# Westinghouse

# Electrostatic Air Cleaner

## INSTRUCTION BOOK

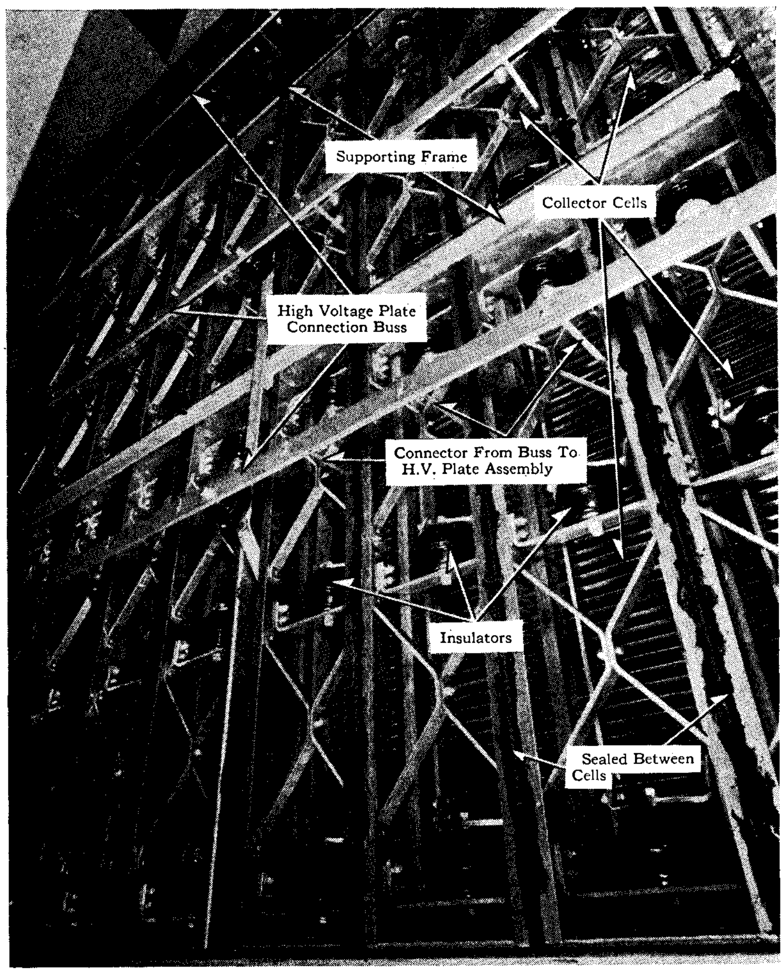


FIG. 1—VIEW INSIDE DUCT OF FIG. 8 LOOKING AT CLEAN SIDE OF COLLECTOR CELLS

**Westinghouse Electric & Manufacturing Company**

**East Pittsburgh Works** **East Pittsburgh, Pa.**

**I. B. 5797**

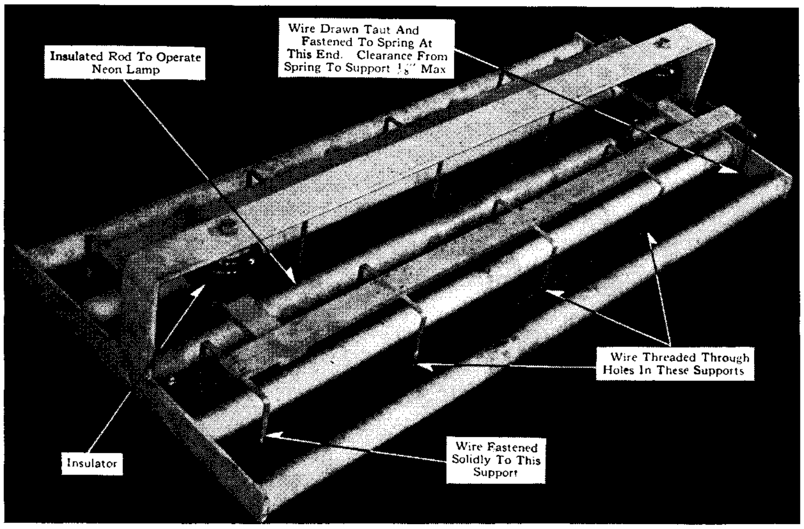


FIG. 2—METHOD OF REPLACING IONIZING WIRE

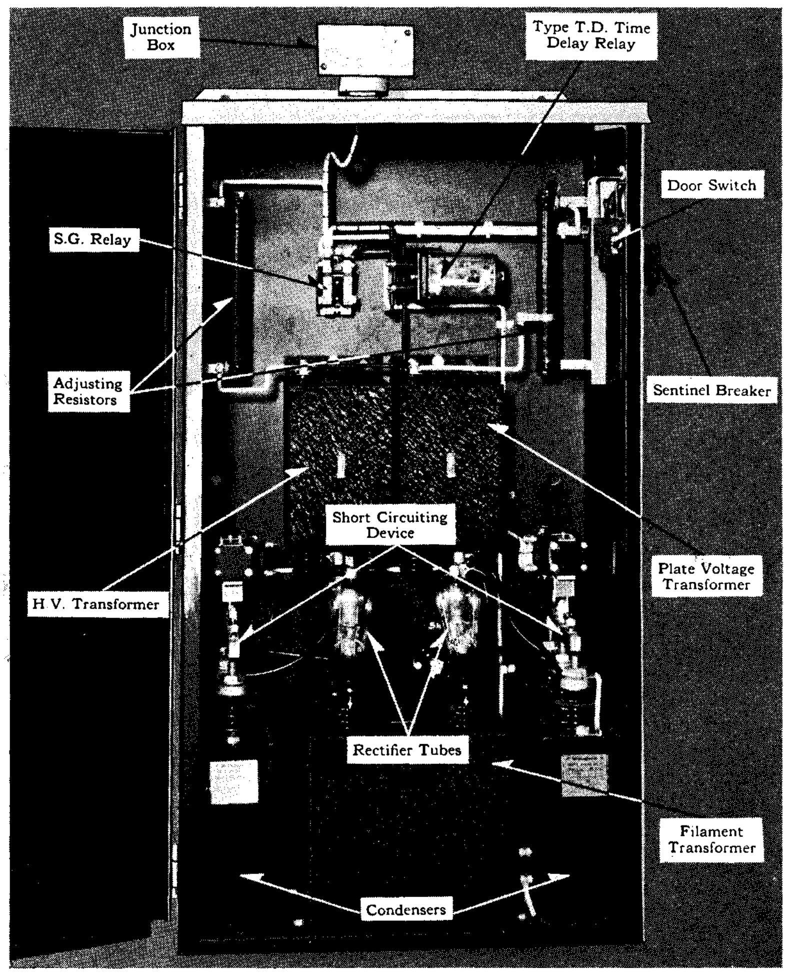


FIG. 3—LARGE POWER SUPPLY

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## Electrostatic Air Cleaner

### INSTRUCTIONS FOR INSTALLATION AND OPERATION

### GENERAL

In order to remove a particle of dirt from the air electrostatically it is given an electrical charge and then placed in an electrostatic field having a voltage gradient high enough to attract it out of the air onto a plate where, in most cases, it will stick by its own adhesion. The charging process occurs in the ionizing chamber where there is a fine wire, at high potential, stretched between parallel rods at ground potential. The voltage gradient in the space between the wire and a rod varies from a very high number of volts per centimeter near the wire to a relatively low value near the rod. The gradient very near the wire is high enough to produce ionization by collision of the air molecules. The air near the wire is broken up into positive and negative charges or ions. The charges which are opposite in sign to that of the wire are immediately attracted to it and discharged. The charges of the same sign as the wire are repelled and tend to follow the electrostatic lines of flux to the grounded rod. A particle of dirt in an air stream entering this region will assume a charge the value of which will depend upon the dielectric constant of the particle and the intensity of the field. The air stream carrying the charged dirt particles then flows between a system of parallel plates so arranged that a high uniform voltage gradient exists between each pair of plates. The charged particle is repelled by a plate having the same sign as that of its charge and attracted by a plate having the opposite sign. It is thus efficiently removed from the air stream and adheres to a plate. After a layer of dirt has built up on the plates of the collector cells it may be readily removed by washing the outfit with a hose.

