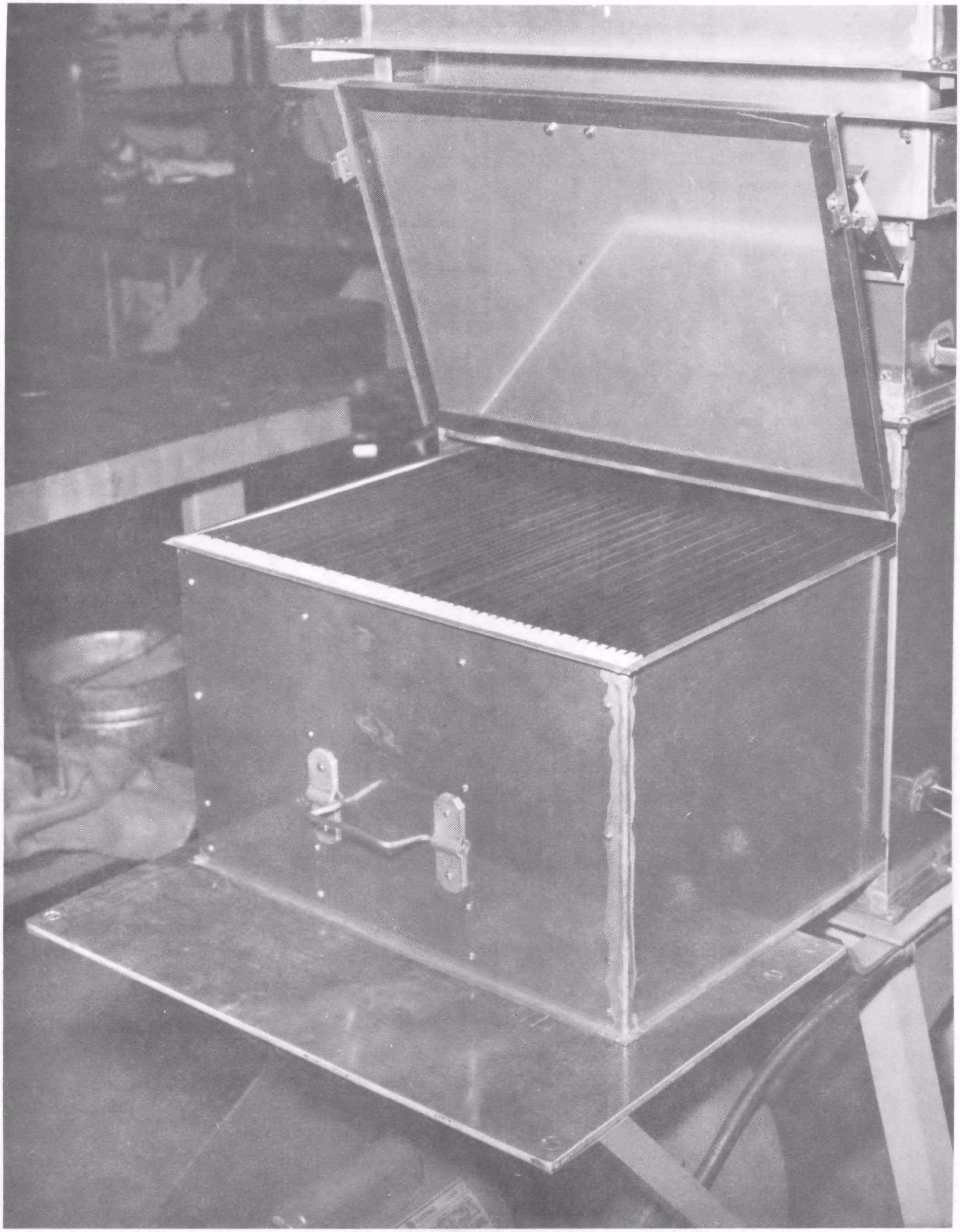

FIGURE A-3. ELECTROSTATIC PRECIPITATOR ASSEMBLY, PARTIALLY WITHDRAWN door and lock it with the two snap connectors. A rear view of the sampler (Figure A-4) shows the shelf on which the electrostatic assembly is held during installation and removal.

Step Six--

After completion of the above steps, the sampler is ready to be connected to an electrical outlet which has a capacity of at least 20 A. In order to start the sampler, the following steps should be followed:

(a) Set high-voltage meter relay at 2000 V.

(b) Turn both circuit breaker switches on (switches are located at side of control box.

(c) Push in override switch in the middle of control box. This will override high-voltage relay switch.

(d) Adjust potentiometer so that the high voltage to precipitator plates is approximately 5000 V. (Minimal arcing across plate should occur.)

(e) If excessive arcing occurs, check precipitator plates for straightness. A bent plate will reduce spacing between plates and will cause arcing at a low-voltage setting.

(f) If it is not possible to obtain any voltage reading on the plates, check for proper orientation. <u>Each plate is notched and the unnotched end fits into a spring clip attached to a bus bar. Therefore, the notches on every other plate are opposite each other. If one plate gets in backwards, it will short out the power supply</u>.

(g) Check magnehelic gage reading. The magnehelic gage measures the pressure drop across the sampler. Without any excessive leaks, the magnehelic gage should read approximately 16.0 cm of water pressure drop. This is equivalent to 17.3 m^3/min.

Step Seven--

<u>Changing impactor assembly and recovery of impaction collection</u>-- Remove the impactor plate assembly, replace it with spare assembly, and close the door. Start up sampler again. [Note: As instructed in Step Four, the

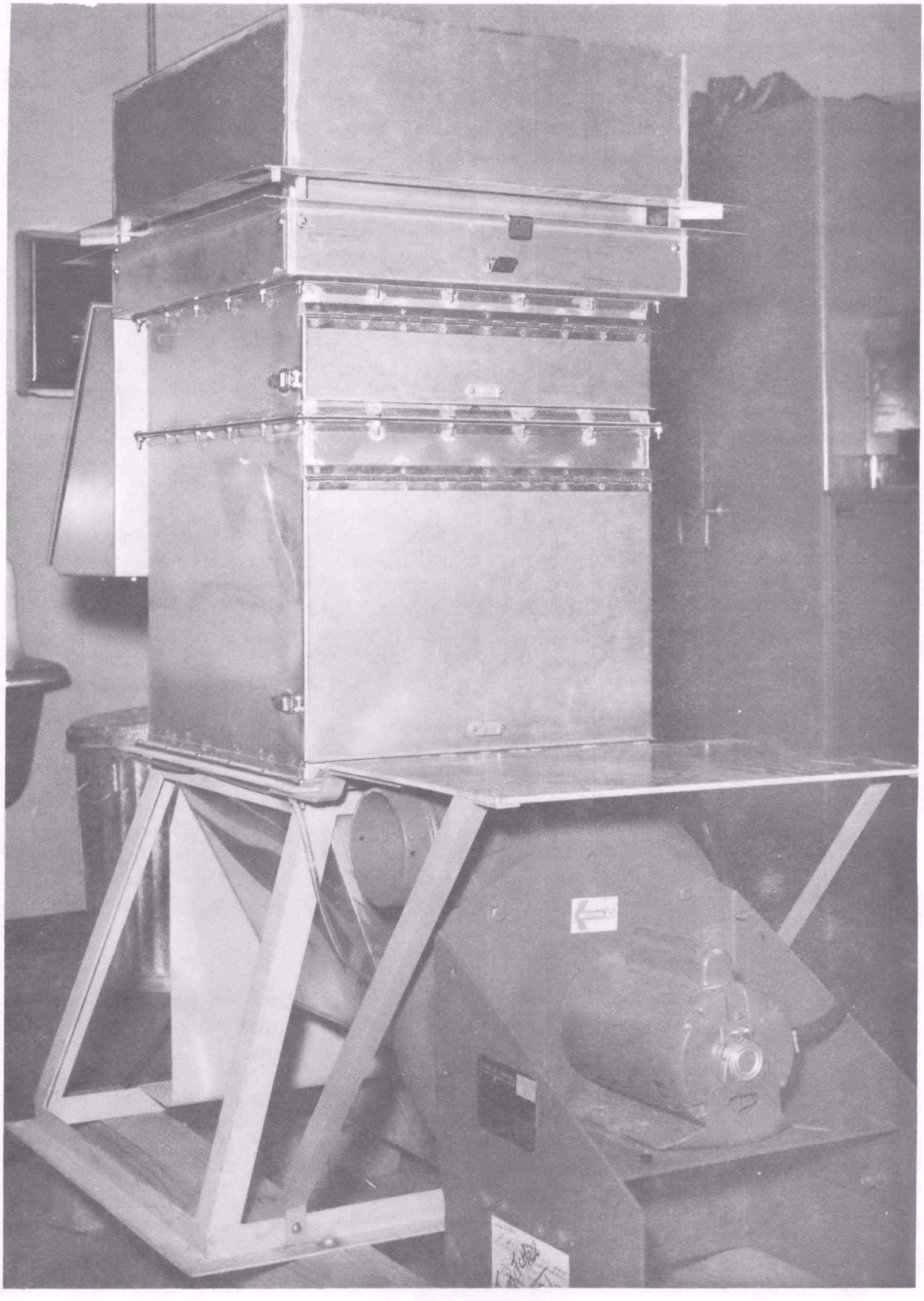

FIGURE A-4. REAR VIEW OF MASSIVE-VOLUME AIR SAMPLER

sampler is kept in nearly continuous operation by alternate use of two assemblies changed every 24 to 72 h.]

Recovery (requires about 1/2 h)-- Place a long clean strip of heavy gage aluminum foil on work bench to catch any spilled material removed from plates. Place a second piece of aluminum foil in the center of the working area. Remove impactor plate assembly door, and remove and clean plates in the following sequence:

(a) Top Plate. The top plate is the impactor jet for the first stage and should collect very little if any particulate (any material which is collected probably caused primarily by electrostatics). Brush any material off of the plate and place in a sample collection bottle labeled "1st Stage." Set the cleaned plate aside for subsequent reinstallation in the assembly, keeping in mind its correct orientation.

(b) Second Plate (1st Stage Collector). Remove plate and stand plate up with slots perpendicular to table top, placed in the middle of the top aluminum foil with the dirty side facing you. Then use a soft spatula to scrape dirt off plate. Start at the middle of the plate and scrape down. After the bottom half of the plate has been scraped, brush any particulates from the slots with a camel's hair brush. Set plate aside, and transfer particulates to sample bottle (1st Stage) by using the aluminum foil sheet as a funnel; if any material is spilled, remove it from the bottom layer of foil. Replace both layers of foil, and scrape other half of plate (positioned with collected particulates near the foil). Repeat above procedure. Please note that it is much easier to remove ambient samples after they have been allowed to equilibrate with the humidity in the room air (dry particles are much easier to remove than damp ones). There is no need to insure that 100% of the particles are removed since the process is repeated at the end of the next sample period.

(c) Third Plate. This is the slot plate for the second impactor stage assembly. It should contain very little collection material. Treat as with (a) above, but place any collections in a sample bottle marked "2nd Stage."

(d) Fourth Plate. This plate contains the second stage impactor collections. Treat as with (b) above, but add the collections to the sample bottle marked "2nd Stage."

How often the plates need to be cleaned is a function of the ambient dust loading. It is recommended that they be scraped at least twice weekly in a moderately dirty atmosphere. (Test at the LACS has shown that there is no great loss or blowoff of particulates for periods even up to 10 d.

Step Eight--

Change of Electrostatic Assembly*--

(a) Turn off all electrical power to sampler.

(b) Open the two snaplocks and raise door to assembly until it engages the magnetic latch. Pull assembly out until it rests on platform. Although the unit is disconnected from power supply, it is advisable to place a screw driver across any two plates in order to discharge any capacitor effect.

(c) Place the electrostatic assembly with the particulate-laden plates in the shipping boxes provided or take immediately to clean area.

(d) Install the second electrostatic assembly.

Step Nine--

Recovery of Sample Collection from Electrostatic Plates-- Open the shipping box and remove the electrostatic assembly in a clean area. Remove the plates individually, place on clean subsurface such as aluminum wrap (see Step Seven), and remove the collected particulates by scraping both sides of each plate with a sharp-edged plastic or Teflon spatula. Using a clean lab brush, brush the particulates into a sample bottle labeled "electrostatic precipitator catch."

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*The time interval for this change will vary depending on the particulate loading of the location being sampled. If the loading is known to be $\sim$100 $\mu g/m^3$, a weekly to bimonthly change appears appropriate from sample collection and recovery aspects.

After recovery of the sample, scrub the plates clean using a detergent, rinse with deionized water, dry, and reinstall the plates back into the electrostatic assembly according to the following procedure.*

The precipitator plate assembly is designed so that every other plate is either at ground potential or connected to the high-voltage potential. Thus, in order that the individual plates can be interchangeable, they are notched at the bottom corner so that there will not be a direct short across the two bus bars. The first plate should be installed so that the unnotched corner slides into a small clip attached to the bus bar and the notched corner does not touch the bus bar on opposite side. Each additonal plate is placed in the same manner, and the notches will be opposite each other. This positioning is absolutely necessary for sampler operation.

After the plates have been installed, place the assembly into the shipping box and ship back to the sampling site.

*This step is optional. If a continuous sampling at a specific site is maintained, the plates can be reinstalled without washing. They should be thoroughly cleaned if the sample site is moved or if there is definite indication that the air contaminants at the sampling site have changed.

APPENDIX B

PARTS/PRICE/SUPPLIER LIST AND REPRODUCTION OF DRAWINGS

Appendix B consists of two parts:

Table B-1: Parts, Price and Supplier List

Complete set of drawings for construction of the sampler

TABLE B-1. EPA MASSIVE VOLUME AIR SAMPLER PARTS/PRICE/SUPPLIER LIST

TABLE B-1. EPA MASSIVE VOLUME AIR SAMPLER PARTS/PRICE/SUPPLIER LIST

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
8	6352-D-039-042	Teflon coat with conductive teflon impactor plates	$225	Wilkinson Ind. Coatings, Inc. 107 E. 2nd Street Williamstown, W. Va. 26187
110	6352-D-005	Teflon coat with conductive teflon electrostatic plates	$550	"
2	-	Teflon rod, 1" diameter x 12" long	$ 12	American Plastic Distributors 1375 King Avenue Columbus, Ohio 43212
110	6352-D-005	6061-T6 Aluminum Sheets, 12" x 18" x 16 gauge (0.050-in. thick)	$150	Williams & Company 900 Williams Avenue Columbus, Ohio 43216
1	C-16C20	16 x 20 x 11-5/32 consolet (hoffman)	$ 40	Electric Motor & Control Corp. 57 E. Chestnut Street Columbus, Ohio 43215
1	B-671	1-hp open dripproof motor, 115 N., 1 phase, 3450 rpm, #56 frame	$ 70	Columbus Electrical Works Co. 777 N. 4th Street Columbus, Ohio 43215
6	CGH-5	1000 meg. ohm resistors	$ 50	IRC Division TRW, Inc. P. O. Box 393 Boone, North Carolina 28607
1	Model-D	American Standard blower, 1000 CFM, hp	$250	Kramer Equipment Company 1350 West Fifth Avenue Columbus, Ohio 43212

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
1	Model 2010	Magnehelic differential pressure gage, 0-10" of water	$ 30	Dwyer Instruments, Inc. P. O. Box 393 Michigan City, Indiana 46360
1	190-225-101 (W92X11-2-25)	Wood electric circuit breaker, 25 amp	$ 25	Newark Electronics 9799 Princeton Road Cincinnati, Ohio 43246
1	122-202-101 (W91X-11-2-2)	Wood electric circuit breaker, 2 amp	$ 10	"
1	50-240311AAAB	G.E. elapsed time indicator	$ 30	Pioneer Standard Electronics 1900 Troy Street Dayton, Ohio 45404
1	103-3101-1211-403	Indicator lamp assembly, dial CO	$ 5	Graham Electronics 1843 North Reading Road Cincinnati, Ohio 45215
1	53-0402-7502	API meter relay	$200	Pioneer Standard Electronics 1900 Troy Street Dayton, Ohio 45404
1	115F60	Amperite flasher relay	$ 3	Hughes-Peters, Inc. 481 E. 11th Avenue Columbus, Ohio 43211
1	20241-83	Series 900 detrol relay	$ 10	McJunkin Corporation 1700 Joyce Avenue Columbus, Ohio 43219

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
2	SHW-1626	Braun latch	$14/	Braun Manufacturing Company
2	SKHL-1628	Braun keaper	set	1655 N. Kostner Avenue
				Chicago, Illinois 60639
2	AUC-045	Power supplies, 10 KV, 5 milliamps	$444	Advanced High Voltage Co. 14532 Arminta Avenue Van Nuys, California 91402
1	6352-D-001	Cover	-	T. N. Cook, Inc. 3520 Fulton, East Columbus, Ohio 43227
1	6352-D-002	Electrostatic precipitator housing	-	"
2	6352-D-003	Wire retainer	-	"
1	6352-D-004	Electrostatic door	-	"
110	6352-D-005	Electrostatic plate	-	"
1	6352-D-006	High voltage spring contact	-	"
9	6352-D-008	Separator plate	-	"
1	6352-D-012	Impactor flange housing	-	"
1	6352-D-013	Large particle separator	-	"
1	6352-D-016	Impactor door	-	"
4	6352-D-019	Electrostatic door handle bracket	-	"

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
2	6352-D-020	High voltage plate contact	-	T. N. Cook, Inc. 3520 E. Fulton Columbus, Ohio 43227
2	6352-D-021	Electrostatic drawer handle	-	"
2	6352-D-022	Electrostatic drawer housing	-	"
1	6352-D-031	Base plate	-	"
1	6352-D-032	Exit duct	-	"
8	6352-D-038	Impact housing bracket	-	"
2	6352-D-039	Upper nozzle (plate No. 1)	-	"
2	6352-D-040	Upper impactor plate (No. 2)	-	"
2	6352-D-041	Lower nozzle (plate No. 3)	-	"
2	6352-D-042	Lower impactor plate (No. 4)	-	"
			$3,562/lot	
4	6352-D-007	Electrostatic insulator, front and rear housing	-	Blacklick Machine Shop 265 North Street Blacklick, Ohio 43004
4	6352-D-009	High voltage insulator plate	-	"
4	6352-D-014	Adjustable corner brace	-	"