The Westinghouse Research Laboratories have developed a cleaner which performs the above functions efficiently and at the same time generates such a small amount of ozone that it can be used in air conditioning applications in the home, office or industrial plant.

When speaking of cleaner efficiencies several factors must be taken into account. The kind and particle size of the dirt used in making the test as well as the method of determining the efficiency must be stated. It was found that all mechanical filters were relatively ineffectual in removing atmospheric dust. A method of test was developed which depended upon the blackening of a piece of white filter paper when a sample of the air being tested was drawn through it. (A method now in use by the Bureau of Standards, Washington, D.C.). A comparison of the times necessary to obtain a sample of the same degree of blackness ahead of the cleaner and behind the cleaner is a very good index of the efficiency on that particular type of dirt. The development of such a test was necessary because other methods either consumed too much time or were not critical enough. A cleaner which is 95% efficient by the blackness test will give an efficiency of 99% or better by weight. The best mechanical filters give efficiencies of less than 50% by blackness test.

Any mechanical filter must have very small air passages to be efficient on small particles for the size of the opening determines the size of the particle that will pass through it. If a mechanical filter capable of removing particles a fraction of a micron in diameter was available it would be found to have a very large area and a very high pressure drop. The pressure drop would increase very rapidly with the collection of dirt, and the air flow through it would be decreased as the free area decreased. Such a filter would require frequent cleaning or replacement and it would take a large amount of power to force air through it even when it was clean.

The **ELECTROSTATIC CLEANER** has none of these objections for its pressure drop and power requirements are very low.

Particle size means very little to the **ELECTROSTATIC AIR CLEANER** for all the particles regardless of size or chemical composition receive a charge. It can be constructed to remove tobacco smoke particles from the air. It is constructed of metal and porcelain and is therefore unaffected by the washing out process so that its useful life is very long.

The first cost of an electrostatic air cleaner is a little higher than that of mechanical filters but it is justified by the higher efficiency obtained and the permanence of the installation.

### DESCRIPTION OF APPARATUS

The three principal parts of an **ELECTROSTATIC AIR CLEANER** are the ionizing unit, (Fig. 2), the collector cell, (Fig. 1) and the power supply, (Fig 3 and Fig. 4). The ionizing unit consists of a system of parallel rods about one inch in diameter, which are at ground potential. Suspended midway between each pair of rods and parallel to them is a very small diameter wire which, in operation, is at 12,000 volts D.C. above ground. The particles of dirt in passing between the wires and rods are given an electrical charge. They then pass into a system of parallel plates called the collector cell. This part of the cleaner has a construction which is similar to that of a parallel plate air dielectric fixed condenser. Every other plate and the case is at ground potential and the system of insulated plates (one plate between each pair of grounded plates) is approximately 5,000 volts D.C. above ground. It is in this unit that the dirt which is not removed in the ionizing unit itself is collected.

The power supply normally consists of a modified voltage doubling circuit involving a magnetic leakage type transformer, half wave rectifier tubes and suitable condensers for smoothing out the voltage pulsations, The magnetic leakage type transformer is not injured when its secondary winding is completely

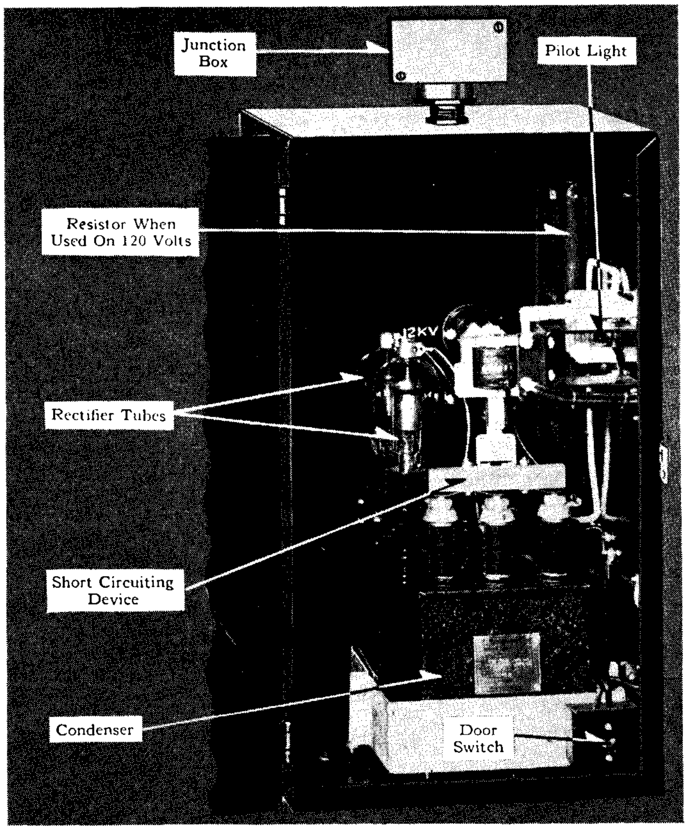


FIG. 4—SMALL POWER SUPPLY

short-circuited because the maximum secondary current is limited. This characteristic of the transformer protects the power supply from injury in case the cells or ionizing units are temporarily shorted for any reason.

From the schematic circuits shown in (Fig. 5) and (Fig. 6), it can be seen that one of the condenser sections is charged during each half cycle. The voltages of the condenser sections are additive so that across one condenser section we obtain approximately 5,000 volts D-C. and across the two sections in series we obtain approximately 12,000 volts D-C. Since one side of each unit in the system is at ground potential it is only necessary to run two high voltage connections between the power supply and the other units. These connections are made with 15,000 volt standard Underwriters' Approved gas tube sign cable. (Westinghouse P.D.S. #7620-3).

In each ionizing unit one rod is supported on insulators. The charge which this rod collects is allowed to flow through a resistor to ground, the resistor having such a value that the voltage drop obtained across it is approximately 110 volts. A small neon lamp is connected across the resistor and furnishes an indication when the cleaner is in normal operation. The connections to the insulated rods may be made with wire having ordinary 110 volt insulation (Fig. 7).

## UNPACKING

Extreme care should be used in uncrating the various parts of the cleaner in order to avoid breaking the small wires in the ionizing unit and to avoid damaging the plates in the cells. The rectifier tubes for the power supply should be handled carefully.

## INSTALLATION

The cross sectional area of duct required for the cleaner installation will, of course, depend upon the volume of air to be cleaned and the cleaning efficiency desired. A unit 8¼" by 35¾" in cross section is capable of handling 750 cu. ft. of air per minute at an efficiency (by blackness test) of 95% (Fig. 8). If the same unit be rated at 500 cu. ft. per minute, the efficiency will increase to 98%. To handle 1500 cu. ft. per minute then (at 95% efficiency) a duct area of approximately 4.25 square feet is required. In the direction of air flow a length of at least three feet is required. The duct should be arranged to get uniform air distribution through the cleaner. From the standpoint of ease of cleaning it is desirable to arrange the installation so that the air flow is vertically upward through the cleaner, although the air flow can be horizontal, (Fig. 12). If the unit is installed with the plates vertical it may be very easily cleaned by allowing water from a hose to flow through it from top to bottom and providing a suitable drip pan with a drain to carry away the dirt and water.

If the drain opening is on the suction side of the cleaner it should be provided with a cover, valve, or suitable trap so that air will not be drawn into the duct system from the waste line. If the drain has a water seal it should contain enough water to maintain the seal from one cleaning period to the next.