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
2	6352-D-017	Rear impactor plate frame	-	Blacklick Machine Shop 265 North Street Blacklick, Ohio 43004
1	6352-D-018	High voltage insulator cap	-	"
2	6352-D-023	Right impactor plate frame	-	"
6	6352-D-025	Ionization wire insulator	-	"
12	6352-D-027	Stiffener "T" bar	-	"
4	6352-D-029	Bus bar	-	"
14	6352-D-035	Front impactor plate alignment pin	-	"
4	6352-D-036	Impactor frame front alignment pin	-	"
8	6352-D-037	Rear impactor plate regulator pin	-	"
2	6352-D-043	Impactor frame front cross member	-	"
2	6352-D-044	Left impactor plate frame	-	"
2	6352-D-045	Front impactor plate frame	-	"
			$3,782/Lot	
2	T-9755	Amerock magnetic catch	$ 5	Battelle Stock Items
2	-	1/4 x 1" strap x 8', cold rolled steel	$ 5	"

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
2	-	Hose bib (brass), 1/8"	$ 1	Battelle Stock Items
1	-	Aluminum plate, 13.62 x 20.62 x 1/4	$ 10	"
1	-	20 Ky Insulated Wire x 25'	$ 25	"
1	-	3/16" x 1" x 8' Support Bracket; Cold Rolled Steel	$ 15	"
2	-	1/8" x 1" x 1" x 8' Angle; Cold Rolled Steel	$ 15	"
1	6352-D-010	Electrostatic Flange Gasket; 1/8" Neoprene Foam Rubber	$ 15	"
1	6352-D-015	Impactor Door Gasket, 1/8" Neoprene Foam Rubber	$ 15	"
1	6352-D-011	Flange Gasket, 1/8" Neoprene Foam Rubber	$ 15	"
110	6352-D-028	0.030" Brass	$ 25	"
100'	6352-D-024	Ionization Wire, 0.005", Stainless Steel	$50/Roll	"
20	E0120-016-0750-S	Extension spring, 1/8" diameter 3/4" long	$ 20	Associated Spring or Equivalent
4	5-40 UNC	Round head cap screw, 1" long, stainless steel	-	Battelle Stock Items

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
6	5-40 UNC	Round head cap screw, 1/2" long, stainless steel	-	Battelle Stock Items
14	5-40 UNC	Hex nut, stainless steel	-	"
14	#5	Lockwasher, stainless steel	-	"
4	5-40 UNC	Round head cap screw x 1/2" long, stainless steel	-	"
28	6-32 UNC	Flat head screw x 5/8" long, stainless steel	-	"
4	6-32 UNC	Socket head cap screw x 1/2" long, stainless steel	-	"
24	6-32 UNC	Round head screw x 1/2" long, stainless steel	-	"
4	6-32 UNC	Round head screw x 3/4" long, stainless steel	-	"
4	6-32 UNC	Hex nut, stainless steel	-	"
4	6-32 UNC	Round head screw x 3/8" long, stainless steel	-	"
12	8-32 UNC	Round head screw x 5/15" long, stainless steel	-	"
16	10-24 UNC	Round head cap screw x 1/2" long, stainless steel	-	"

(continued)

TABLE B-1 (continued)

QUANTITY	DRAWING NUMBER/ PART NUMBER	PART NAME/MANUFACTURER	PRICE	SUPPLIER
60	10-24 UNC	Hex nut, stainless steel	-	Battelle Stock Items
76	#10	Lockwasher, stainless steel	-	"
60	10-24 UNC	Round head cap screw x 3/4" long, stainless steel	-	"
2	1/4-20 UNC	Brass knurled head screw x 1" long	-	"
2	1/4-20 UNC	Socket head cap screw x 0.50 long, stainless steel	-	"
6	1/4-20 UNC	Flat socket head screw x 0.50 long, stainless steel	-	"
			$50/Lot	
		Total Purchased Parts:	$9,728	
		Plus 5% P.O. Charges:	486	
		Grand Total:	$10,214	

Figure B-1. Drawings for construction of the massive volume air sampler.

The following section of this report contains reproductions of the drawings necessary to construct the Massive Air Sampler described in this publication. For further information regarding building of such a sampler, the Project Officer may be contacted as specified below:

Dr. Richard J. Thompson
Environmental Monitoring and Support Laboratory
U.S. Environmental Protection Agency
Mail Drop 78
Research Triangle Park, North Carolina 27711
Telephone (Commercial) (919) 541-2150

Note: Drawing No. 6352-A-030 supercedes drawing No. 6352-A-034.

DRAWING NUMBERS	Battelle Columbus Laboratories	505 King Avenue Columbus, Ohio 43201 Telephone (614) 299-3151

ACCT. G-6352-3 JOB NO.

BY N. H. DATE 9-9-76

DWG. NO.	DWG. SIZE	DESCRIPTION	USED ON DWG.	BY	DATE
6352-D-001	E	COVER	6352-A-030		
002	E	ELECTROSTATIC PRECIPATATOR HOUS.	6352-A-030		
003	D	WIRE RETAINER	6352-D-002		
004	D	ELECTROSTATIC DOOR	6352- -030		
005	D	ELECTROSTATIC PLATE	6352-A-026		
006	B	HIGH VOLT. SPRING CONTACT	6352-A-030		
007	D	ELECT. INSUL. FRONT & REAR HOU.	6352-A-026		
008	C	SEPERATOR PLATE			
009	C	HIGH VOLTAGE INS. PLATE	6352-A-030		
010	C	ELECTROSTATIC FLANGE GASKET	6352-A-030		
011	C	FLANGE GASKET	6352-A-030		
012	E	IMPACTOR FLANGE HOUSING	6352-A-030		
013	E	LARGE PARTICLE SEPERATOR	6352-A-030		
014	B	ADJUSTABLE CORNER BRACE	6352-A 030		
015	C	IMPACTOR DOOR GASKET	6352-A-030		
016	C	IMPACTOR DOOR	6352-A-030		
017	D	REAR IMPACTOR PL. FRAME	6352-A-033		
018	C	HIGH VOLTAGE INSULATOR CAP	6352-A-030		
019	A	ELECT. DRAWER HANDLE BRACKET	6352-A-026		
020	B	HIGH VOLTAGE PLATE CONTACT	6352-A-026		
021	B	ELECTROSTATIC DRAWER HANDLE	6352-A-026		
022	E	ELECTROSTATIC DRAWER HOUSING	6352-A-026		
023	E	RIGHT IMPACTOR PL. FRAME	6352-A-033		
024	B	IONIZATION WIRE	6352-D-002		
6352-D-025	B	IONIZATION WIRE INSULATOR	6352-D-002		

CAT. 284162 FORM D-4 11-73

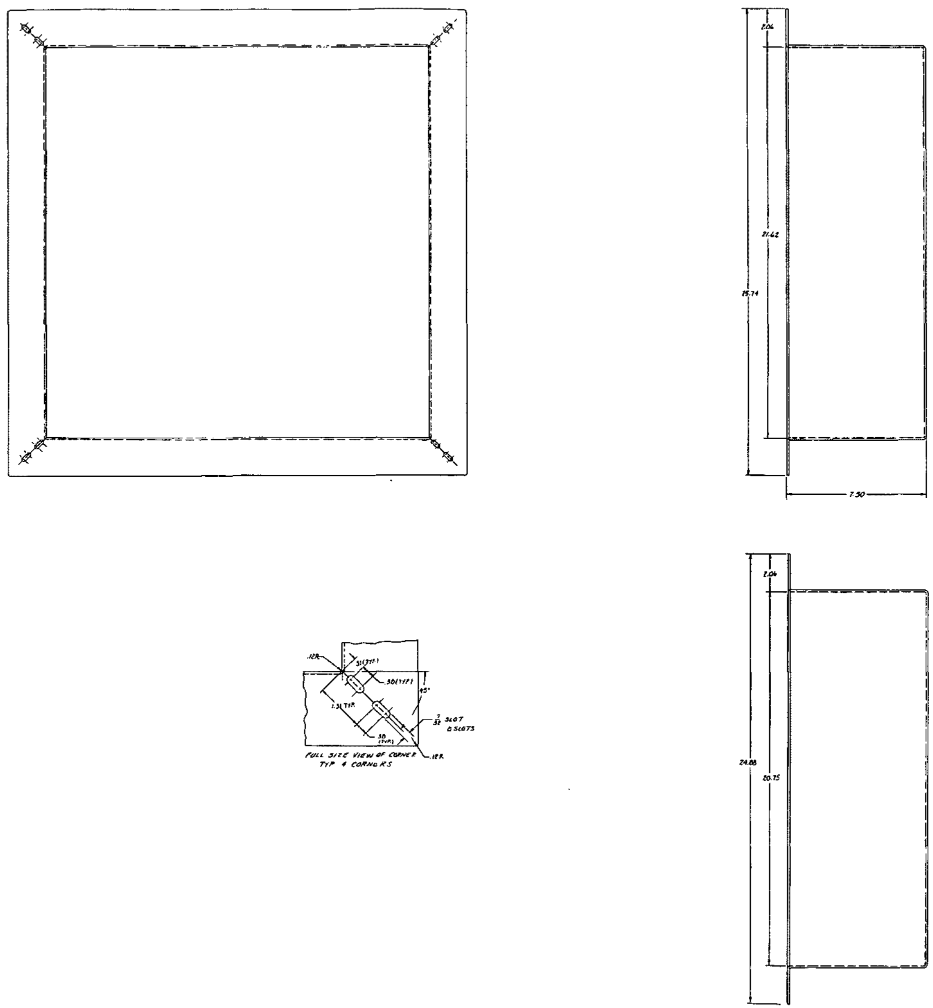
DRAWING NUMBERS	Battelle Columbus Laboratories	505 King Avenue, Columbus, Ohio 43201, Telephone (614) 299-3151

ACCT. G-6352-3 JOB NO.

BY N H DATE 9-9 76

DWG. NO.	DWG. SIZE	DESCRIPTION	USED ON DWG.	BY	DATE
6352-D-026	E	ELECT. PRECIPATATOR DRAWER ASSY	6352-A-030		
027	C	STIFFENER 'T' BAR	6352-A-026		
028	A	CLIP	6352-A-026		
029	C	BUS BAR	6352-A-026		
030	E	HIGH VOL. AIR SAMPLER ASSY.			
031	E	BASE PLATE	6352-A-034		
032	E	EXIT DUCT	6352-A-034		
033	E	IMPACTOR ASS'Y	6352-A-030		
034	E	BASE, EXIT DUCT & BLOWER ASS'Y.	6352-A-030		
035	A	FRONT IMPACTOR PL. ALIGN. PIN.	6352-A-033		
036	A	IMPACTOR FRAME FRONT ALIG. PIN	6352-A-033		
037	A	REAR IMPACT. PL. REG. PIN	6352-A-033		
038	B	IMPACTOR HOUSING BRACKET	6352-A-033		
039	D	UPPER NOZZLE (PLATE #1)	6352-A-033		
040	D	UPPER IMPACTOR PLATE # 2	6352-A-033		
041	D	LOWER NOZZLE PLATE # 3	6352-A-033		
042	D	LOWER IMPACTOR PLATE #4	6352-A-033		
043	D	IMPACTOR FR. FRONT CROSS MEMB.	6352-A-033		
044	D	LEFT IMPACTOR PL. FRAME	6352-A-033		
045	D	FRONT IMPACTOR PL. FRAME	6352-A-033		
046					
047					
048					
049					
050					

CAT. 204183 FORM D-4 11-73



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION
THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = ±.01 .XXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT
16 GA (.062)
304 STAINLESS STEEL

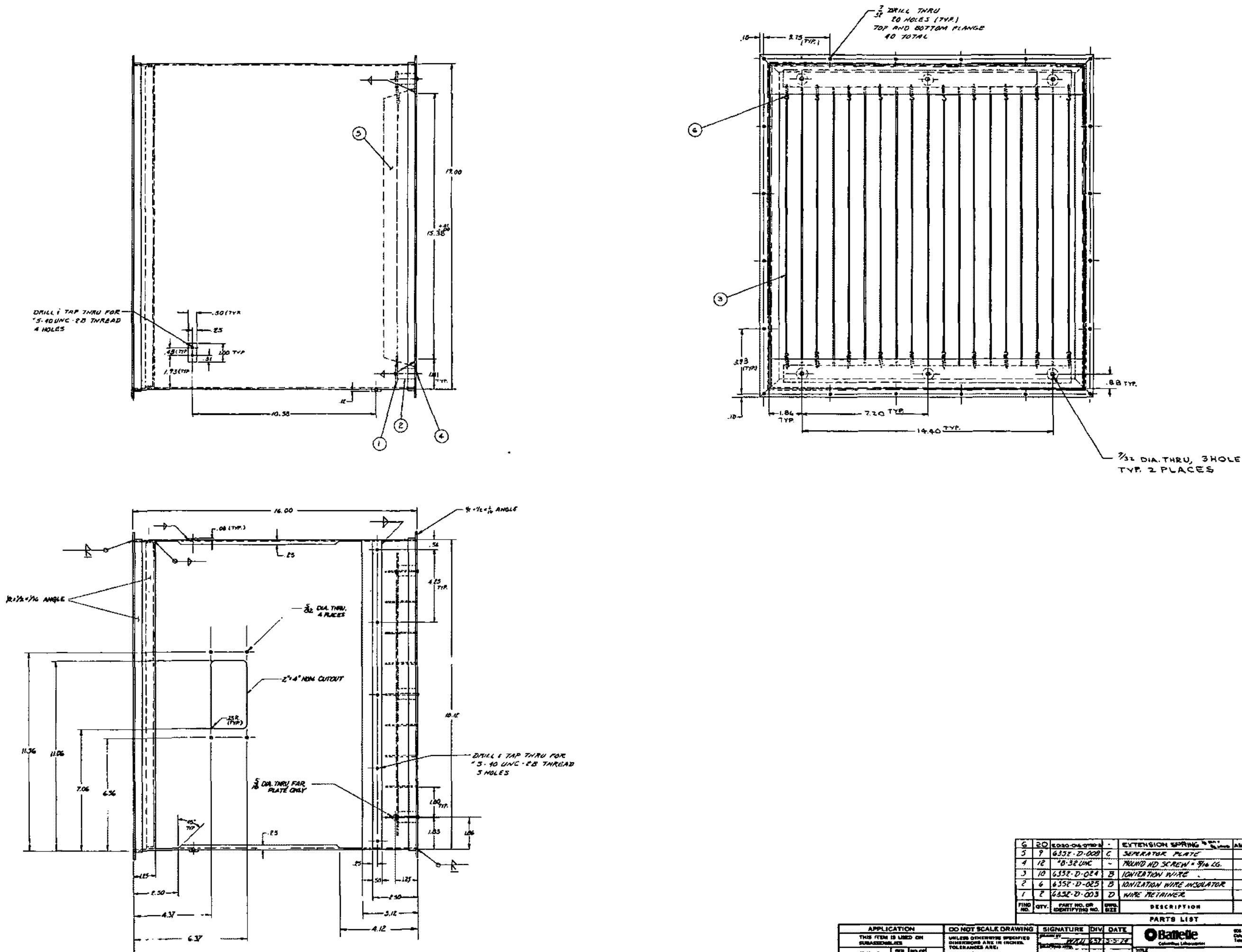
SIGNATURE		DIV.	DATE
DRAWN BY	WRD	654	5-11-78
DRAFTING APPD.			
DESIGN APPD.			
APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

Battelle
Columbus Laboratories

TITLE: COVER

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	644	6352-D-001	

SCALE 1/2-1 ACCT. G-6352-3 SHEET



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
6	20	E020-016-0750-M	-	EXTENSION SPRING	ASSOCIATED SPRING	
5	9	6352-D-008	C	SEPERATOR PLATE		
4	12	#8-32 UNC	-	ROUND HD SCREW × 5/16 LG.		
3	10	6352-D-024	B	IONIZATION WIRE		
2	6	6352-D-025	B	IONIZATION WIRE INSULATOR		
1	2	6352-D-003	D	WIRE RETAINER		

PARTS LIST

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES
TO MAKE FINAL ASSEMBLY — TOTAL REQD. 1

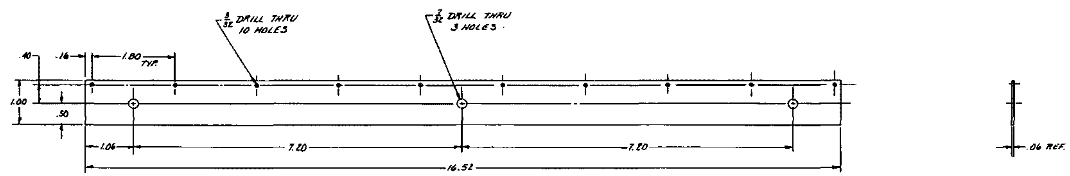
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01
MATERIAL AND TREATMENT: 16 GA (.062) 304 STAINLESS STEEL

SIGNATURE: DRAWN BY WKW — DIV. 657 — DATE 3-5-74

Battelle Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201, Telephone (614) 299-3151

TITLE: ELECTROSTATIC PRECIPATATOR HOUSING

SIZE E | CODE IDENT. NO. 79986 | DIV. NO. 644 | DWG. NO. 6352-D-002
SCALE 1/2:1 | ASSY. G-6352-3 | SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-D-002	2	1	2

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 2

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = ±.01 .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT

16 GA (.062) THICK 304 STAINLESS STEEL

SIGNATURE	DIV.	DATE
DRAWN BY WRD	659	4-20-74
DRAFTING APPR.		
DESIGN APPR.		
APPR.		
APPR.		
PROJECT APPR.		
SPECIAL APPR.		