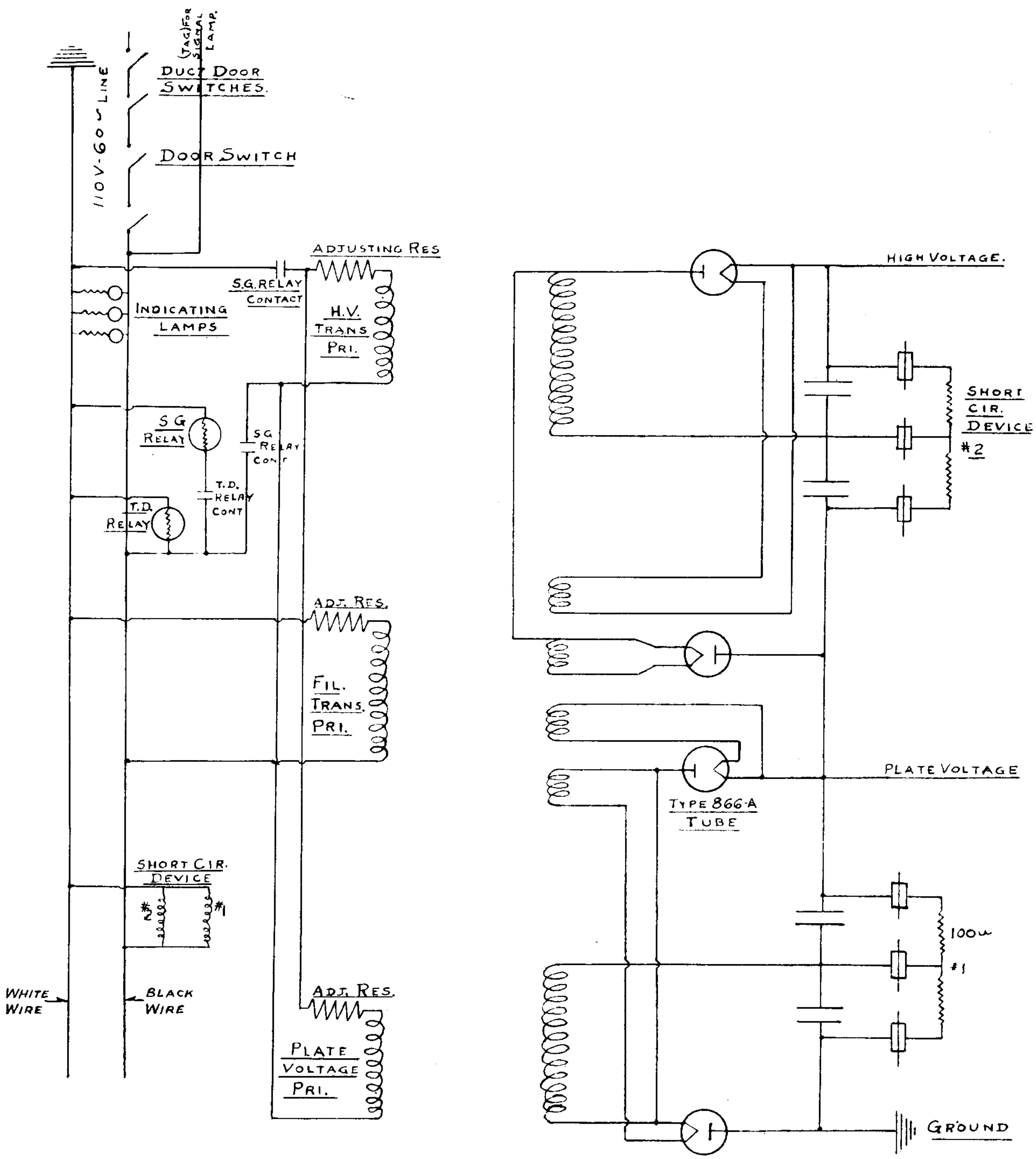


FIG. 5—SCHEMATIC WIRING DIAGRAM FOR LARGE POWER SUPPLY

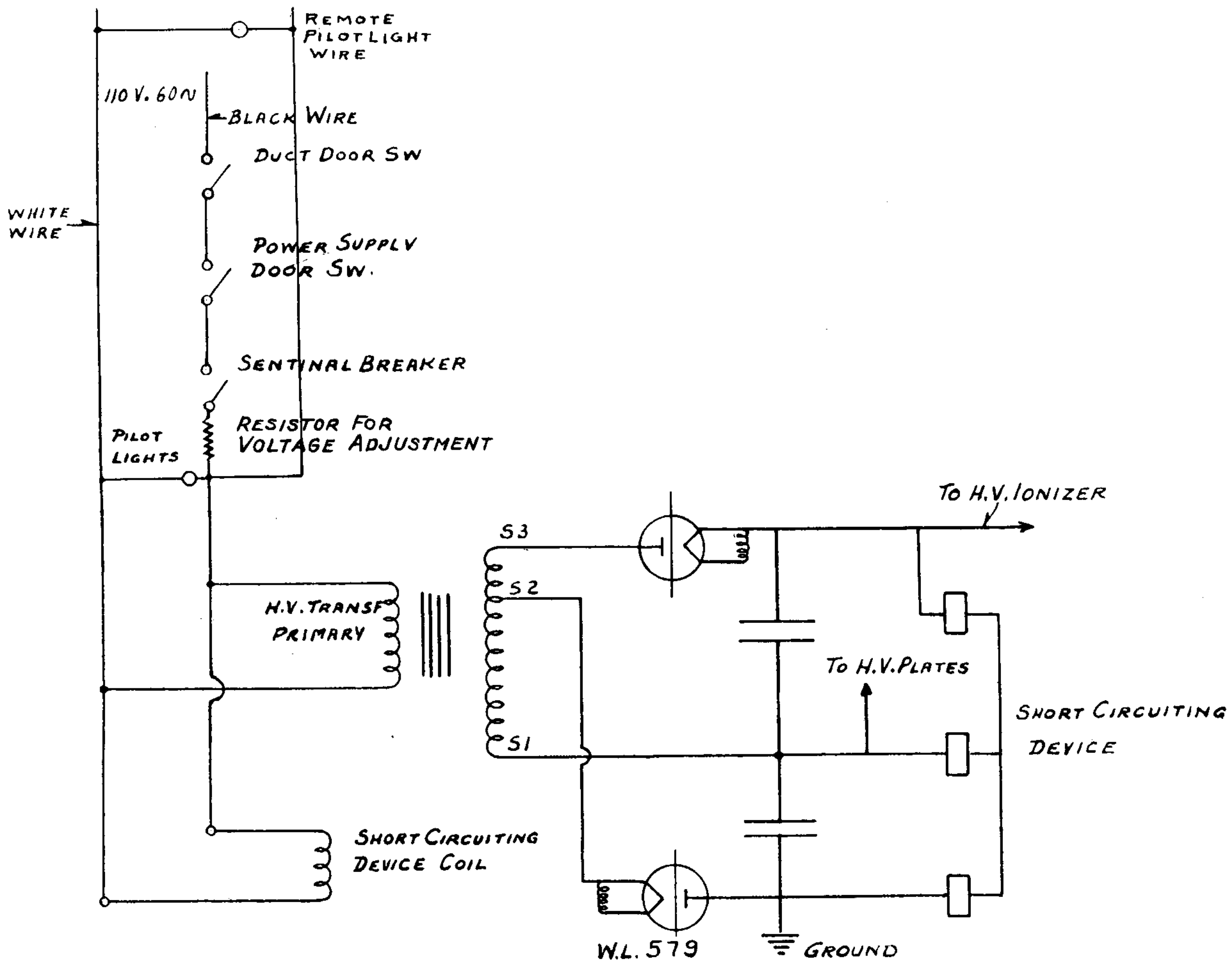


FIG. 6—SCHEMATIC WIRING DIAGRAM FOR SMALL POWER SUPPLY

After flushing the cleaner with water it should be allowed to dry out for 15 or 20 minutes before it is again placed in service.

In any installation the duct should be arranged so that the cleaner may be washed out by directing water from the clean side toward the dirty side of the cleaner. Then if any dirt collects on the duct walls it will collect on the dirty side of the cleaner and if it should be picked up by the air stream it will be taken out again in passing through the cleaner. It is necessary to seal the cleaner at the ionizing section so that all air that flows in the duct must pass between a wire and a rod. It is also necessary to seal the cleaner at the plate assembly section so that all air that flows in the duct must pass between the parallel plates in the cell structure. The cells and ionizing units may be conveniently supported on a frame fabricated from standard structural steel shapes of a size which will carry the weight involved. The power supply may also be supported by a structural frame designed to carry its weight. In most installations it will be found convenient to mount the power supply on the outside of the duct with the two high voltage connections projecting inside the duct. (Fig. 12.)

A suitable drain pan should be arranged under the cleaner to carry away the water and dirt during the cleaning process. In cities which are fairly dirty in the winter months, it will be found necessary to clean the unit once every four to six weeks if ordinary air is being cleaned.