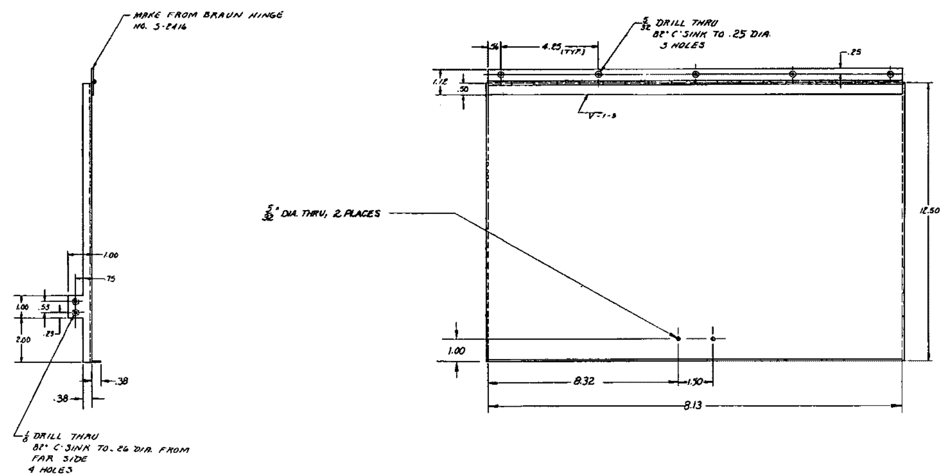
Battelle Columbus Laboratories

505 King Avenue Columbus, Ohio 43201 Telephone (614) 299-3151

TITLE: WIRE RETAINER

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352-D-003	

SCALE 1:1 ACCT. G-6352-3 SHEET



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY: 6352-A-030 — TOTAL REQD.: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = ±.01 .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT: 16 GA. (.062) 304 STAINLESS STEEL

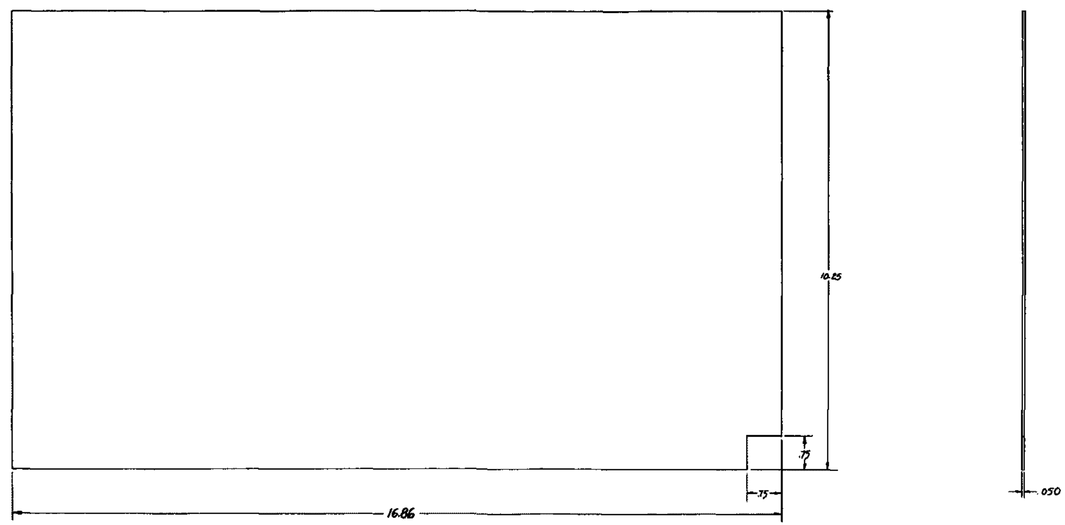
SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	4-27-79
DRAFTING APPR.			
DESIGN APPR.			
APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: ELECTROSTATIC DOOR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352- D -004	

SCALE 1/2:1 — ACCT. G-6352-3 — SHEET 1 OF 1



NOTE:
1. TEFLON COAT AS FOLLOWS:
   - PRIMER 850-308 WITH VM7799 ACCELERATOR .0005 THICK. CURED AT 450°F FOR 15 MIN.
   - TEFLON 855-225 .001 THICK CURED AT 750°F FOR 20 MIN.
   - SEE DUPONT SPECIFICATION SHEET FOR SURFACE PREPARATION DETAILS

REVISIONS

SYM	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-026	55	1	55

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 55

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01 .XXXX = .XXX = ANGLES =

MATERIAL AND TREATMENT: 6061-T ALUMINUM 16 ga (0.050 THICK) TEFLON COATED AS PER NOTE

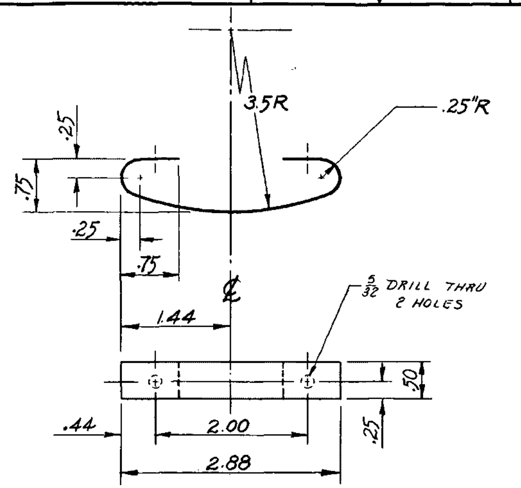
SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	4-20-74
DRAFTING APPD.			
DESIGN APPD.			
APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: ELECTROSTATIC PLATE

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352- D -005	

SCALE 1:1 ACCT. G-6352-3 SHEET



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX ±.02 .XXXX ±
.XXX± ANGLES±

MATERIAL & TREATMENT
SPRING GRADE BRASS .015" THK. GOLD PLATED

SIGNATURE	DIV.	DATE
DRAWN BY [illegible]	644	1/20/7[illegible]
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

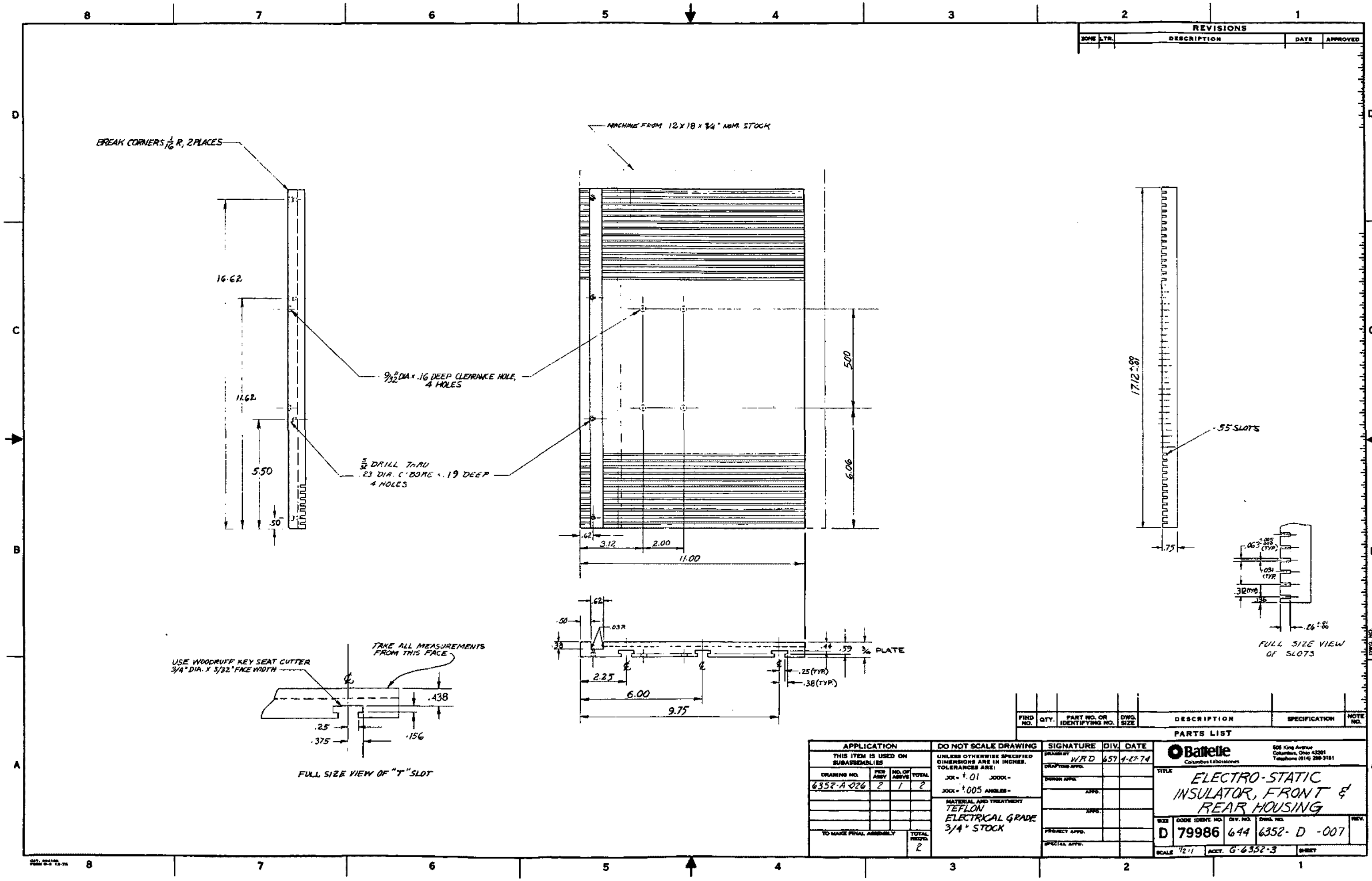
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE HIGH VOLTAGE SPRING CONTACT

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352-D 006	

SCALE FULL ACCT. G6352-3 SHEET 1 OF 1

CAT. 894168 FORM D-7 12-73



REVISIONS
ZONE LTR. DESCRIPTION DATE APPROVED
BREAK CORNERS 1/16 R, 2 PLACES
MACHINE FROM 12 X 18 X 3/4" NOM. STOCK
16.62
11.62
5.50
.50
9/32 DIA x .16 DEEP CLEARANCE HOLE, 4 HOLES
5/32 DRILL THRU .23 DIA. C'BORE x .19 DEEP 4 HOLES
5.00
6.06
.62
3.12
2.00
11.00
17.12
55 SLOTS
.75
FULL SIZE VIEW OF SLOTS
.50
.03 R
.38
.44
.59
3/4 PLATE
.25 (TYP.)
.38 (TYP.)
2.25
6.00
9.75
USE WOODRUFF KEY SEAT CUTTER 3/4" DIA. X 3/32" FACE WIDTH
TAKE ALL MEASUREMENTS FROM THIS FACE
.438
.25
.375
.156
FULL SIZE VIEW OF "T" SLOT
FIND NO. | QTY. | PART NO. OR IDENTIFYING NO. | DWG. SIZE | DESCRIPTION | SPECIFICATION | NOTE NO.
PARTS LIST
APPLICATION
THIS ITEM IS USED ON SUBASSEMBLIES
DRAWING NO. | PER ASSY | NO. OF ASSYS | TOTAL
6352-A-026 | 2 | 1 | 2
TO MAKE FINAL ASSEMBLY | TOTAL REQ'D. 2
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = ±.01 .XXXX =
.XXX = ±.005 ANGLES =
MATERIAL AND TREATMENT
TEFLON ELECTRICAL GRADE 3/4" STOCK
SIGNATURE | DIV. | DATE
DRAWN BY WRD | 659 | 4-27-74
DRAFTING APPD.
DESIGN APPD.
APPD.
APPD.
PROJECT APPD.
SPECIAL APPD.
Battelle Columbus Laboratories
505 King Avenue Columbus, Ohio 43201 Telephone (614) 299-3151
TITLE ELECTRO-STATIC INSULATOR, FRONT & REAR HOUSING
SIZE D | CODE IDENT. NO. 79986 | DIV. NO. 644 | DWG. NO. 6352-D-007 | REV.
SCALE 1/2:1 | ACCT. G-6352-3 | SHEET

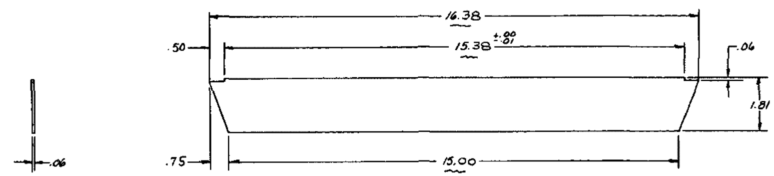
4	3	2	1

REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

D

C



B

A

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-002	9	1	9

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 9

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = ±.01 .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT

16 GA. (.062

304 STAINLESS

STEEL

SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	5-5-74
DRAFTING APPD.			
DESIGN APPD.			
APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

Battelle Columbus Laboratories

505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE

SEPARATOR PLATE

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352-D-008	

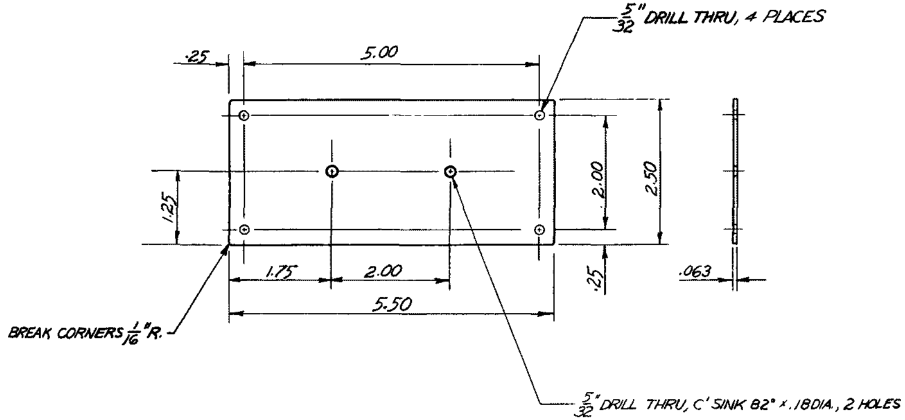
SCALE 1/2:1 ACCT. G-6352-3 SHEET 1 OF 1

DWG. NO.

CAT. 894167 FORM D-5 12-72

REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 2

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .01 .XXXX =
.XXX = .005 ANGLES =

MATERIAL AND TREATMENT

TEFLON PL
1/16 THK.
ELECTRICAL GRADE

SIGNATURE	DIV.	DATE
DRAWN BY MCH	644	1/11/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

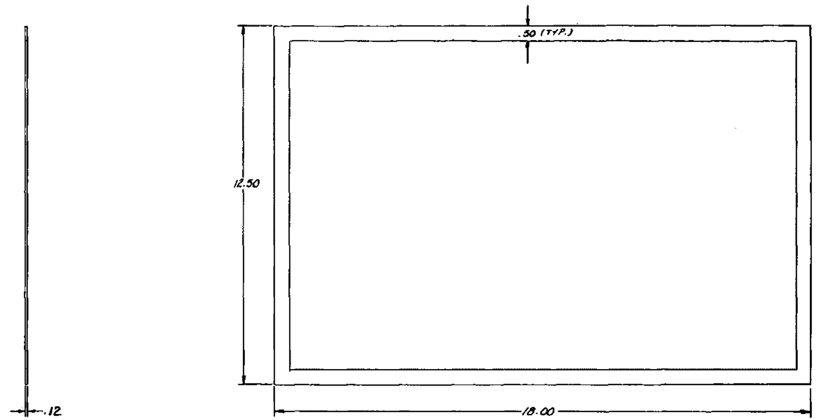
Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE

HIGH VOLTAGE INSULATOR PL.

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352- D -OC9	

SCALE FULL ACCT. G6352-3 SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY: 6352-A-030 — TOTAL REQ'D.: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

XX = ±.03 XXXX =
XXX = ANGLES =

MATERIAL AND TREATMENT: CLOSED PORE NEOPRENE RUBBER FOAM SHEET

SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	4-27-74
DRAFTING APPD.			
DESIGN APPD.			
APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

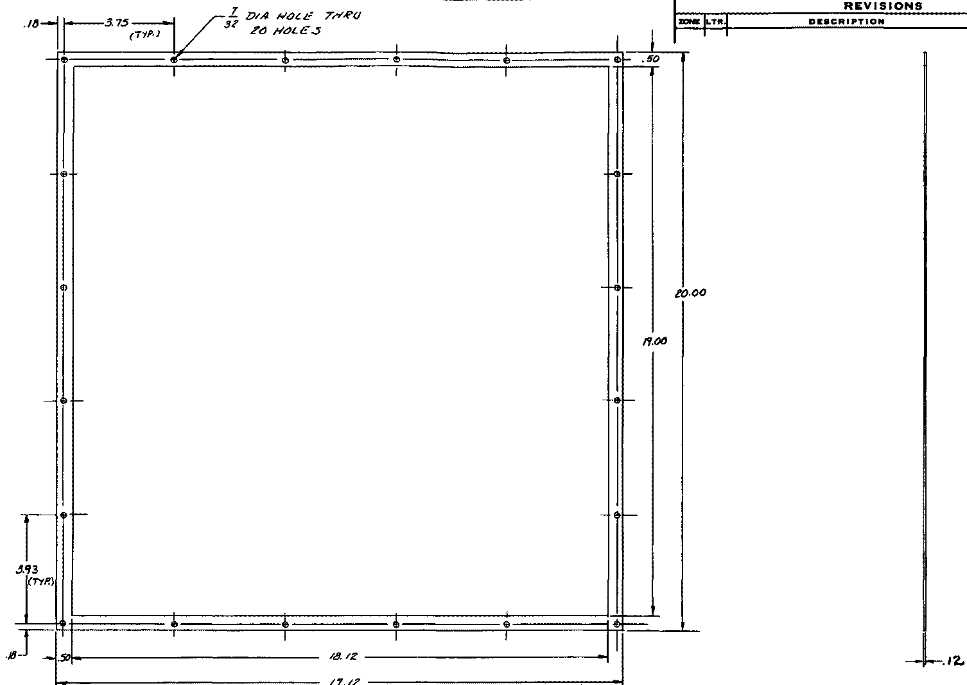
Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: ELECTROSTATIC DOOR GASKET

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352-D-010	-

SCALE 1/2:1 ACCT. G-6352-3 SHEET 1 OF 1

CAT. 284187 FORM D-8 12-73



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY: 6352-A-030 — TOTAL REQ'D.: 3

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = ±.01 .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT: CLOSED PORE NEOPRENE RUBBER FOAM SHEET

SIGNATURE	DIV.	DATE
DRAWN BY WRD	659	5-5-74
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

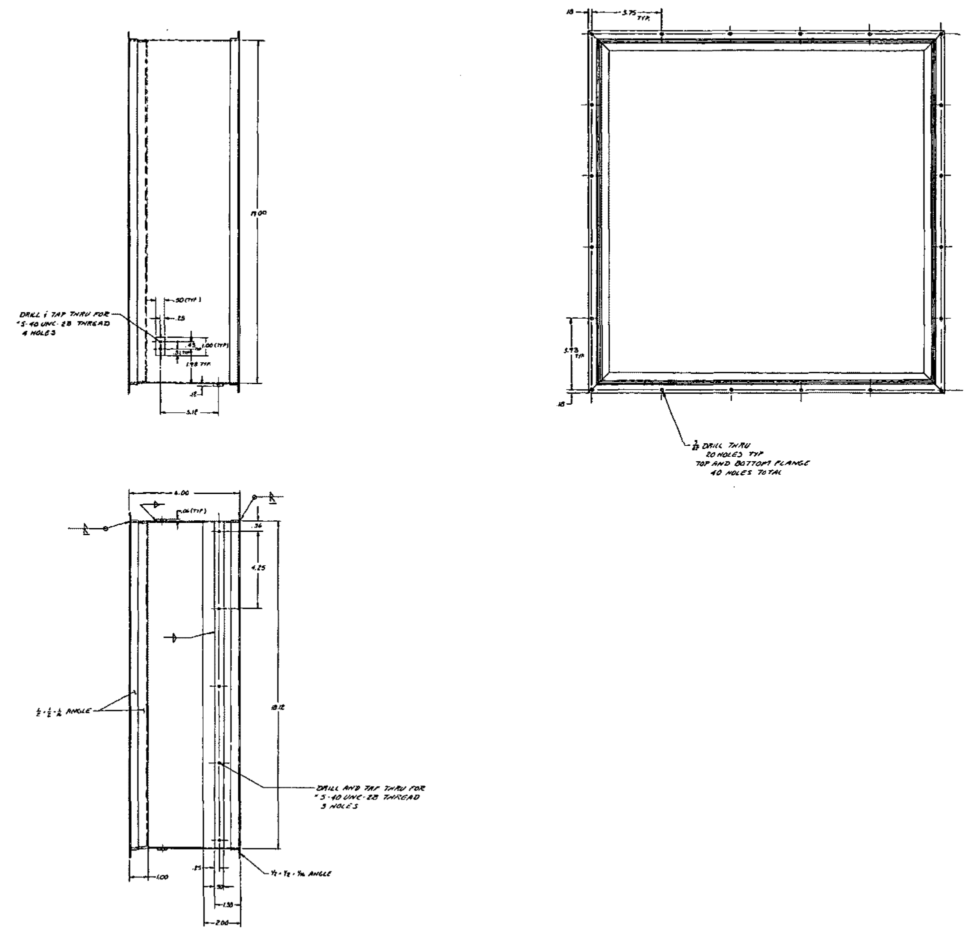
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: FLANGE GASKET

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352-D-011	

SCALE 1/2 - 1 ACCT. G-6352-3 SHEET 1 OF 1

CAT. 384187 FORM D-8 12-73



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

TO MAKE FINAL ASSEMBLY: 6352-A-030 — TOTAL REQD.: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01

MATERIAL AND TREATMENT: 16 GA. (.062) 304 STAINLESS STEEL

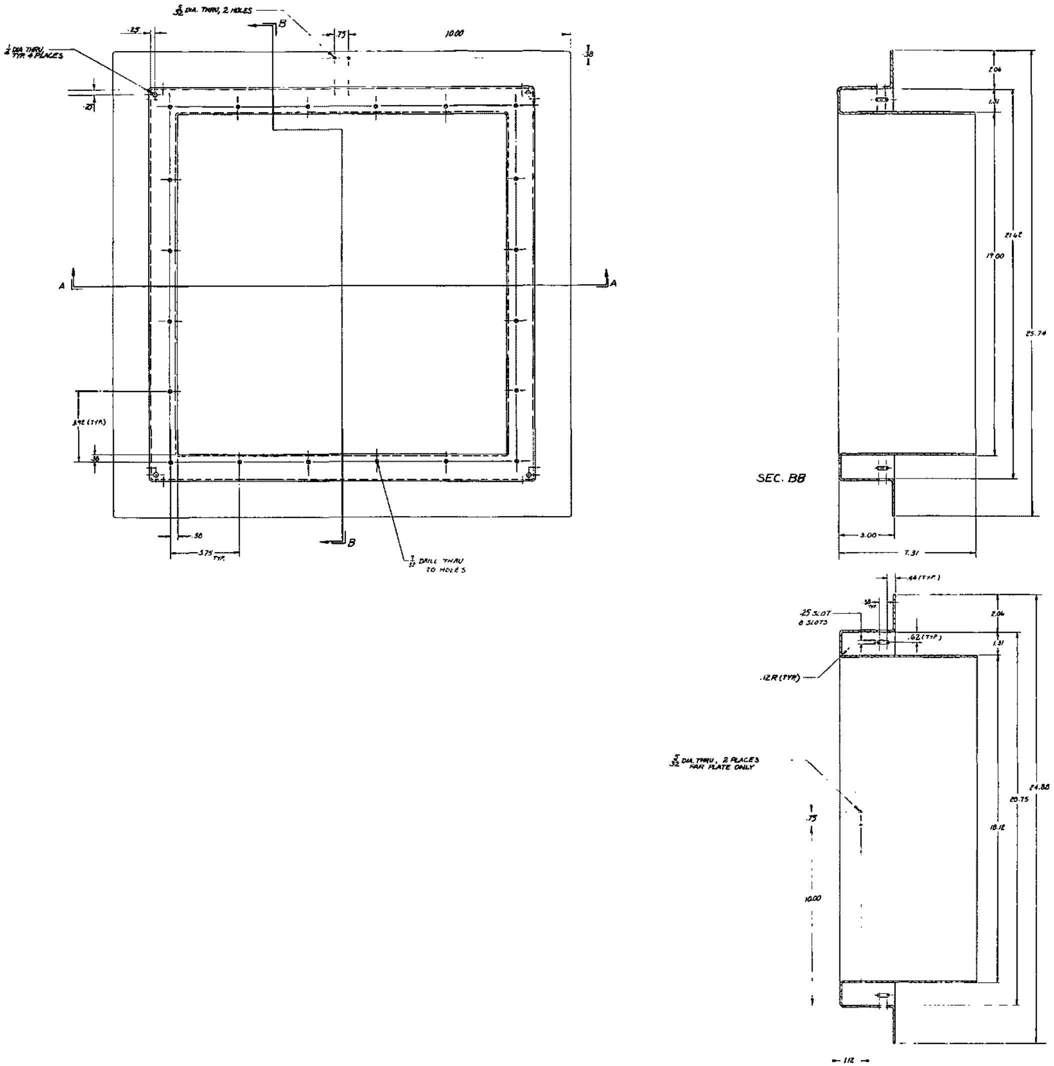
SIGNATURE — DRAWN BY: WRD — DIV. 659 — DATE 5-5-74

Battelle Columbus Laboratories

TITLE: IMPACTOR FLANGE HOUSING

SIZE: E — CODE IDENT. NO. 79986 — DIV. NO. 644 — DWG. NO. 6352-D-012

SCALE 1/1-1 — ACCT. G-6352-5



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

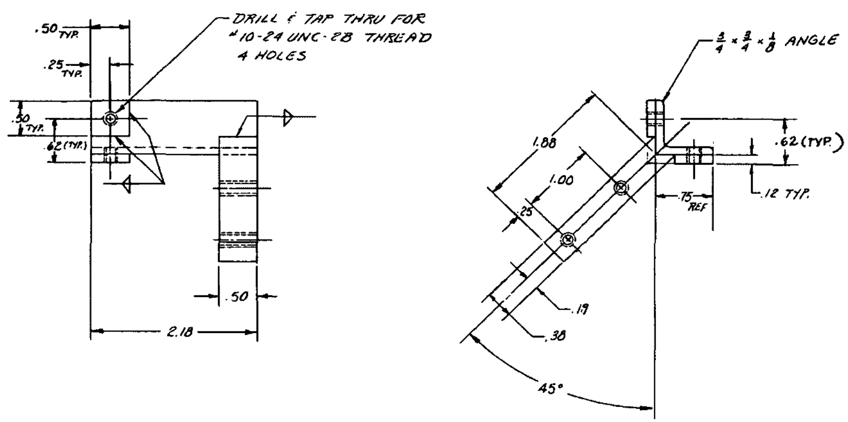
APPLICATION	DO NOT SCALE DRAWING	SIGNATURE	DIV.	DATE
THIS ITEM IS USED ON SUBASSEMBLIES	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01 .XXXX = .XXX = ANGLES =	DRAWN BY HRD	357	5-11-74
TO MAKE FINAL ASSEMBLY 6352 ACX	MATERIAL AND TREATMENT 16 GA (.062) 304 STAINLESS STEEL			

Battelle Columbus Laboratories

TITLE LARGE PARTICLE SEPARATOR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	644	6352-D-013	

SCALE 1:1 ACCT. G-6352-3 SHEET



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION: THIS ITEM IS USED ON SUBASSEMBLIES

TO MAKE FINAL ASSEMBLY: 6352-A-030 — TOTAL REQ'D.: 4

DO NOT SCALE DRAWING. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01 .XXXX = .XXX = ANGLES =

MATERIAL & TREATMENT: 304 STAINLESS STEEL

SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	5-13-74
DRAFTING APPD.			
DESIGN APPD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

BATTELLE MEMORIAL INSTITUTE
COLUMBUS LABORATORIES
505 KING AVE., COLUMBUS, OHIO 43201

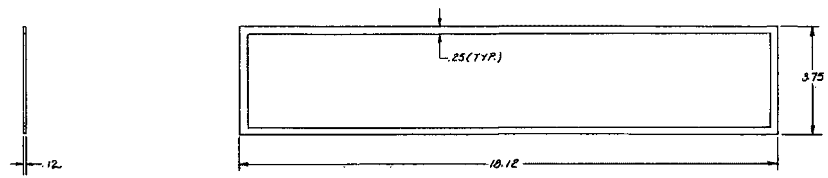
TITLE: ADJUSTABLE CORNER BRACE

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352 D-014	

SCALE 1/1 — ACCT. G-6352-3 — SHEET 1 OF 1

CAT. 284165 FORM D-7 5-70

REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL

TO MAKE FINAL ASSEMBLY	TOTAL REQ'D.
6352-A-030	1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = ±.03 .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT

CLOSED PORE NEOPRENE RUBBER FOAM SHEET

SIGNATURE	DIV.	DATE
DRAWN BY WRD	659	5-8-74
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (814) 299-3151

TITLE

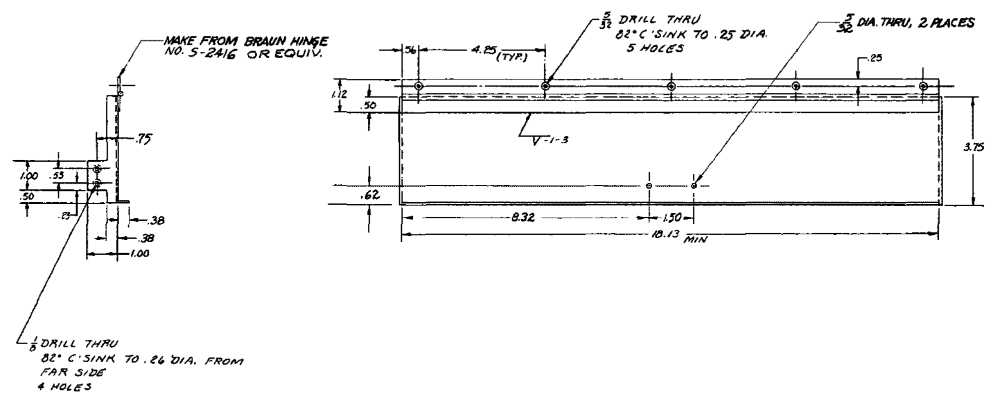
IMPACTOR DOOR GASKET

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352- D -015	

SCALE 1/2:1 ACCT. G-6352-3 SHEET

DWG. NO.

CAT. 594167 FORM D-6 12-73



APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
TO MAKE FINAL ASSEMBLY: 6352-A-030			TOTAL REQ'D: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01

MATERIAL AND TREATMENT: 16 GA. (.062) 304 STAINLESS STEEL

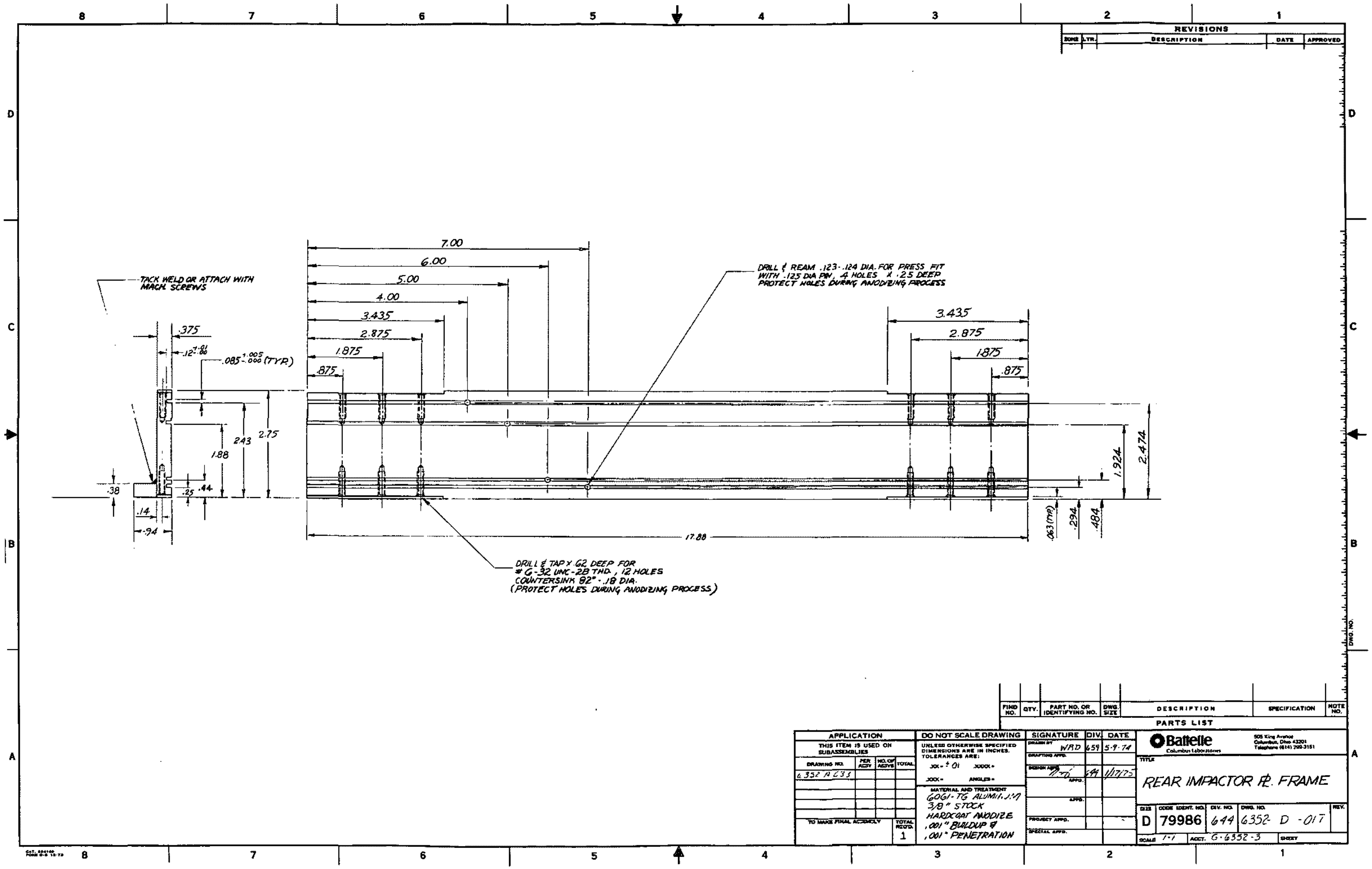
SIGNATURE	DIV.	DATE
DRAWN BY WRD	659	5-8-74

Battelle Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201, Telephone (614) 299-3151

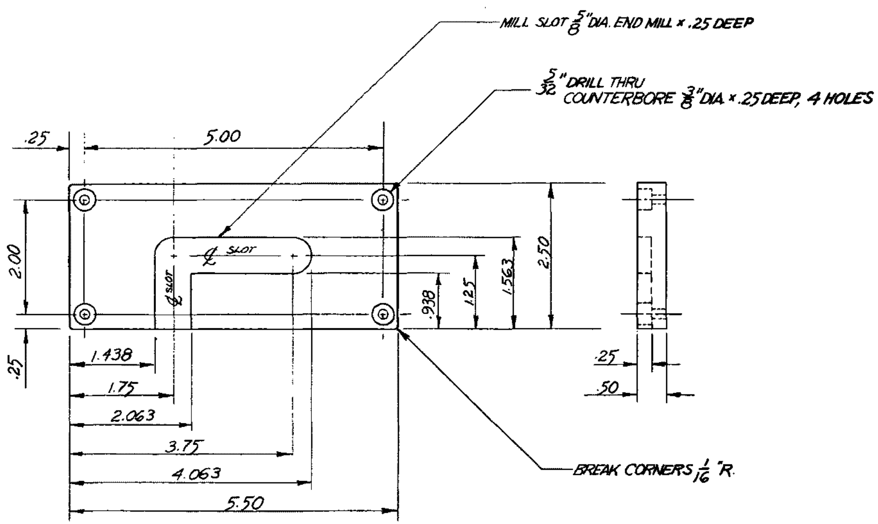
TITLE: IMPACTOR DOOR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352-D-016	

SCALE 1/2:1 ACCT. G-6352-3



REVISIONS
ZONE | LTR. | DESCRIPTION | DATE | APPROVED
TACK WELD OR ATTACH WITH MACH. SCREWS
.375
.12 +.01 -.00
.085 +.005 -.000 (TYP.)
2.75
2.43
1.88
.38
.44
.25
.14
.94
7.00
6.00
5.00
4.00
3.435
2.875
1.875
.875
DRILL & REAM .123-.124 DIA. FOR PRESS FIT WITH .125 DIA PIN, 4 HOLES X .25 DEEP PROTECT HOLES DURING ANODIZING PROCESS
3.435
2.875
1.875
.875
2.474
1.924
.063 (TYP)
.294
.484
17.88
DRILL & TAP X .62 DEEP FOR # 6-32 UNC-2B THD., 12 HOLES COUNTERSINK 82° - .18 DIA. (PROTECT HOLES DURING ANODIZING PROCESS)
FIND NO. | QTY. | PART NO. OR IDENTIFYING NO. | DWG. SIZE | DESCRIPTION | SPECIFICATION | NOTE NO.
PARTS LIST
APPLICATION
THIS ITEM IS USED ON SUBASSEMBLIES
DRAWING NO. | PER ASSY | NO. OF ASSYS | TOTAL
6352 A 633
TO MAKE FINAL ASSEMBLY
TOTAL REQ'D. 1
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = ± .01   .XXXX =
.XXX =   ANGLES =
MATERIAL AND TREATMENT
6061-T6 ALUMINUM
3/8" STOCK
HARDCOAT ANODIZE
.001" BUILDUP &
.001" PENETRATION
SIGNATURE | DIV. | DATE
DRAWN BY WRD 659 5-9-74
DRAFTING APPD.
DESIGN APPD. 644 1/17/75
APPD.
APPD.
PROJECT APPD.
SPECIAL APPD.
Battelle Columbus Laboratories
505 King Avenue Columbus, Ohio 43201 Telephone (614) 299-3151
TITLE
REAR IMPACTOR PL. FRAME
SIZE D | CODE IDENT. NO. 79986 | DIV. NO. 644 | DWG. NO. 6352- D -017 | REV.
SCALE 1:1 | ACCT. G-6352-3 | SHEET