Any wiring inside the duct should, of course, be made splash-proof (i.e. Raintight) so that its operation will be unaffected by the washing out process (Fig. 12). The door switch mounting should be similar to that used in the power supply. It should be lined with insulating material such as fishpaper having a minimum thickness of $\frac{1}{32}$ inch and having a minimum spacing of $\frac{3}{4}$ inch from any live part to ground.

Pilot lights and door switches must be types approved by the Underwriterer's Laboratories. Bryant pilot light No. 427 is one that is satisfactory. Arrow-Hart and Hegeman switch No. 8252-F is is one that is suitable for use as a door switch. Bryant switch No. H-61 is suitable for use insidethe duct.

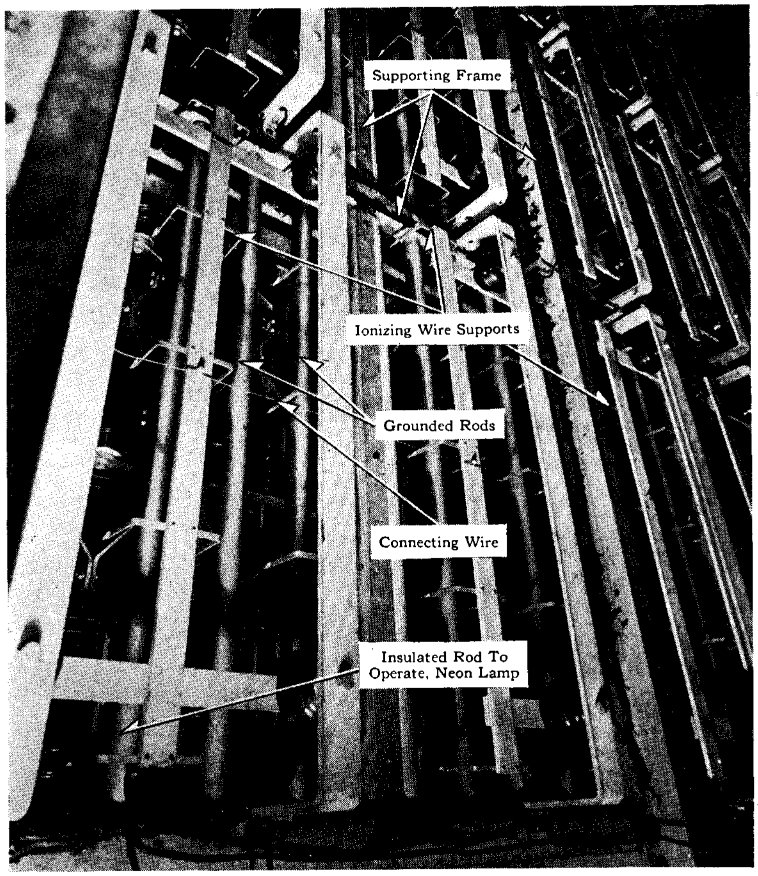


FIG. 7—VIEW INSIDE DUCT OF FIG. 8 LOOKING TOWARD IONIZING CHAMBER (DIRTY) SIDE

Any grilles which are removable and through which it might be possible for a person to enter the duct and get into the section in which the cleaner is installed must be fastened so they can only be removed from inside the duct.

High voltage signs must be placed on all access doors to the cleaner. The power supply cabinet door and all access doors should be provided with locks so that unauthorized persons cannot tamper with the cleaner.

Before an attendant enters the duct for any purpose he should throw the sentinel breaker to the "off" position and open the power supply door. When he enters the duct he should throw the safety switch just inside the duct door to the "off" position. The attendant should be provided with a metal short-circuiting device having an insulated handle, which he can use to ground the high voltage terminals to the duct. (Figs. 13, 14 and 15).

It will be found desirable in most installations to provide some means of closing off the discharge ducts from the cleaner during the cleaning operation because there is some flow of air through the duct with the fan shut down. Otherwise, some of the dirt which is knocked off the plates during cleaning may get back into the discharge duct and be picked up by the air stream when the fan is started. The duct may be closed off with canvas flaps or by metal dampers. An alternative method is to back up the **ELECTROSTATIC AIR CLEANER** with a cheap mechanical filter which will catch large particles. The collected dirt never gets back into the fine state in which it existed before it was precipitated electrostatically, so an ordinary mechanical filter will serve for this purpose. It will have to be replaced very infrequently.

The largest power supply in use at present has an input of approximately 480 watts and the smaller one has an input of approximately 85 watts, so that any ordinary lighting circuit will carry the load safely. A number of safety features must be incorporated in the line which is supplying power to the unit. A door switch must be used on each duct door which gives access to the cleaner. A manually operated mechanical latch on the door will prevent it from slamming shut and putting power on the unit if the sentinel breaker has not been opened (Fig. 16). An additional switch should be placed inside the duct near each duct door. This switch should be operated by any person entering the duct and will open the line so that no one can close the door and throw on the power until that switch is closed. All switches are to be placed in the ungrounded side of the supply circuit. A pilot light with a red jewel is provided on the power supply to indicate when the primary voltage is on. Similar pilot

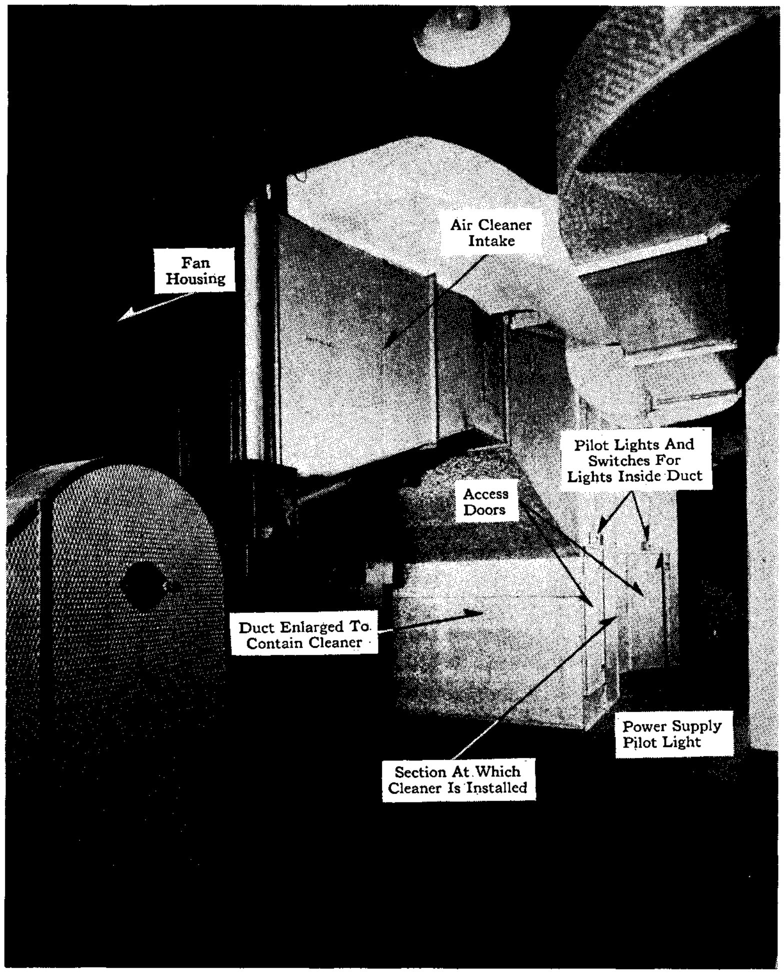


FIG. 8—AIR CLEANER INSTALLED
(30000 C.F.M. APPROX.)

lights must be provided at each duct door. A sentinel breaker located on the side of the power supply contains a thermal overload device which opens the primary circuit when a sustained short circuit occurs in the cleaner. A short circuiting device discharges the condensers when the supply circuit is opened. The metal of the duct, the outside case of the cells, the framework of the ionizing units and the power supply must all have a common ground and must also be connected to the framework of the building or to the water line. Where the water line is used a jumper must be provided to shunt the water meter if one has not already been installed.

The high voltage connections to the collector cells may be made by mounting buss bars on insulators and connecting directly between the buss and one high voltage bar of each cell. The buss bars are then connected together and a connection made from them to the plate voltage terminal of the power supply. The high voltage parts of the ionizing units may be connected by using number fourteen or larger bare copper wire. The high voltage connection to the ionizing unit must be made with 15,000 volt standard gas tube cable run through a conduit. The open ends of the conduit should be directed downward to prevent water from collecting in it. The cell cases and ionizing units must be well grounded to the supporting frame, The frame must be grounded to the framework of the building or to the water line or both if convenient.