ZONE	LTR.	DESCRIPTION	DATE	APPROVED

REVISIONS

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 1

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .01 .XXXX =
.XXX = .005 ANGLES =

MATERIAL AND TREATMENT
TEFLON ℄
ELECTRICAL GRADE
1/2" STOCK

SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	1/20/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE
HIGH VOLTAGE INSULATOR CAP

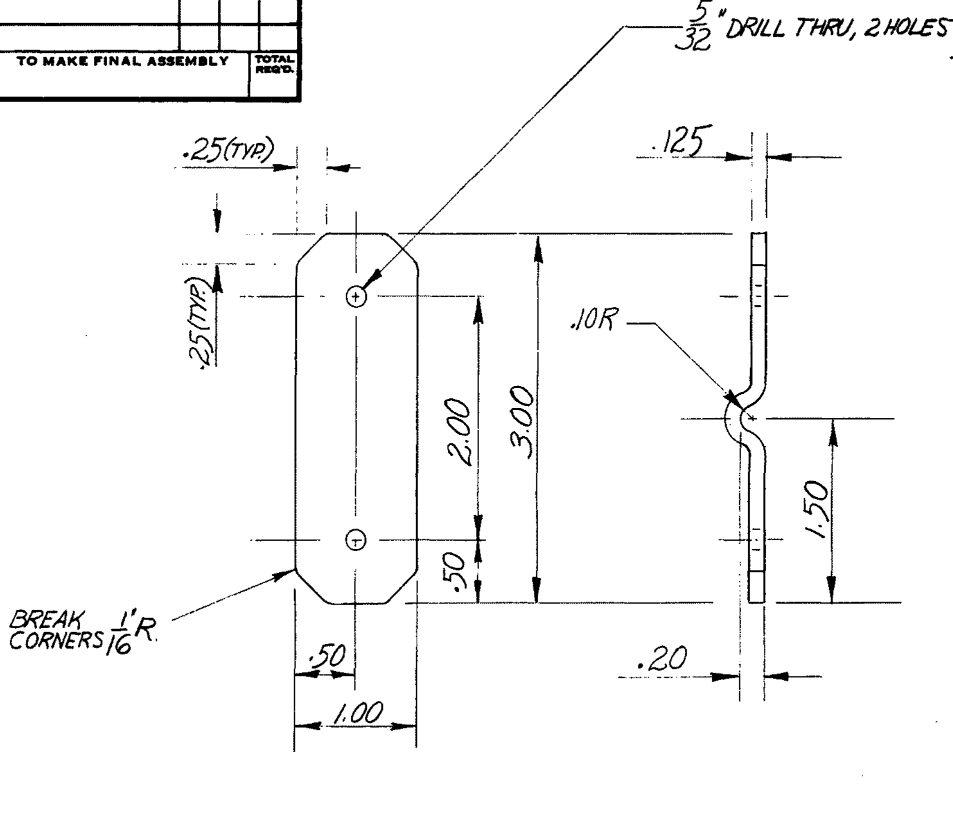
SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352- D -018	

SCALE FULL ACCT. G6352-3 SHEET 1 OF 1

CAT. 594167 FORM D-8 12-76

APPLICATION			
THIS ITEM IS USED ON SUB ASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6532-A-026	2	1	2
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



MAKE 2

DO NOT SCALE DRAWING	SIGNATURE	DIV.	DATE
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	DRAWN BY MCH	644	1/21/76
.XX = .01 .XXXX =	DRAFTING APPD.		
.XXX = ANGLES =	DESIGN APPD.		
MATERIAL & TREATMENT	APPD.		
304 SS	PROJECT APPD.		
1/8" STOCK	SPECIAL APPD.		

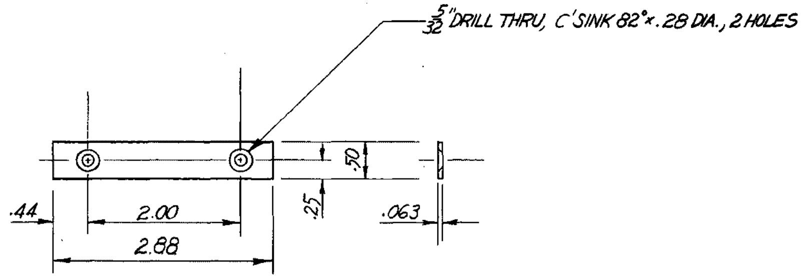
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE ELECTROSTATIC DRAWER HANDLE BRACKET

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
A	79986	644	6352-D-019	

SCALE FULL | ACCT. G6352-3 | SHEET 1 OF 1

CAT. 294164 FORM D-6 12-73



APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-030	1	1	1
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = .01 .XXXX =
.XXX= ANGLES=

MATERIAL & TREATMENT
BRASS
.063" STOCK
GOLD PLATED

SIGNATURE	DIV.	DATE
DRAWN BY MCH	644	[illegible]
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE
HIGH VOLTAGE PLATE CONTACT

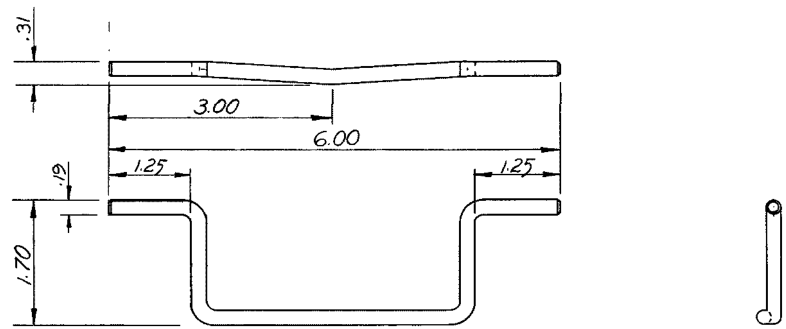
SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352-D-020	

SCALE FULL ACCT. G6352-3 SHEET 1 OF 1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

CAT. 284165 FORM D-7 12-73



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-026	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .XXXX =
.XXX= ANGLES=

MATERIAL & TREATMENT: STAINLESS STL. 3/16" DIA. STOCK

SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	1/22/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

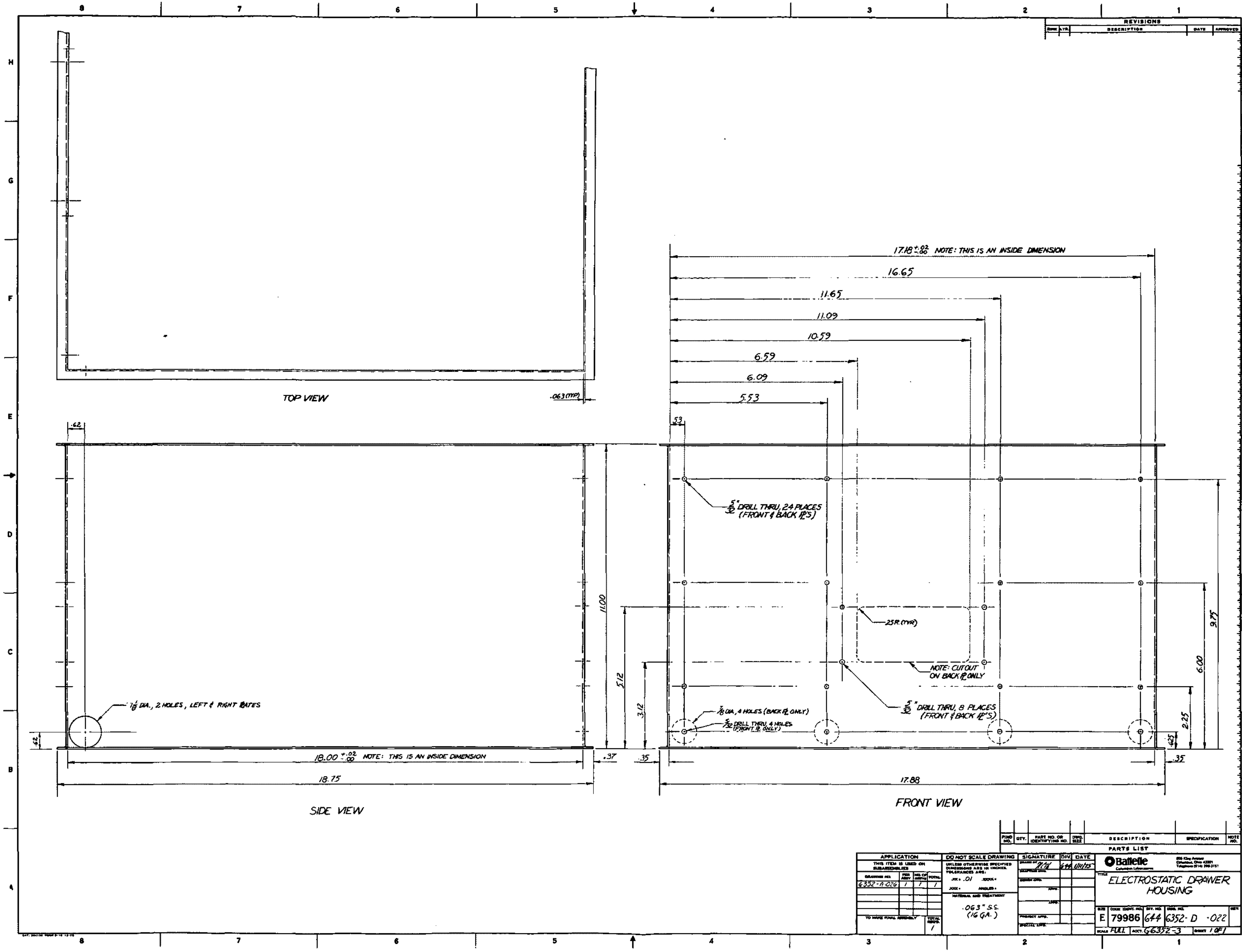
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: ELECTROSTATIC DRAWER HANDLE

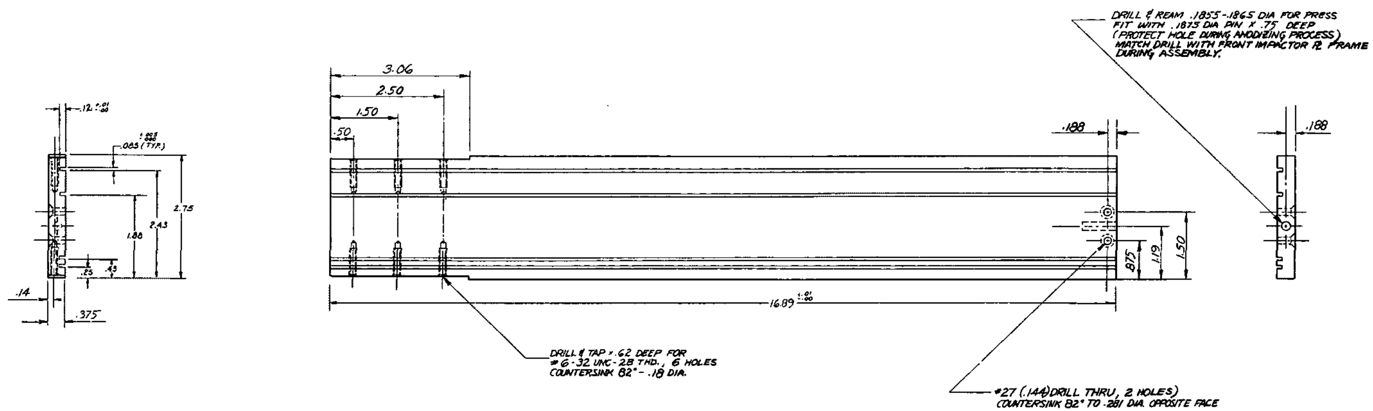
SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352-D-021	

SCALE FULL ACCT. G6352-3 SHEET 1 OF 1

CAT. 294165 FORM D-7 12-73



TOP VIEW
.063(TYP)
SIDE VIEW
FRONT VIEW
17.18 +.02 -.00 NOTE: THIS IS AN INSIDE DIMENSION
16.65
11.65
11.09
10.59
6.59
6.09
5.53
.53
.62
5/32" DRILL THRU, 24 PLACES (FRONT & BACK PL'S)
.25R.(TYP)
NOTE: CUTOUT ON BACK PL ONLY
5/32" DRILL THRU, 8 PLACES (FRONT & BACK PL'S)
7/8 DIA., 4 HOLES (BACK PL ONLY)
5/32 DRILL THRU, 4 HOLES (FRONT PL ONLY)
1 1/8 DIA., 2 HOLES, LEFT & RIGHT PLATES
11.00
5.12
3.12
9.75
6.00
2.25
.625
.37
.35
18.00 +.02 -.00 NOTE: THIS IS AN INSIDE DIMENSION
18.75
17.88
REVISIONS
PARTS LIST
APPLICATION
6352-A-026
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX ± .01
MATERIAL AND TREATMENT
.063" S.S. (16 GA.)
Battelle
ELECTROSTATIC DRAWER HOUSING
E 79986 644 6352-D -022
SCALE FULL
ACCT. G6352-3
SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = ±.01 .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT
6061-T6 ALUMINUM
3/8" STOCK
HARD COAT ANODIZE
.001" BUILD-UP &
.001" PENETRATION)

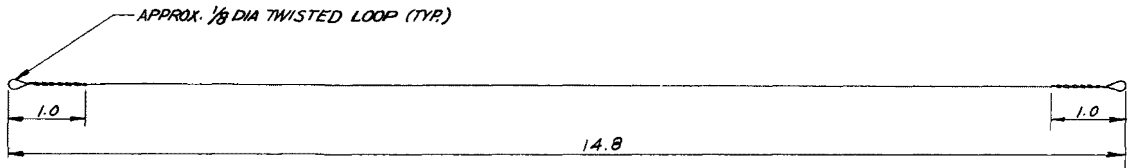
SIGNATURE		DIV.	DATE
DRAWN BY	WRD	659	5-10-74
DRAFTING APPD.			
DESIGN APPD.	[signature]	644	1/16/74
CHKD.			
APPD.			
PROJECT APPD.			
SPECIAL APPD.			

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: RIGHT IMPACTOR R. FRAME

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352- D -023	

SCALE FULL ACCT. G-6352-3 SHEET 1 OF 1



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-D-002	10	1	10
TO MAKE FINAL ASSEMBLY			TOTAL REQD. 10

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .10 .XXXX =
.XXX= ANGLES=

MATERIAL & TREATMENT
.005 HARD STAINLESS STEEL WIRE

SIGNATURE	DIV.	DATE
DRAWN BY		
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

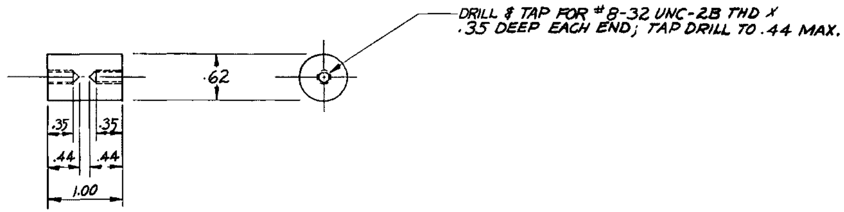
Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE IONIZATION WIRE

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352 D 024	

SCALE FULL ACCT G6352-3 SHEET 1 OF 1

CAT. 294168 FORM D-7 12-73



REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-D-002	6	1	6
TO MAKE FINAL ASSEMBLY		TOTAL REQD.	6

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .XXXX =
.XXX= ANGLES=

MATERIAL & TREATMENT: TEFLON - ELECTRICAL GRADE - 5/8 STK.

SIGNATURE	DIV.	DATE
DRAWN BY		
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

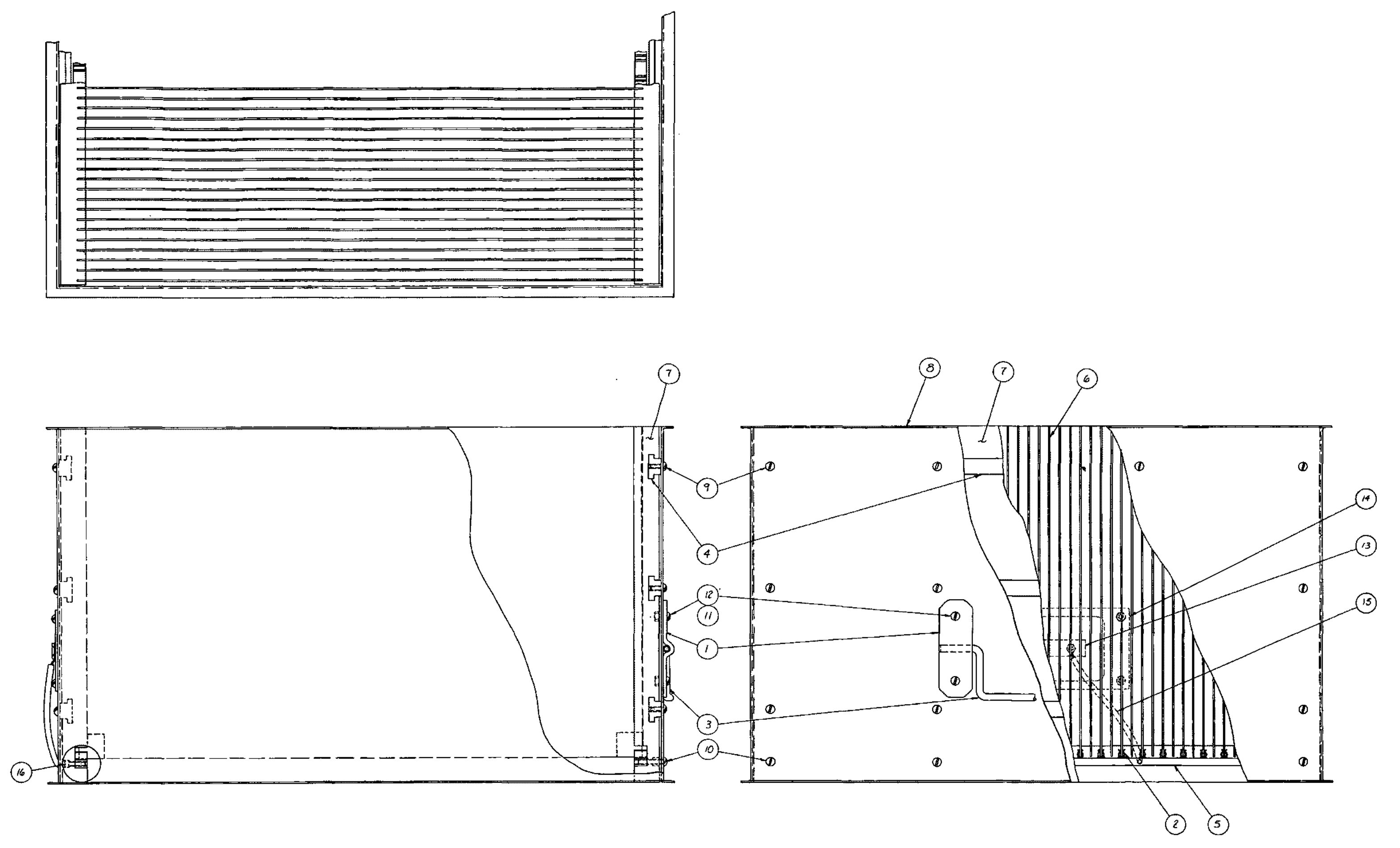
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: IONIZATION WIRE INSULATOR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352 D-025	

SCALE FULL ACCT G6352-3 SHEET 1 OF 1

CAT. 294165 FORM D-7 12-73



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

TO MAKE FINAL ASSEMBLY: 635_ A 030 — TOTAL REQ'D.: 1

DO NOT SCALE DRAWING — UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

MATERIAL AND TREATMENT

SIGNATURE | DIV. | DATE

Battelle Columbus Laboratories

TITLE: ELECTROSTATIC PRECIPATATOR DRAWER ASS'Y.