One of the rods in each ionizing unit is supported on insulators. In an installation a number of these insulated rods are connected in parallel and the charge they collect is allowed to flow through a fixed resistor of such a value that the voltage drop obtained is approximately 110 volts D.C. This voltage is used to operate a neon indicator lamp. When anything occurs which decreases the voltage on the ionizing wire the indicator lamp goes out showing that the cleaner is inoperative. In some installations it may be desirable to include a relay in this circuit which will operate to close a set of contacts when the indicator lamp goes out. The contacts may be used to operate an alarm system which will call attention to the fact that one of the installations is out of order. Then by looking at the panel upon which the indicator lamps are mounted one can tell which particular cleaner is at fault.

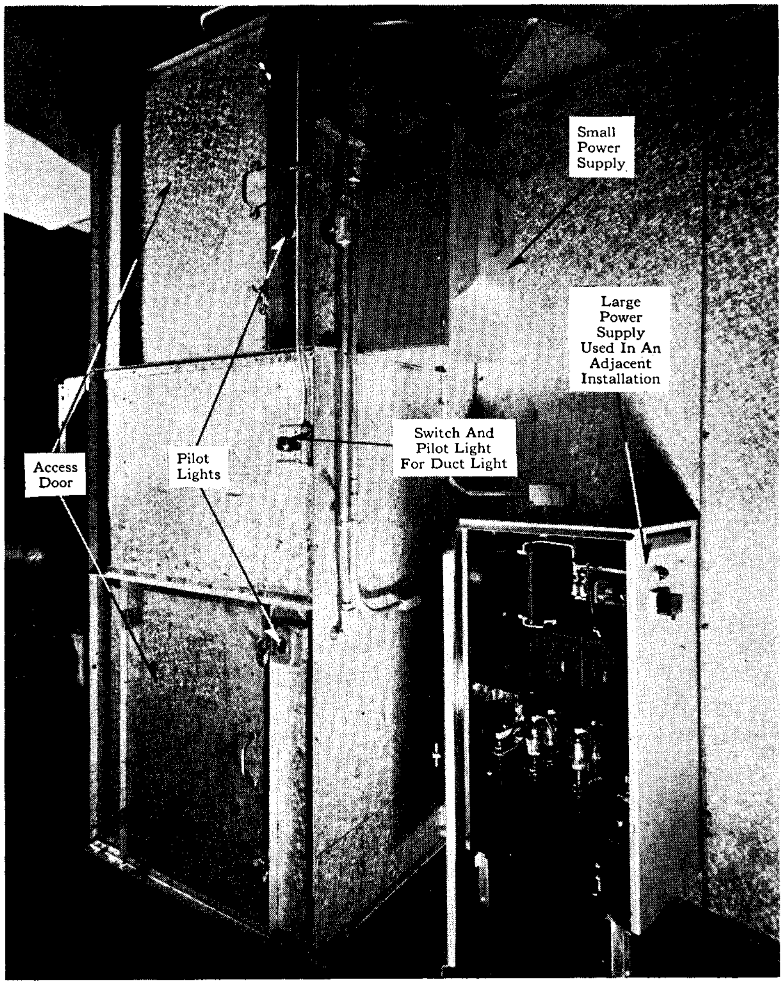


FIG. 9—AIR CLEANER INSTALLATION APPROX. 4500 C.F.M.
USING SMALL POWER SUPPLY

## OPERATION AND MAINTENANCE

The cleaner power supply is designed to be self protecting. A sustained short circuit in either the plate circuit or the ionizing circuit will not injure it. When a short circuit does occur the neon indicator lamp goes out and in something less than five minutes (the time depending upon the completeness of the short circuit) the sentinel breaker trips and opens the primary power supply to the unit. One of the troubles which may give rise to short circuits is the breaking of an ionizing wire. (Fig. 2.) In replacing the wire, care should be taken to remove all pieces of the broken wire to make sure that no pieces get into the cells where they may cause further short circuits. The new wire should be fastened to the spring at one end and then threaded through the holes in the wire supports and fastened to the end support under tension at the other end. The tension spring should be within one eighth of an inch of the wire support to which it is fastened.

If a rectifier tube should fail, the indicator lamp will again go out. These tubes should have a life comparable to that of a radio tube in continuous operation. When the large power supply is first put into operation, the filaments of the tubes should be allowed to heat up for 15 or 20 minutes before the high voltage is applied, (See Westinghouse Electronic Tubes, Bulletin T. D. 54). This may be done by placing paper in the S. G. relay contacts to keep the primary circuits of the high voltage transformers open. The heat vaporizes the mercury which collects on the glass during shipment and prevents back firing which may occur if the high voltage is applied immediately.

The time delay relay should be checked to see that it allows the filaments to heat for approximately 30 seconds before the high voltage is applied.

The time delay relay may be adjusted by adjusting the stop which holds the moving contacts. This may be done by loosening the screw which holds it in position.

The voltages on the plates and ionizing units may be adjusted in the large power supply by varying the value of the adjusting resistors shown in Fig, 3. This should not be necessary for the power supply is adjusted properly for a given

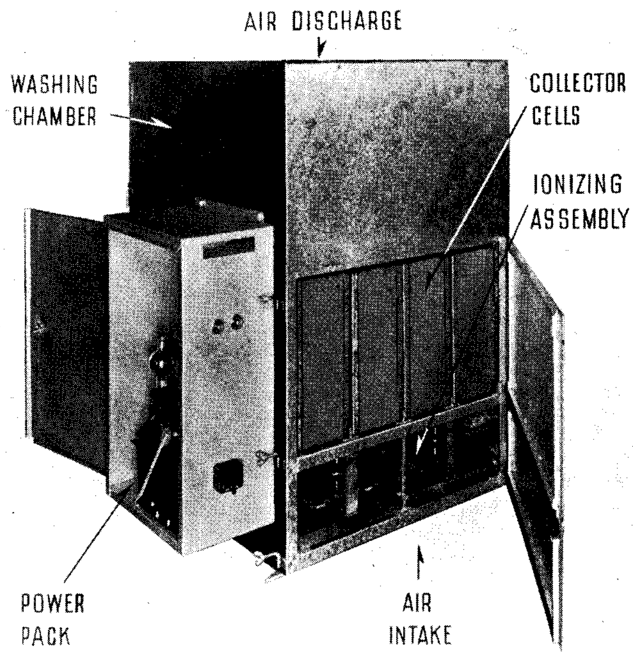


FIG. 10—TYPICAL 2400 C.F.M. INDUSTRIAL CLEANER

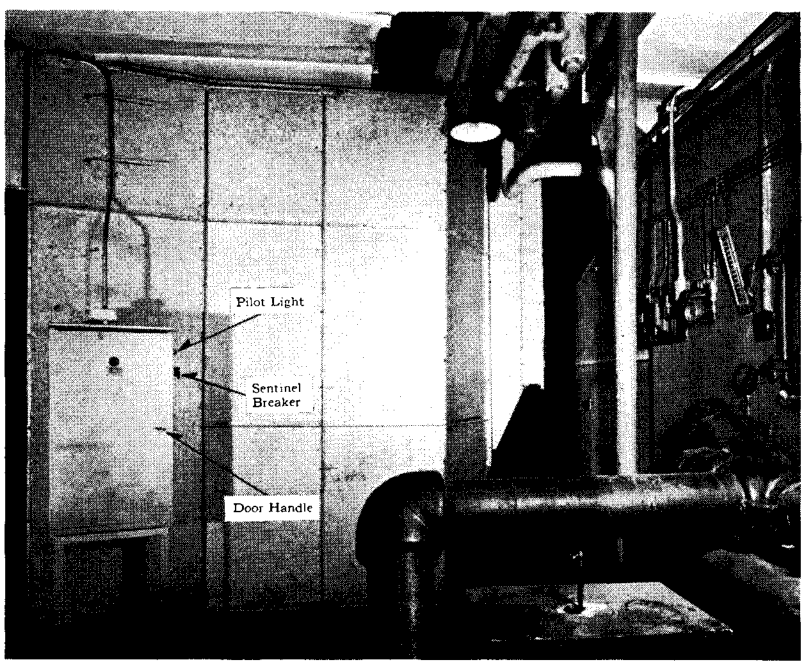


FIG. 11—POWER SUPPLY FOR INSTALLATION SHOWN IN FIG. 8

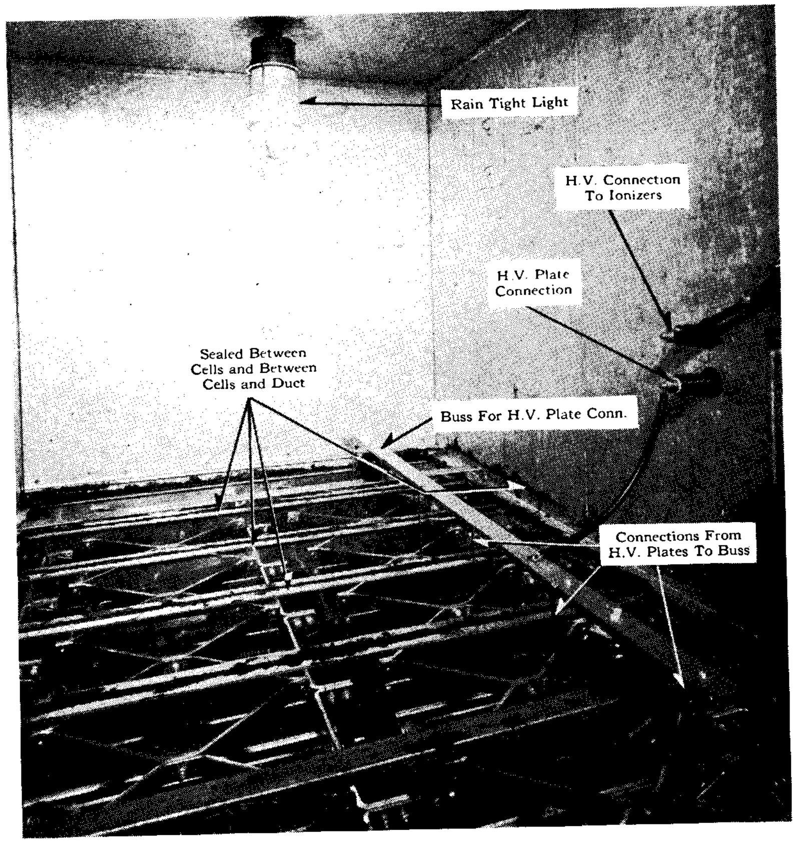


FIG. 12—LOOKING INTO UPPER ACCESS DOOR OF CLEANER SHOWN IN FIG. 9 (CLEAN SIDE) AIR FLOW VERTICALLY UPWARD

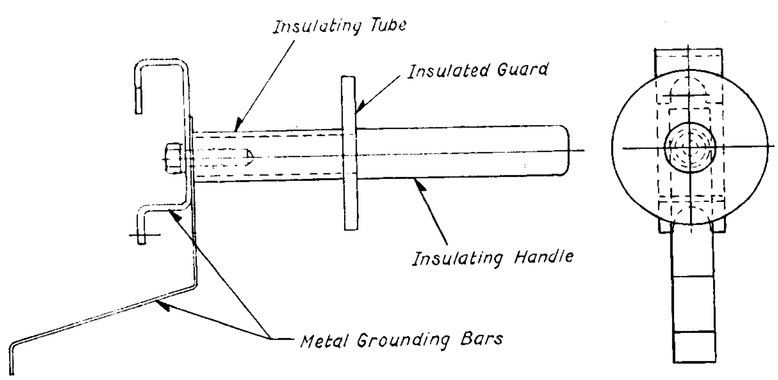


FIG. 13—GROUNDING DEVICE FOR SMALL POWER SUPPLY

installation when it leaves the factory. A high voltage meter (Fig. 17) is necessary to assure proper adjustment. In general decreasing the value of the resistor will raise the voltage.

As stated elsewhere, when the neon lamp fails to glow it indicates that the cleaner is not operating normally. The most common causes of failure are:

(a) Ionizing wire breakage.

(b) Foreign conducting material between cell plates.