SIZE: E — CODE IDENT. NO. 79986 — DIV. NO. 644 — DWG. NO. 6552-A -026

SCALE 1-1 — ACCT. G6352-3 — SHEET

PARTS LIST

PURCHASED | FABRICATED

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 424-6424

CODE IDENT NO.	DIV. NO.	DWG NO.	REV.	TITLE
79986		6352-P-026		

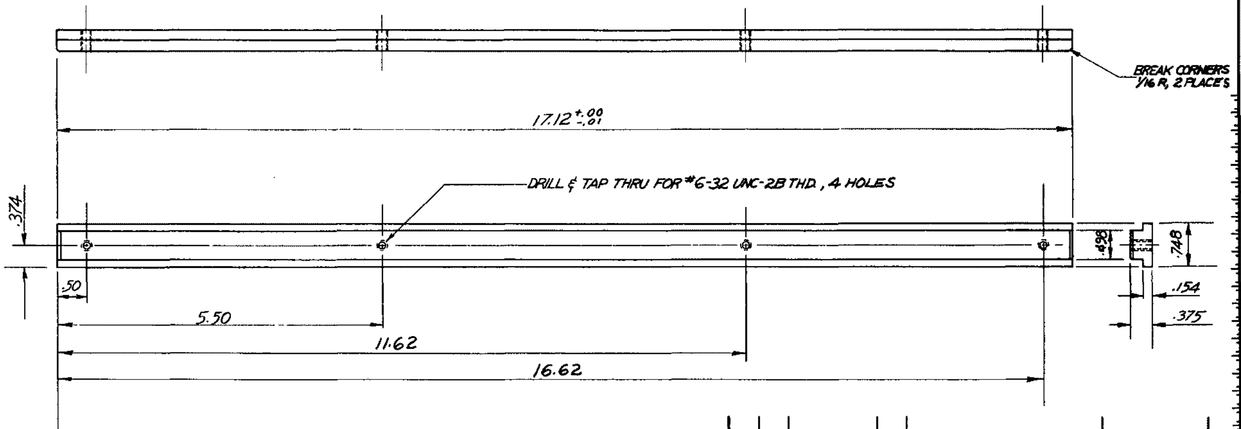
BY	DIV.	DATE	APPD.	DIV.	DATE	ACCT.	SHEET
						G-6352-3	

ITEM	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION
1	2	6352-D-019	A	ELECT. DRAWER HANDLE BRACK.	
2	54	6352-D-028	A	CLIP	
3	1	6352-D-021	B	ELECTRO. DRAWER HANDLE	
4	6	6352-D-027	C	STIFFENER "T" BAR	
5	2	6352-D-029	C	BUS BAR	
6	55	6352-D-005	D	ELECTROSTATIC PLATE	
7	2	6352-D-007	D	ELECTRO. INSUL. FRONT & READ HOUS	
8	1	6352-D-022	E	ELECTROSTATIC DRAWER HOUSING	
9	24	#6-32 UNC	~	ROUND HEAD SCREW × 1/2 LONG	SST
10	4	#6-32 UNC	~	ROUND HEAD SCREW × 3/4 LONG	SST
11	4	#6-32 UNC	-	HEX NUT	SST
12	4	#6-32 UNC	-	ROUND HEAD SCREW × 3/8 LONG	SST
13	7	6352-D-020	B	HIGH VOLTAGE PLATE CONTACT	
14	1	6352-D-009	C	HIGH VOLTAGE INSUL. PLATE	
15	AR	~	-	20,000 VOLT WIRE	
16	4	#6-32 UNC	-	SOCKET HD. CAP SCREW × 1/2 LONG	SST

DWG. NO. ______ SHT. ______

BRUNING 40-21 29084

CAT. 294181 FORM D-3 6/78



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-026	6	1	6

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 6

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
XX = ±.01 XXXX =
XXX = ±.002 ANGLES =

MATERIAL AND TREATMENT: BRASS

SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	1/11/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

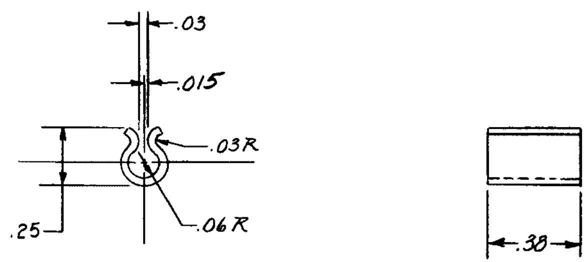
TITLE: STIFFENER "T"-BAR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352-D -027	

SCALE FULL ACCT G6352-3 SHEET 1 OF 1

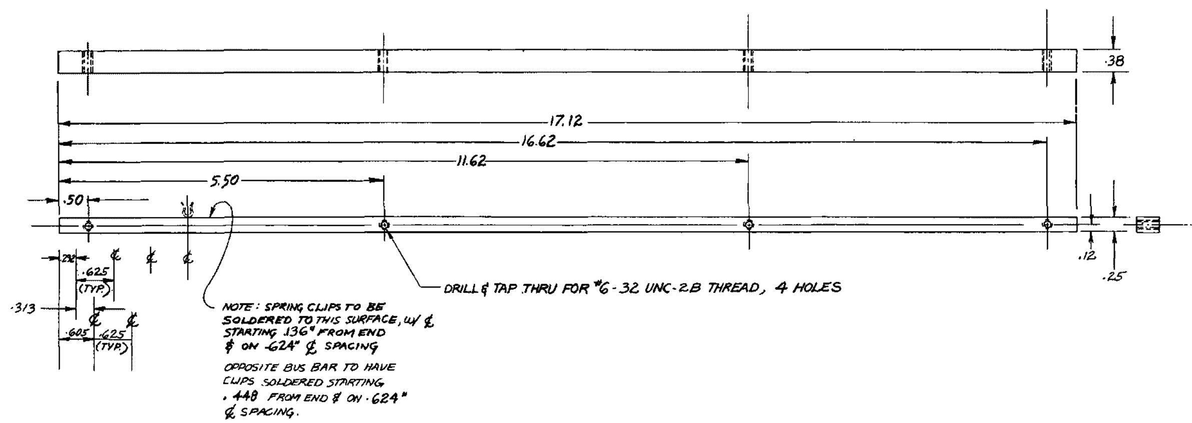
CAT. 294167 FORM D-9 12-72

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



APPLICATION				DO NOT SCALE DRAWING	SIGNATURE	DIV.	DATE	BATTELLE MEMORIAL INSTITUTE COLUMBUS LABORATORIES 505 KING AVE., COLUMBUS, OHIO 43201
THIS ITEM IS USED ON SUBASSEMBLIES				UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	DRAWN BY WRD			TITLE CLIP
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL	.XX = .XXXX =	DRAFTING APPD.			
6352-A-026	54	1	54	.XXX = ANGLES =	DESIGN APPD.			
				MATERIAL & TREATMENT	APPD.			SIZE A; CODE IDENT. NO. 79986; DIV. NO. 644; DWG. NO. 6352 D -028; REV.
				BRASS	PROJECT APPD.			
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 54		SPECIAL APPD.			SCALE 2" = 1"; ACCT 6-6352-3; SHEET 1 OF 1

CAT. 294163 FORM D-8 5-70



REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-026	2	1	2

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 2

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT: BRASS 1/4" STOCK

SIGNATURE	DIV.	DATE
DRAWN [signature]	644	2/5/75
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

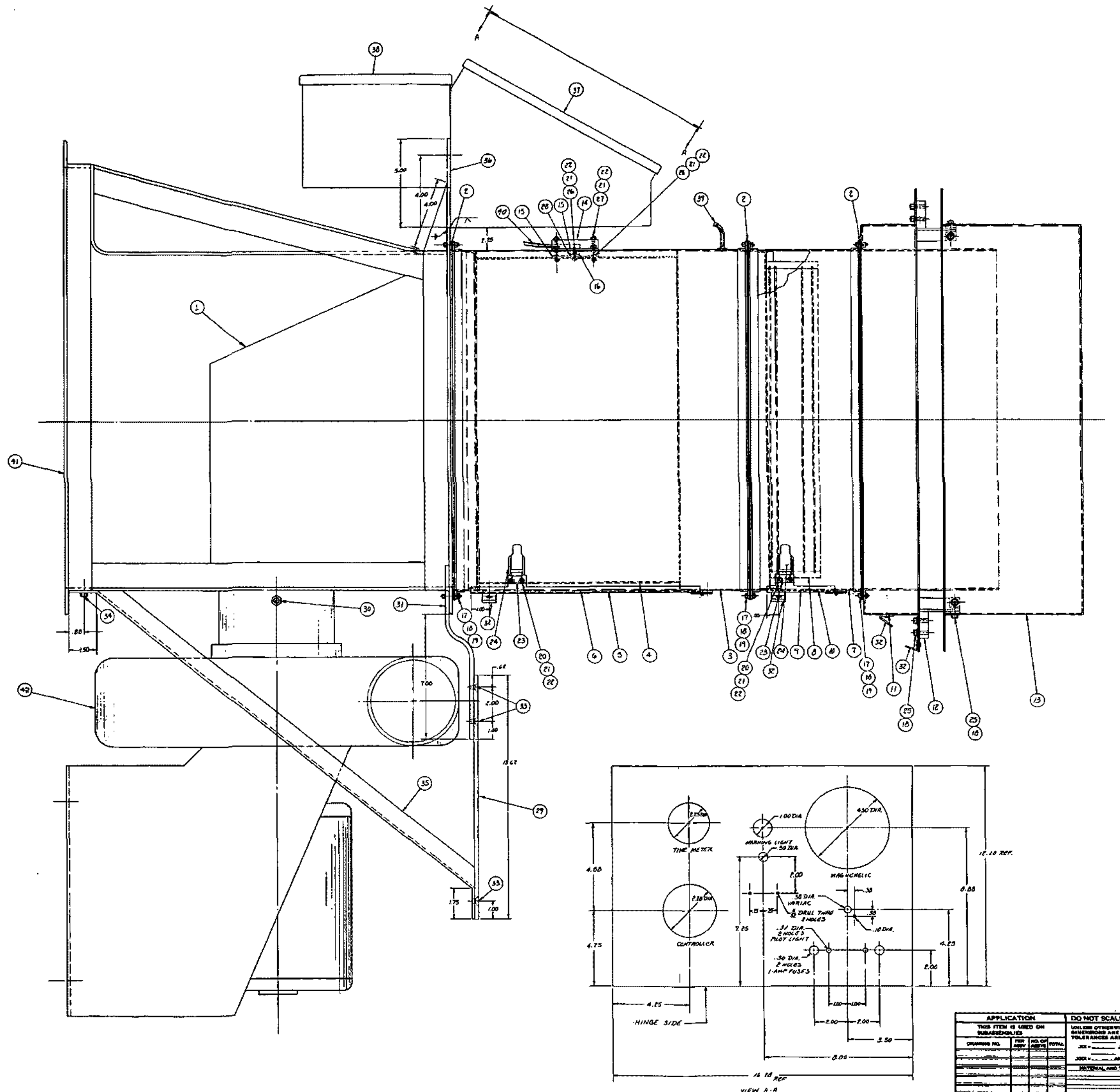
Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: BUS BAR

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986	644	6352- D -029	

SCALE 1:1 ACCT. G-6352-3 SHEET 1 OF 1

CAT. 294187 FORM B-8 10-73



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
42	1	MODEL-D	~	1000 CFM H.P. BLOWER	AMERICAN STD.	
41	1	6352-D-031	E	BASE PLATE.		
40	A.R.	~	~	ELECTROSTATIC PR. POWER LEAD	20 KV INSUL. WIRE	
39	A.R.	~	~	IONIZATION POWER LEAD	20 KV INSUL. WIRE	
38	1	A-1086G1E	~	HOFFMAN OIL TIGHT ENCL.		
37	1	C-12C16	~	HOFFMAN OIL TIGHT CONSOLET.		
36	2	~	~	3/16 × 1 SUPPORT BRACKET	CRS	
35	2	~	~	1/8 × 1 × 1 ANGLE	CRS	
34	2	1/4-20 UNC	~	SOCKET HEAD CAP SCREW, .50 LG.	SST	
33	6	1/4-20 UNC	~	FLAT SOCKET HD SCREW × .50 LG.	SST	
32	2	T-9755	~	AMEROCK MAGNETIC CATCH		
31	2	~	~	1/4 × 1; STRAP	CRS	
30	1	1/8	~	HOSE BIB	BRASS	
29	1	~	~	13.62 × 20.62 × 1/4	ALUM	
28	1	6352-D-020	B	HIGH VOLTAGE CONTACT PLATE.		
27	4	#5-40 UNC	~	ROUND HEAD CAP SCREW × 1 1/4 LG	SST	
26	6	#5-40 UNC	~	ROUND HEAD CAP SCREW × 1/2 LG	SST	
25	16	#10-24 UNC	~	ROUND HEAD CAP SCREW × 1/2 LG	SST	
24	4	3HW-1626	~	LATCH (BRAUN MFG. CO.)		
23	4	3KHL-1628	~	KEEPER (BRAUN MFG. CO.)		
22	14	#5-40 UNC	~	HEX NUT	SST	
21	14	#5	~	LOCKWASHER	SST	
20	4	#5-40 UNC	~	ROUND HEAD CAP SCREW × 1/2 LG	SST	
19	60	#10-24 UNC	~	HEX NUT	SST	
18	76	#10	~	LOCKWASHER	SST	
17	60	#10-24 UNC	~	ROUND HD CAP SCREW × 3/4 LG	SST	
16	1	6352-D-006	B	HIGH VOLTAGE SPRING CONTACT		
15	2	6352-D-009	C	HIGH VOLTAGE INSULATOR PLATE		
14	1	6352-D-018	C	HIGH VOLTAGE INSULATOR CAP		
13	1	6352-D-001	E	COVER		
12	4	6352-D-014	B	ADJUSTABLE CORNER BRACE		
11	1	6352-D-013	E	LARGE PARTICLE SEPARATOR		
10	1	6352-D-015	C	IMPACTOR DOOR GASKET		
9	1	6352-D-016	C	IMPACTOR DOOR		
8	1	6352-A-033	E	IMPACTOR ASS'Y.		
7	1	6352-D-012	E	IMPACTOR FLANGE HOUSING		
6	1	6352-D-010	C	ELECTROSTATIC FLANGE GASK.		
5	1	6352-D-004	D	ELECTROSTATIC DOOR		
4	1	6352-A-026	E	ELECTROSTATIC PREC. DRAWER ASS'Y		
3	1	6352-D-002	E	ELECTROSTATIC PREC. HOUSING		
2	3	6352-D-011	C	FLANGE GASKET		
1	1	6352-D-032	E	EXIT DUCT		

PARTS LIST

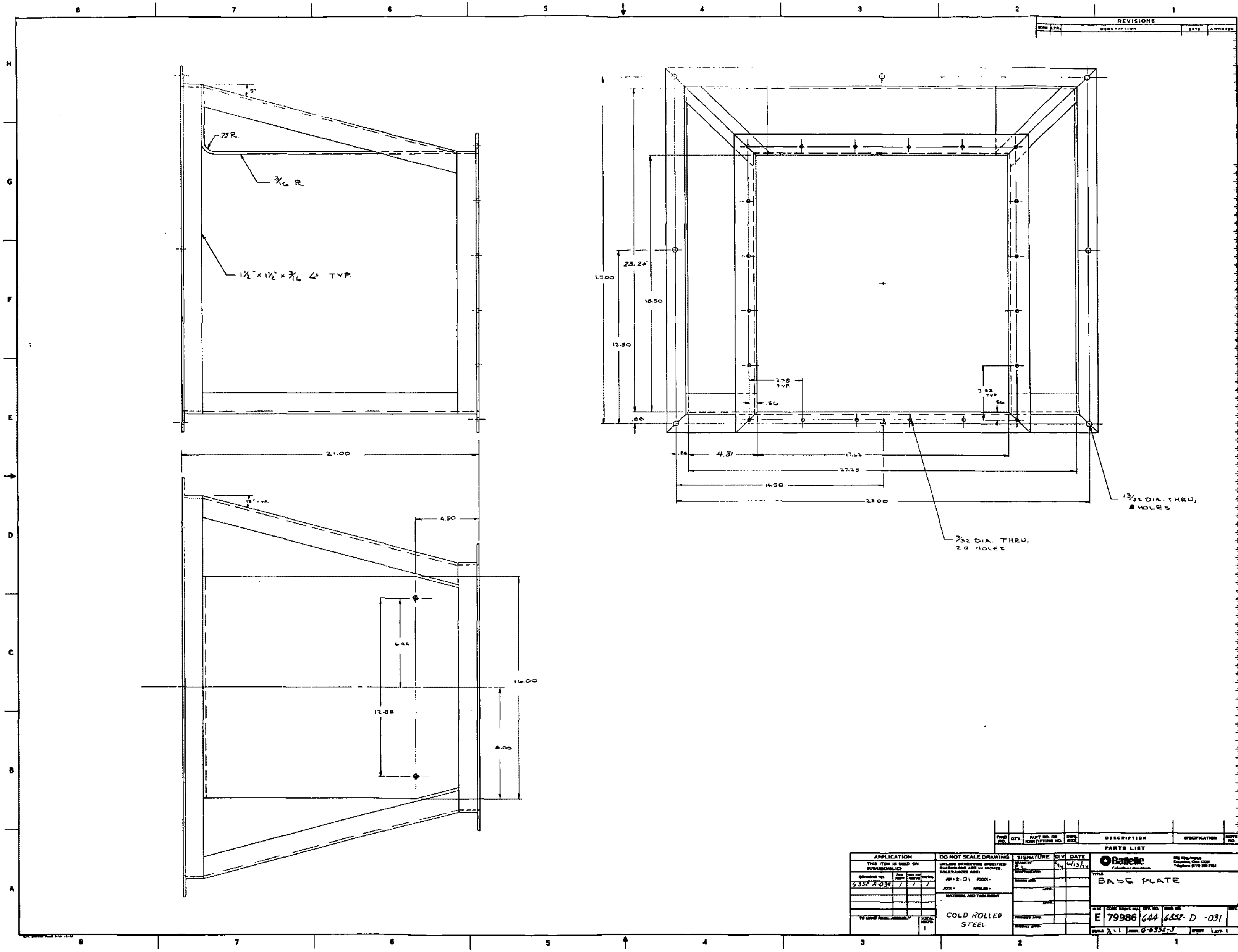
APPLICATION	DO NOT SCALE DRAWING	SIGNATURE	DIV	DATE
THIS ITEM IS USED ON SUBASSEMBLIES	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	WRD		
			644	5/18/75