(c) Sentinel breaker may trip out if cleaner is placed in service too

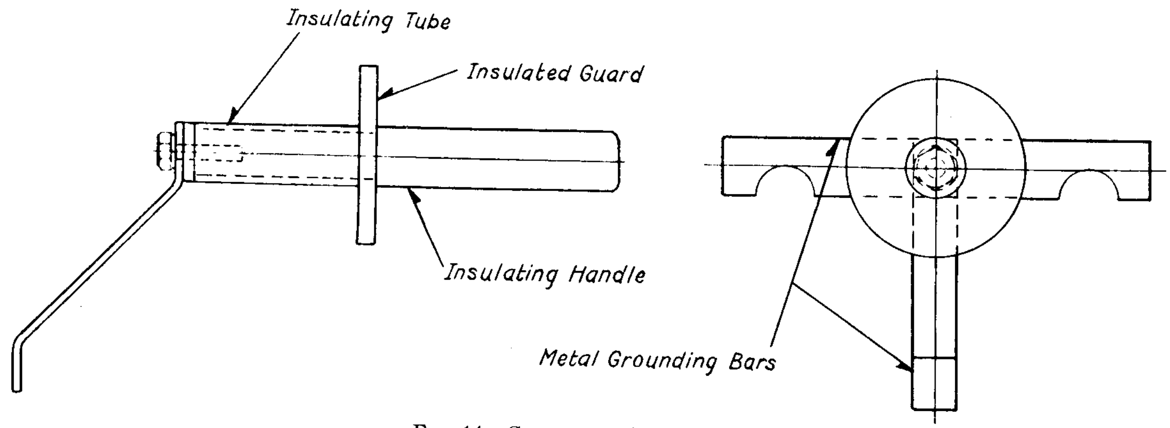


FIG. 14—GROUNDING DEVICE FOR
LARGE POWER SUPPLY

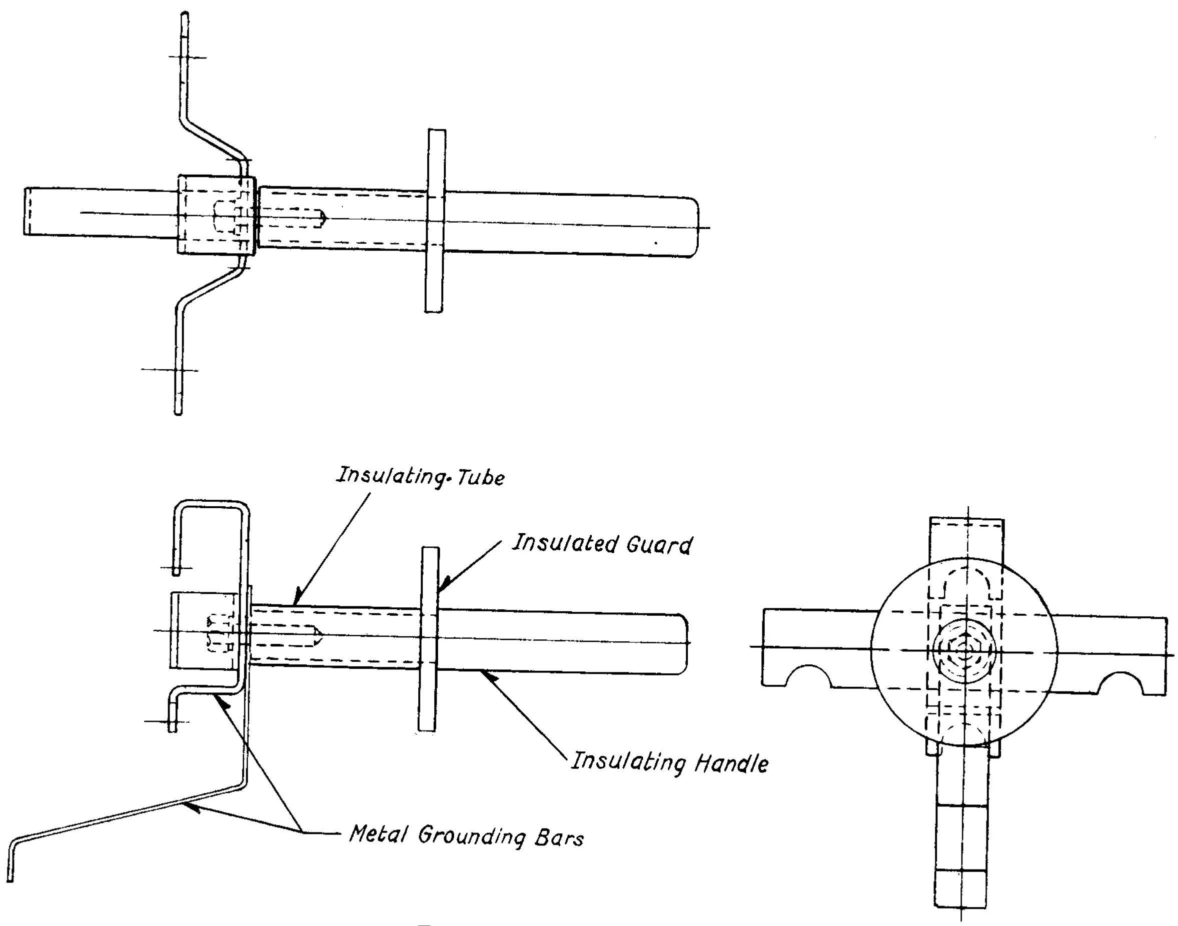


FIG. 15—GROUNDING DEVICE FOR
BOTH LARGE AND SMALL POWER SUPPLY

soon after washing out because of water between the plates.

In normal operation the collector cells will spark over occasionally. This sparking does no harm for the unit clears itself instantly and continues in operation.

The best way to locate trouble in the cleaner is by measuring the D.C. voltages. This requires a high voltage very low drain voltmeter. Such a voltmeter may be made by using a microammeter (25 microamperes full scale) and a billion ohm resistor. The resistor may be made up of 10-100 megohm (Fig. 17) S.S. White resistors placed in a glass tube or suitably insulated in some manner.

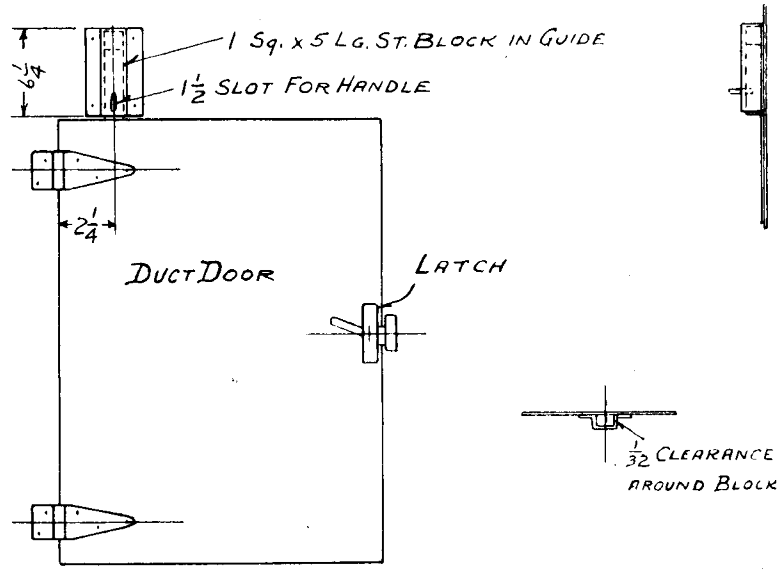


FIG. 16—MECHANICAL INTERLOCK FOR DUCT DOOR

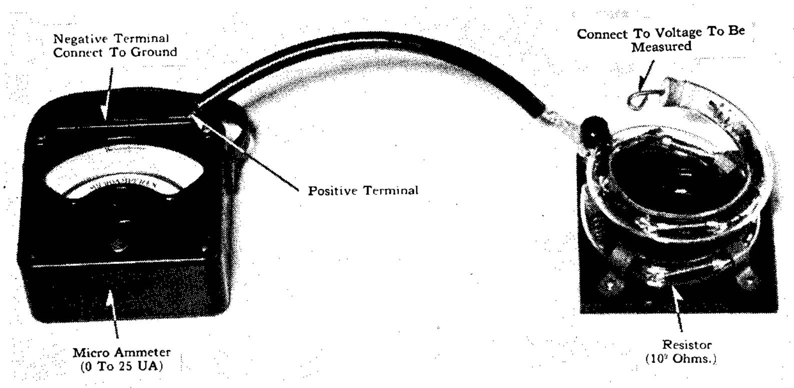


FIG. 17—HIGH VOLTAGE METER

## Tabulation of Weights of Various Cleaner Parts

| Name of Part | Style Number | Weight in Pounds |
|---|---|---|
| 600 cfm Corten collector cell | 1 043 056 | 130 |
| 600 cfm Aluminum collector cell | 1 020 972 | 75 |
| 2 cell ionizing unit | 1 020 974 | 34½ |
| 3 cell ionizing unit | 1 020 973 | 40 |
| Small power supply (4 unit) | 1 020 976 | 76 |
| Large power supply (20 to 40 Unit) | 1 020 975 | 325 |

## REFERENCES

1. A New Electrostatic Precipitator. G. W. Penney in January, 1937. Electrical Engineering.
2. Westinghouse Electronic Tubes. Bulletin T.D. 54.
3. Ions Electrons and Ionizing Radiations. Crowther.

# MEMORANDUM

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# WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