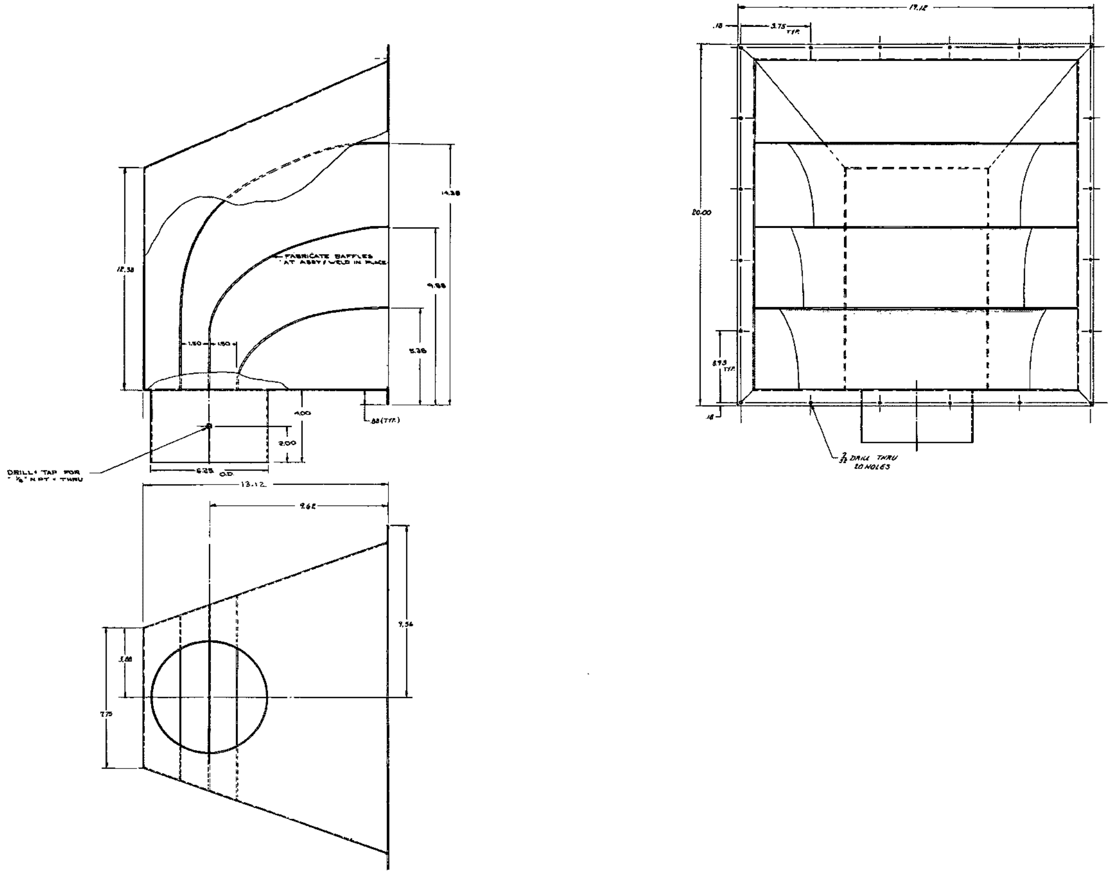
Battelle Columbus Laboratories

TITLE: HIGH VOLUMN AIR SAMPLER ASS'Y

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	644	6352-A-030	

ACCT. G-6352-3 SHEET 1 OF 1


REVISIONS
.75 R.
3/16 R
1½" × 1½" × 3/16 ∠ TYP.
21.00
15° TYP.
4.50
6.44
12.88
16.00
8.00
23.25
25.00
18.50
12.50
3.75 TYP.
.56
3.93 TYP.
.88
4.81
17.62
27.25
14.50
25.00
13/32 DIA. THRU, 8 HOLES
7/32 DIA. THRU, 20 HOLES
PARTS LIST
APPLICATION
6352-A-034
DO NOT SCALE DRAWING
COLD ROLLED STEEL
SIGNATURE
DIV.
DATE
Battelle
TITLE
BASE PLATE
E
79986
644
6352-D-031
G-6352-3



APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-034	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQD. 1

DO NOT SCALE DRAWING — UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ±.01 .XXXX = .XXX = ANGLES =

MATERIAL AND TREATMENT: 16 GA. (.062) 304 STAINLESS STEEL

SIGNATURE	DIV	DATE
DRAWN BY WRD	635	6-11-74

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

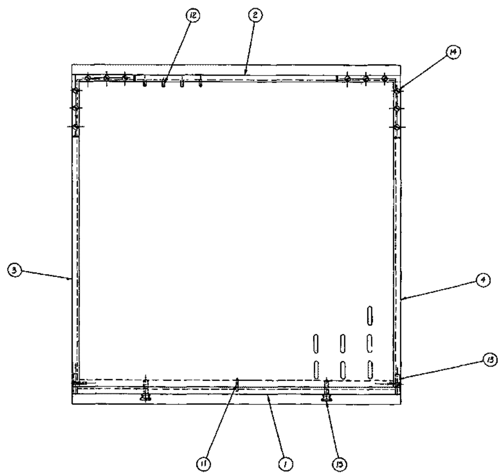
PARTS LIST

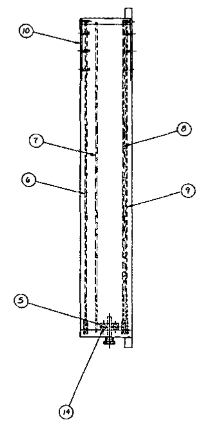
Battelle Columbus Laboratories

TITLE: EXIT DUCT

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	644	6352- D -032	

SCALE 1/2:1 ACCT. G-6352-3 SHEET





FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
15	2	1/4-20 UNC	-	BRASS KNURLED HEAD SCR.		
14	28	#6-32 UNC	-	FLAT HD. SCREW - 3/8 LONG		
13	2	6352-D-036	A	IMPACTOR FRAME FRONT ALIG. PIN		
12	4	6352-D-037	A	REAR IMPACTOR PL. REG. PIN		
11	7	6352-D-035	A	FRONT IMPACTOR PL ALIGN. PIN		
10	4	6352-D-030	B	IMPACT HOUSING BRACKET		
9	1	6352-D-042	D	LOWER IMPACTOR PLATE (#4)		
8	1	6352-D-041	D	LOWER NOZZLE (PLATE #3)		
7	1	6352-D-040	D	UPPER IMPACTOR PLATE (#2)		
6	1	6352-D-039	D	UPPER NOZZLE (PLATE NO. 1)		
5	1	6352-D-043	D	IMPACTOR FR. FRONT CROSS MB.		
4	1	6352-D-023	D	RIGHT IMPACTOR PL. FRAME		
3	1	6352-D-044	D	LEFT IMPACTOR PL. FRAME		
2	1	6352-D-017	D	REAR IMPACTOR PL. FRAME		
1	1	6352-D-045	D	FRONT IMPACTOR PL. FRAME		

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

TO MAKE FINAL ASSEMBLY: 6352 A-030 — TOTAL REQD.: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

MATERIAL AND TREATMENT

SIGNATURE	DIV.	DATE
WRD	637	7-2-76

Battelle
Columbus Laboratories

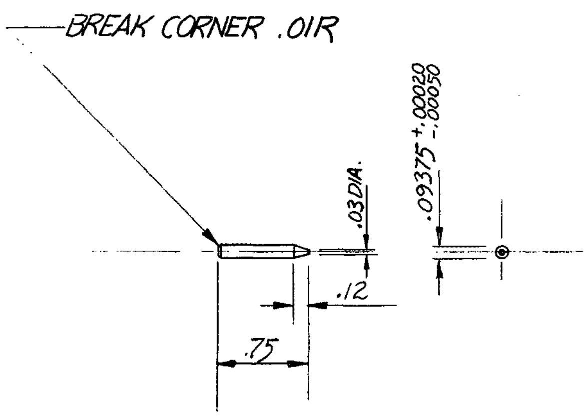
TITLE: IMPACTOR ASS'Y

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
E	79986	644	6352-A-033	

SCALE 1/2:1 ASSY. G-6352-1 SHEET

APPLICATION			
THIS ITEM IS USED ON SUB ASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	7	1	7
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 7

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



DO NOT SCALE DRAWING	SIGNATURE	DIV.	DATE
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	DRAWN BY MH	644	1/22/76
.XX = .01 .XXXX =	DRAFTING APPD.		
.XXX= ANGLES=	DESIGN APPD.		
MATERIAL & TREATMENT	APPD.		
304 SS	PROJECT APPD.		
	SPECIAL APPD.		

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Columbus Laboratories

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TITLE FRONT IMPACTOR PL ALIGNMENT PIN

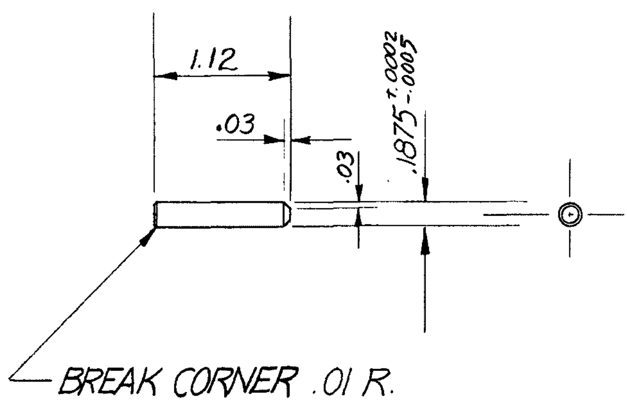
SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
A	79986	644	6352-D-035	

SCALE FULL ACCT G6352-3 SHEET 1 OF 1

CAT. 294164 FORM D-6 12-73

APPLICATION			
THIS ITEM IS USED ON SUB ASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	2	1	2
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 2

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



DO NOT SCALE DRAWING	SIGNATURE	DIV.	DATE
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	DRAWN BY MH	644	1/22/76
.XX = .01 .XXXX = .XXX= ANGLES=	DRAFTING APPD.		
	DESIGN APPD.		
MATERIAL & TREATMENT	APPD.		
304 S.S.	PROJECT APPD.		
	SPECIAL APPD.		

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Columbus, Ohio 43201
Telephone (614) 299-3151

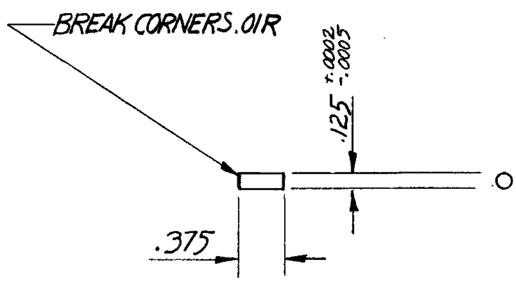
TITLE IMPACTOR FRAME FRONT ALIGNMENT PIN

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
A	79986	644	6352 D-036	
SCALE	ACCT G6352-3		SHEET 1 OF 1	

CAT. 294164 FORM D-6 12-73

APPLICATION			
THIS ITEM IS USED ON SUB ASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	4	1	4
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 4

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED



DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.xx = .01 .xxxx =
.xxx = ANGLES =

MATERIAL & TREATMENT

304 S.S.

SIGNATURE	DIV.	DATE
DRAWN BY [illegible]	644	1/22/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle
Columbus Laboratories

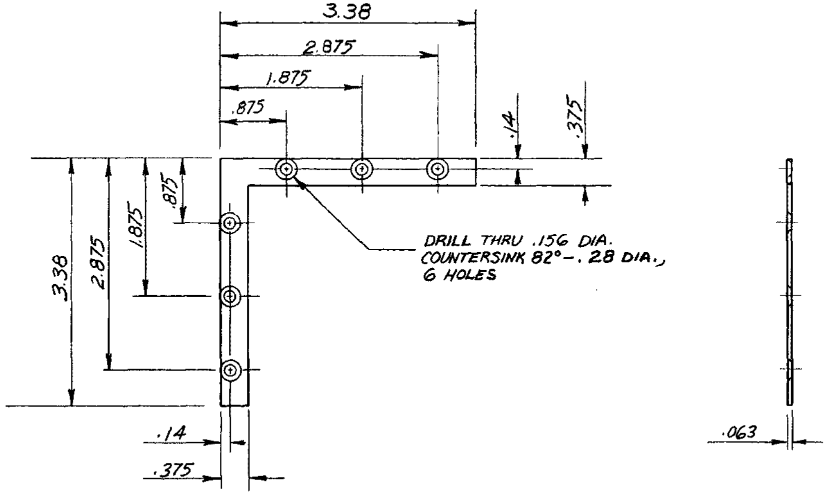
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE REAR IMPACTOR PL REGISTRATION PIN

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
A	79986	644	6352-D-037	

SCALE FULL ACCT G6352-3 SHEET 1 OF 1

CAT. 294164 FORM D-6 12-73



ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	4	1	4
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 4

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .XXXX =
.XXX= ANGLES=

MATERIAL & TREATMENT: .063(16GA) S.S.

SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	1/13/75
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

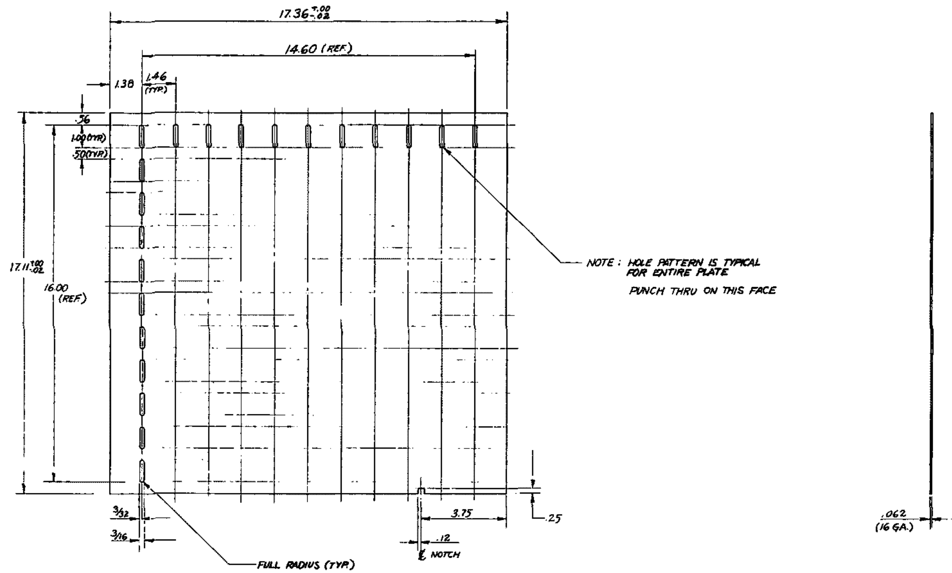
Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: IMPACTOR HOUSING BRACKET

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
B	79986	644	6352 D 038	

SCALE FULL ACCT. 66352-3 SHEET 1 OF 1

CAT. 294188 FORM D-7 12-73



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .01 .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT
304 STAINLESS STL.
16 GA. (.062)

TEFLON COAT ALL SURFACES

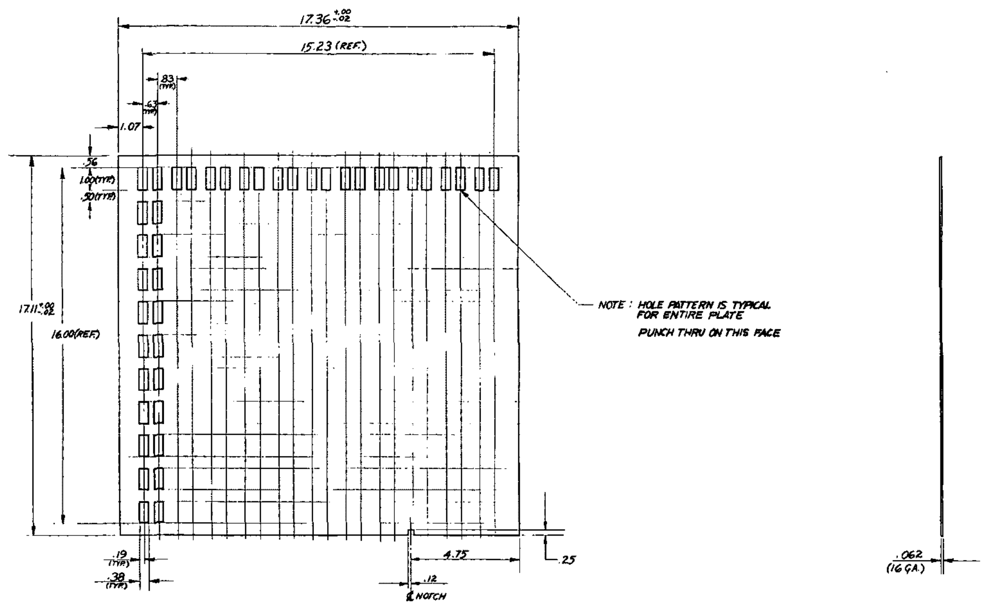
SIGNATURE	DIV.	DATE
DRAWN BY WCK	644	02/26/78
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE
UPPER NOZZLE
(PLATE NO. 1)

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352-D-039	

SCALE 1/2" = 1" ACCT. G6352-3 SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = ± .01 .XXXX = .XXX = ANGLES =

MATERIAL AND TREATMENT: 304 STAINLESS STL. 16 GA. (.062)

TEFLON COAT ALL SURFACES

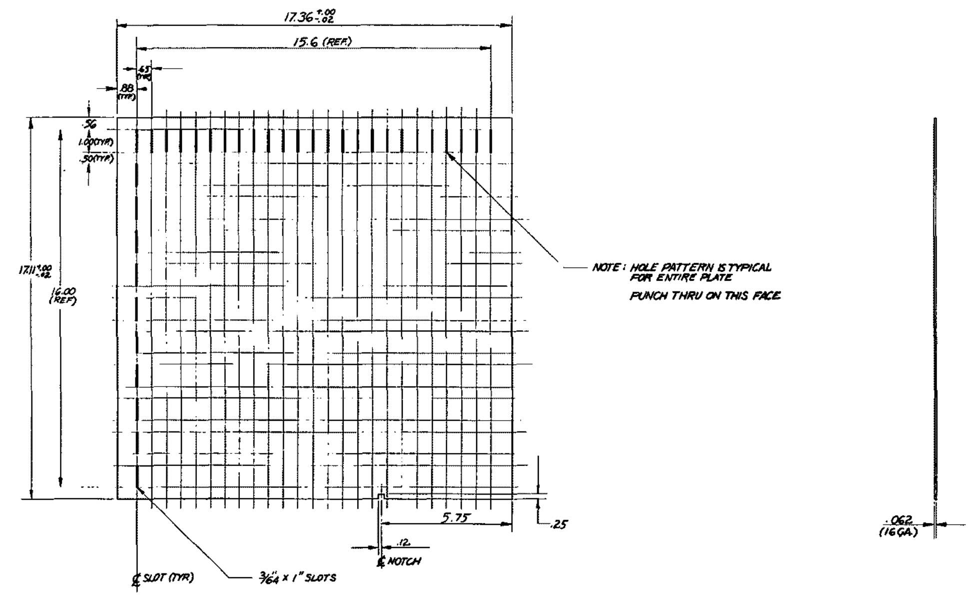
SIGNATURE	DIV.	DATE
DRAWN BY MCK	644	22 DEC 76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

Battelle Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201, Telephone (614) 299-3151

TITLE: UPPER IMPACTOR PLATE (PLATE NO. 2)

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352-D-040	

SCALE 1/4" = 1" ACCT. G6352-3 SHEET 1 OF 1



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQD. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .01 .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT
304 STAINLESS STL.
16 GA. (.062)
TEFLON COAT ALL SURFACES

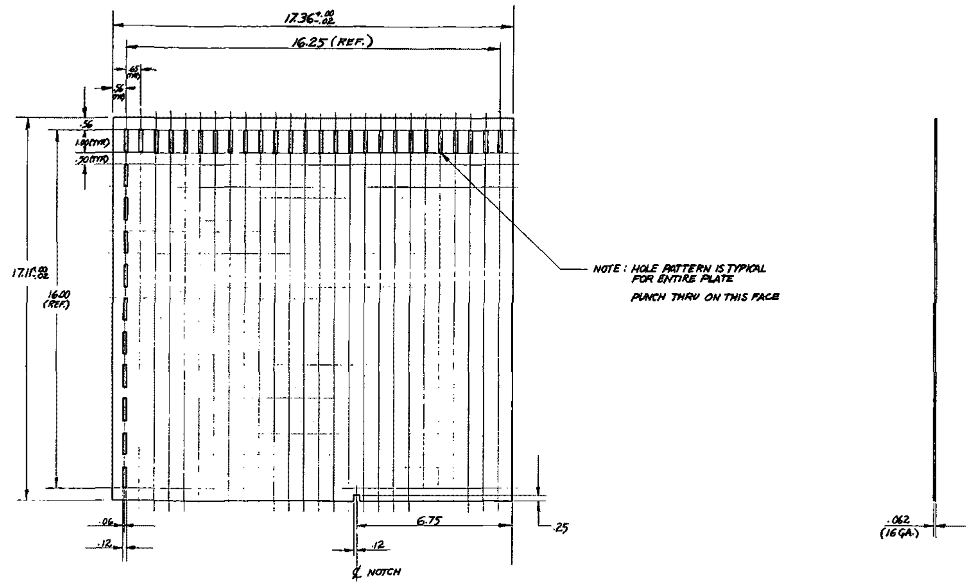
SIGNATURE		DIV.	DATE
DRAWN BY	[illegible]	[illegible]	[illegible]
DRAFTING APPR.			
DESIGN APPR.			
APPR.			
APPR.			
PROJECT APPR.			
SPECIAL APPR.			

Battelle
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE
LOWER NOZZLE
(PLATE NO.3)

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352- D -041	

SCALE 1/2" = 1" ACCT. G6352-3 SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION — THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
.XX = .01 .XXXX =
.XXX = ANGLES =

MATERIAL AND TREATMENT: 304 STAINLESS STL 16 GA (.062)

TEFLON COAT ALL SURFACES

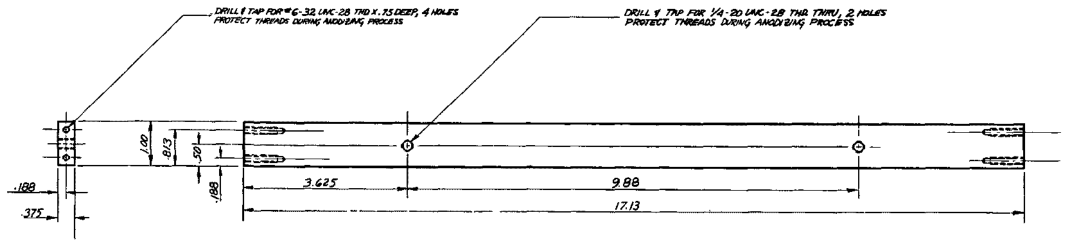
SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	02/26/76
DRAFTING APPR.		
DESIGN APPR.		
APPD.		
APPD.		
PROJECT APPR.		
SPECIAL APPR.		

Battelle Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-3151

TITLE: LOWER IMPACTOR PLATE (PLATE NO. 4)

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352 D -042	

SCALE 1/2 = 1 ACCT. G6352-3 SHEET 1 OF 1



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-083	1	1	1
TO MAKE FINAL ASSEMBLY			TOTAL REQD. 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT: 6061-T6 ALUMINUM 3/8" STOCK HARDCOAT ANODIZE .001" BUILDUP & .001" PENETRATION

SIGNATURE	DIV.	DATE
DRAWN BY MH	644	1/16/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

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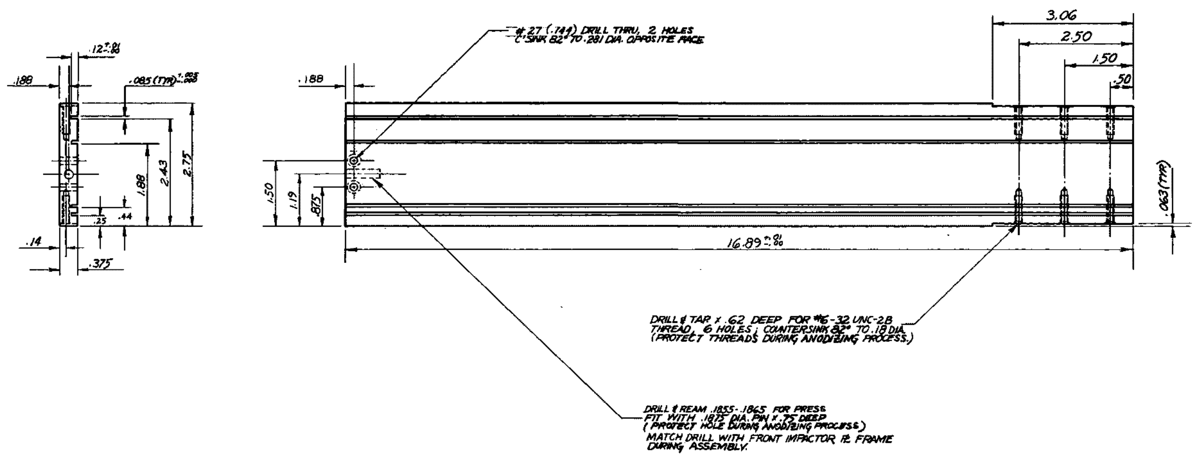
TITLE: IMPACTOR FRAME FRONT CROSS MEMBER

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352 D -043	

SCALE FULL — ACCT. G6352-3 — SHEET 1 OF 1



REVISIONS

ZONE	LTR.	DESCRIPTION	DATE	APPROVED

PARTS LIST

FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

APPLICATION

THIS ITEM IS USED ON SUBASSEMBLIES

DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
6352-A-033	1	1	1

TO MAKE FINAL ASSEMBLY — TOTAL REQ'D: 1

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .XX = .XXXX = .XXX = ANGLES =

MATERIAL AND TREATMENT: 6061-T6 ALUMINUM 3/8" STOCK HARD-COAT ANODIZE .001" BUILDUP & .001" PENETRATION

SIGNATURE	DIV.	DATE
DRAWN BY [signature]	644	1/15/76
DRAFTING APPD.		
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

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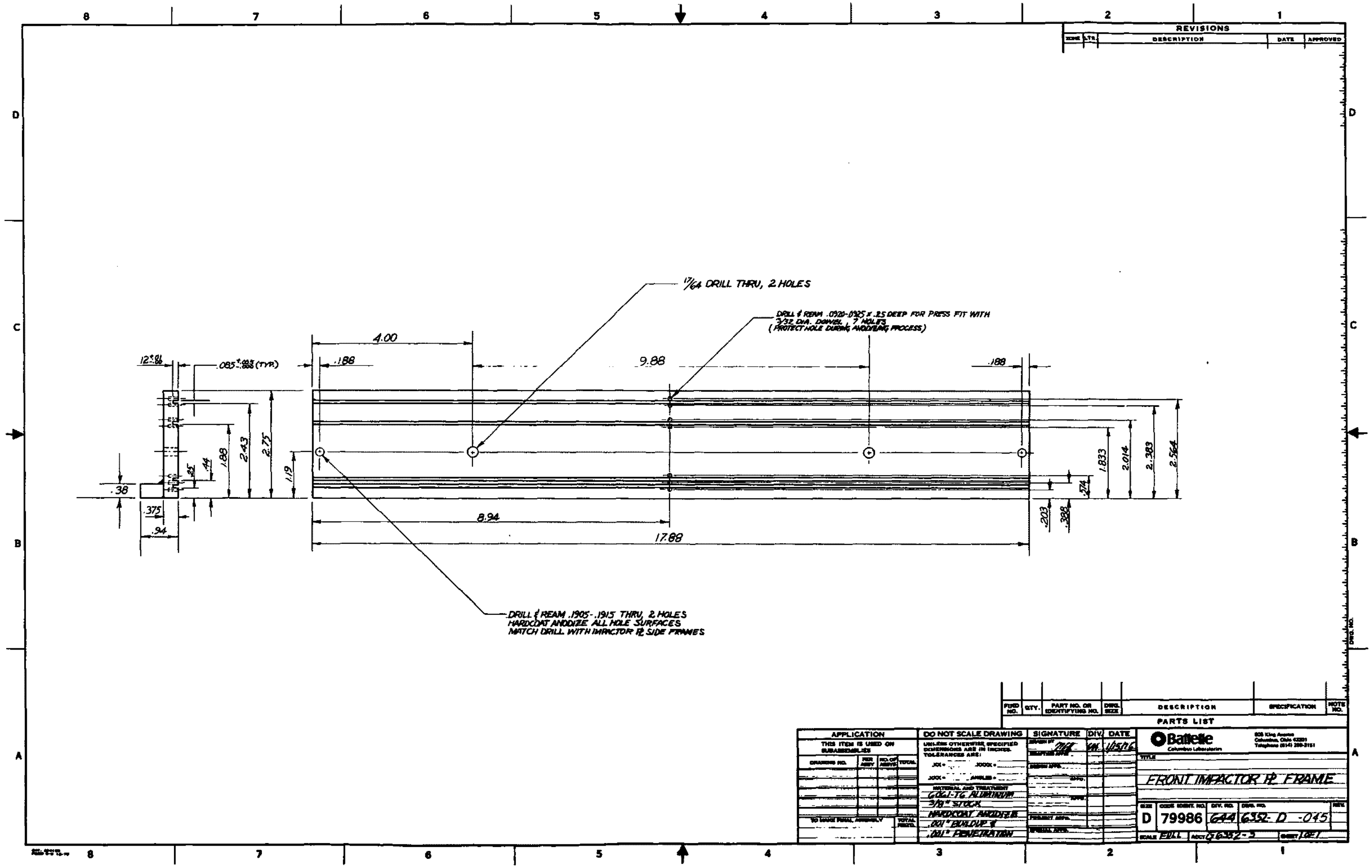
TITLE: LEFT IMPACTOR PL FRAME

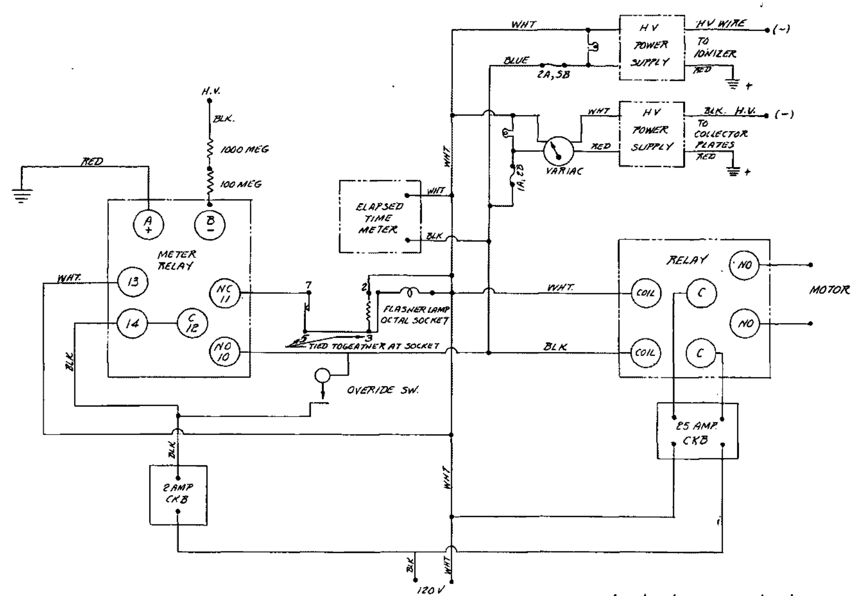
SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
D	79986	644	6352- D -044	

SCALE FULL | ACCT. G-6352-3 | SHEET 1 OF 1



17/64 DRILL THRU, 2 HOLES
DRILL & REAM .0920-.0925 x .25 DEEP FOR PRESS FIT WITH 3/32 DIA. DOWEL, 7 HOLES (PROTECT HOLE DURING ANODIZING PROCESS)
DRILL & REAM .1905-.1915 THRU, 2 HOLES
HARDCOAT ANODIZE ALL HOLE SURFACES
MATCH DRILL WITH IMPACTOR PL SIDE FRAMES
4.00
9.88
.188
.188
8.94
17.88
2.43
2.75
1.88
1.19
.44
.38
.375
.94
1.833
2.014
2.383
2.564
.203
.388
REVISIONS
PARTS LIST
APPLICATION
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
MATERIAL AND TREATMENT
6061-T6 ALUMINUM
3/8" STOCK
HARDCOAT ANODIZE
.001" BUILDUP &
.001" PENETRATION
SIGNATURE
DIV.
DATE
Battelle
Columbus Laboratories
TITLE
FRONT IMPACTOR PL FRAME
D
79986
644
6352-D -045
SCALE FULL
1 OF 1

REVISIONS				
ZONE	LTR.	DESCRIPTION	DATE	APPROVED



FIND NO.	QTY.	PART NO. OR IDENTIFYING NO.	DWG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.

PARTS LIST

APPLICATION			
THIS ITEM IS USED ON SUBASSEMBLIES			
DRAWING NO.	PER ASSY	NO. OF ASSYS	TOTAL
TO MAKE FINAL ASSEMBLY			TOTAL REQ'D.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

.XX = .XXXX =

.XXX = ANGLES =

MATERIAL AND TREATMENT

SIGNATURE	DIV.	DATE
DRAWN BY WRD		
DRAFTING APPD.	644	12/10/76
DESIGN APPD.		
APPD.		
APPD.		
PROJECT APPD.		
SPECIAL APPD.		

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TITLE

ELECTRICAL DIAGRAM

SIZE	CODE IDENT. NO.	DIV. NO.	DWG. NO.	REV.
C	79986		6352-A-046	

SCALE NTS ACCT. G6352-3 SHEET 1 OF 1

DWG. NO.

CAT. 884187 FORM D-6 12-75

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/4-78-031	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE FABRICATION, OPTIMIZATION, AND EVALUATION OF A MASSIVE VOLUME AIR SAMPLER OF SIZED RESPIRABLE PARTICULATE MATTER		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R. I. Mitchell, W. M. Henry, and N. C. Henderson		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle Columbus Laboratories 505 King Avenue Columbus, Ohio 43201		10. PROGRAM ELEMENT NO. 1AD606/1AA601 11. CONTRACT/GRANT NO. 68-02-2281
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Monitoring and Support Laboratory Office of Research and Development U. S. Environmental Protection Agency Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED FINAL 11/76 - 9/77 14. SPONSORING AGENCY CODE EPA-ORD

15. SUPPLEMENTARY NOTES

16. ABSTRACT

A prototype sampler which collects airborne particulate matter in three stages, 3.5 µm, 1.7 µm, and below 1.7 µm (the cutoffs of which closely fit the ACGIH respirable size curve) was constructed previously. Component failures and operational difficulties of the prototype were reviewed, and improvements made. The improvements consisted primarily of design modification and changes in the materials of construction to provide for better strength, durability, and to insure unattended operation and ease of maintenance.

The re-designed samplers were tested experimentally. The reproducibility between two samplers operating in parallel was better than 5 percent, and efficiencies up to 99 percent. Test procedures and results for reproducibility, sharpness of cutoff stages and collection efficiencies are given in the text. The use of a conductive Teflon-clad electrostatic collector constitutes a significant advance.

This report contains a narrative description of the work done, an equipment, materials and supplier list, and copies of engineering drawings to permit construction of the sampler described.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Respirable Sized Particulate Airborne Particulate Matter Massive Volume Air Sampler		13B 14G

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (9-73)