## Business Addresses

### ①Headquarters, Pittsburgh, Pa.

*AKRON, OHIO, 106 South Main St.
*ALBANY, N. Y., 456 No. Pearl St.
§ALEXANDRIA, VA., 121 Frazier Ave.
*ALLENTOWN, PA., 522 Maple St.
①*APPLETON, WISC., 1708 N. Drew St., P.O. Box 206
†APPLETON, WISC., 1029 So. Outagamie St.
✱†*ATLANTA, GA., 426 Marietta St., N. W.
xATTICA, N. Y.
*BAKERSFIELD, CALIF., 2224 San Emedio St.
*BALTIMORE, MD., 118 E. Lombard St.
†BALTIMORE, MD., 501 East Preston Road
§BALTIMORE, MD., 40 S. Calvert St.
①*BEAUMONT, TEXAS, 2293 Broadway Ave., P. O. Box 2367
*BINGHAMTON, N. Y., Suite 704, Marine Midland Bldg., 86 Court St.
*BIRMINGHAM, ALA., 2030 Second Ave.
*BLUEFIELD, W. VA., 208 Bluefield Avenue
§BOISE, IDAHO, P. O. Box 1597
*BOSTON, MASS., 10 High St.
†✱BOSTON, MASS., 12 Farnsworth St.
*†BRIDGEPORT, CONN., Bruce Ave. & Seymour St.
*BUFFALO, N. Y., 814 Ellicott Square
†✱BUFFALO, N. Y., 1132 Seneca St.
*BURLINGTON, IOWA, 1708 River St.
*BURLINGTON, VER., 208 Park Ave.
*BUTTE, MONTANA, 129 West Park St.
✱BUTTE, MONTANA, 742 Bryant Ave.
*CANTON, OHIO, Market & Tuscarawas Sts.
①*CEDAR RAPIDS, IOWA, 507 Longwood Drive, N. E., P. O. Box 148
*†✱CHARLOTTE, N. C., 210 East Sixth St.
①*CHARLESTON, W. VA., 107 Oakmont St., P. O. Box 865
*CHATTANOOGA, TENN., 536 Market St.
*CHICAGO, ILL., 20 N. Wacker Drive
†✱CHICAGO, ILL., 2211 W. Pershing Road
xCHICOPEE FALLS, MASSACHUSETTS
*†✱CINCINNATI, OHIO, 207 West Third St.
*†x✱CLEVELAND, OHIO, 1216 West Fifty-Eighth St.
§COLUMBIA, S. C., 912 Lady St.
*COLUMBUS, OHIO, Gay & Third Sts.
*DALLAS, TEXAS, 209 Browder St.
✱DALLAS, TEXAS, 1712 Carter St.
*DAVENPORT, IOWA, 206 E. Second St.
*DAYTON, OHIO, 30 North Main St.
*DENVER, COLORADO, 910 Fifteenth St.
✱DENVER, COLORADO, 1700 Sixteenth St.
†DENVER, COLORADO, 988 Cherokee St.
①§DENVER, COLORADO, Gas & Elec. Bldg.
xDERRY, PA.
*DES MOINES, IOWA, 523 Sixth Ave.
*†✱DETROIT, MICH., 5757 Trumbull Ave.
*DULUTH, MINN., 10 East Superior St.
①x✱EAST PITTSBURGH, PA.
*EL PASO, TEXAS, 303 N. Oregon St.
✱EL PASO, TEXAS, 450 Canal St.
§EL PASO, TEX., % Zork Hdwe. Co., 309 N. El Paso St.
✱*EMERYVILLE, CALIF., 5815 Peladeau St.
†EMERYVILLE, CALIF., 1466 Powell St.
xEMERYVILLE, CALIF., 6161 Green St.
*ERIE, PA., 1003 State St.
*EVANSVILLE, IND., 201 N. W. First St.
*†FAIRMONT, W. VA., 602 Cleveland Ave.
①§FARGO, N. D., 520—3rd Ave. N.
*FORT WAYNE, IND., 1010 Packard Ave.
*FORT WORTH, TEXAS, 501 Jones St.
①*FRESNO, CALIF., 872 Peralta Way, P. O. Box 632
*GARY, IND., 701 Washington St.
*GRAND RAPIDS, MICH., 507 Monroe Ave. N. W.
*GREENSBORO, N. C., 108 S. Park Drive, P. O. Box 1828.
*GREENVILLE, S. C., West Earle St.
*HAMMOND, IND., 235 167th St.
*HARTFORD, CONN., Main & Pearl Sts.
*HONOLULU, T. H., Hawaiian Elec. Co. Agt.
*HOUSTON, TEXAS, 1314 Texas Ave.
✱HOUSTON, TEXAS, 2313 Commerce Ave.
†HOUSTON, TEXAS, 2315 Commerce Ave.
①§HOUSTON, TEXAS, 611-15 Petroleum Bldg.
*†✱HUNTINGTON, W.VA., 1029 Seventh Ave.
*INDIANAPOLIS, IND., 137 S. Penna. Ave.
†INDIANAPOLIS, IND., 551 West Merrill St.
*ISHPEMING, MICH., 433 High St.
*JACKSON, MICH., 212 West Michigan Ave.
*†JOHNSTOWN, PA., 47 Messenger St.
*JOPLIN, MO., 420 School St.
*KANSAS CITY, MO., 101 W. Eleventh St.
†KANSAS CITY, MO., 2124 Wyandotte St.
*KNOXVILLE, TENN., Gay & Clinch St.
xLIMA, OHIO
*LITTLE ROCK, ARK., 1115 West 24th St.
§LITTLE ROCK, ARK., % Fones Bros. Hdwe., 2nd & Rock Sts.
*†✱LOS ANGELES, CALIF., 420 So. San Pedro St.
*LOUISVILLE, KY., 332 West Broadway
*MADISON, WISC., 508 Edgewood Ave.
xMANSFIELD, OHIO, 200 East Fifth St.
*MARSHALL, TEXAS, 504 Nathan St.
*MEMPHIS, TENN., 130 Madison Ave.
*MIAMI, FLA., 1036 N. Miami Ave.
*MILWAUKEE, WISC., 546 North Broadway
†MILWAUKEE, WISC., 1669 N. Water St.
*†✱MINNEAPOLIS, MINN., 2303 Kennedy St., N. E.
*MONROE, LA., 1301 N. Fourth St.
*NASHVILLE, TENN., 219 N. Second Ave.
*NEWARK, N. J., 1180 Raymond Blvd.
†✱NEWARK, N. J., Haynes Ave. & Lincoln Highway
xNEWARK, N. J., Plane & Orange St.
*NEW HAVEN, CONN., 42 Church St.
†*NEW ORLEANS, LA., 333 St. Charles St.
✱NEW ORLEANS, LA., 527 Poydras St.
*NEW YORK, N. Y., 150 Broadway
†NEW YORK, N. Y., 460 West Thirty-Fourth St.
*NIAGARA FALLS, N. Y., 205 Falls St.
*NORFOLK, VA., 254 Tazewell St.
*OKLAHOMA CITY, OKLA., 10 E. California St.
✱OKLAHOMA CITY, OKLA., Third & Alie Sts.
*OMAHA, NEB., 409 South Seventeenth St.
§OMAHA, NEB., 117 N. 13th St.
*PEORIA, ILL., 104 E. State St.
*†✱PHILADELPHIA, PA., 3001 Walnut St.
*PHOENIX, ARIZONA, 11 West Jefferson St.
xPITTSBURGH, PA., Nuttall Works, 200 McCandless Ave.
z*PITTSBURGH, PA., 306 4th Ave., Box 1017
✱†PITTSBURGH, PA., 543 N. Lang Ave.
*PORTLAND, MAINE, 142 High St.
*PORTLAND, OREGON, 309 S. W. Sixth Ave.
†PORTLAND, OREGON, 2138 N. Interstate Ave.
✱PORTLAND, OREGON, 720 N. Thompson St.
*†PROVIDENCE, R. I., 16 Elbow St.
*RALEIGH, N. C., 803 North Person St.
①§RALEIGH, N. C., P. O. Box 443.
§READING, PA., 619 Spruce St.
*RICHMOND, VA., Fifth & Byrd
*§ROANOKE, VA., 726 First St., S. E.
*†ROCHESTER, N. Y., 410 Atlantic Ave.
*ROCKFORD, ILL., 130 South Second St.
*SACRAMENTO, CALIF., 1805 20th St.
*SALT LAKE CITY, UTAH, 10 West First South St.
†✱SALT LAKE CITY, UTAH, 346 A Pierpont Ave.
①§SALT LAKE CITY, UTAH, McCormick Bldg.
*SAN ANTONIO, TEXAS, 115 W. Travis St.
*SAN FRANCISCO, CALIF., 1 Montgomery St.
*SEATTLE, WASH., 603 Stewart St.
†✱SEATTLE, WASH., 3451 East Marginal Way
xSHARON, PA., 469 Sharpsville Ave.
*SIOUX CITY, IOWA, 2311 George St.
*SOUTH BEND, IND., 216 East Wayne St.
§SOUTH BEND, IND., 107 E. Jefferson St.
xSOUTH PHILA. WKS., Essington, Pa.
°SOUTH PHILA. WKS., P. O. Box 7348, Philadelphia, Pa.
*SPOKANE, WASH., So. 158 Monroe St.
*SPRINGFIELD, ILL., 601 E. Adams St., Box 37
*†SPRINGFIELD, MASS., 395 Liberty St.
xSPRINGFIELD, MASS., 653 Page Boulevard
*ST. LOUIS, MO., 411 North Seventh St.
†✱ST. LOUIS, MO., 717 South Twelfth St.
xST. LOUIS, MO., 3850 Bingham Ave.
*SYRACUSE, N. Y., 420 N. Geddes St.
*TACOMA, WASH., 1023 "A" St.
*TAMPA, FLA., 417 Ellamae Ave., Box 230
*TOLEDO, OHIO, 245 Summit St.
*TULSA, OKLA., 303 East Brady St.
①*✱†UTICA, N. Y., 113 N. Genesee St.
*WASHINGTON, D. C., 1434 New York Ave., N. W.
*WATERLOO, IOWA, 328 Jefferson St., P. O. Box 598.
*WICHITA, KAN., 233 So. St. Francis Ave.
*†WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
*†WORCESTER, MASS., 32 Southbridge St.
*YORK, PA., 143 So. George St.
*YOUNGSTOWN, OHIO, 25 E. Boardman St.

**Where address and P. O. box are both given, send mail to P. O. box, telegrams to address indicated.**

# ①WESTINGHOUSE ELECTRIC SUPPLY COMPANY

**Fully equipped sales offices and warehouses are maintained at all addresses**

①ALBANY, N. Y., 454 No. Pearl St.
ALLENTOWN, PA., 522 Maple St.
ATLANTA, GA., 96 Poplar St., N. W.
AUGUSTA, MAINE, 90 Water St.
BALTIMORE, MD., 40 South Calvert St.
BANGOR, MAINE, 175 Broad St.
BINGHAMTON, N. Y., 87 Chenango St.
BOSTON, MASS., 76 Pearl St.
BURLINGTON, VT., 208 Flynn Ave.
BUTTE, MONTANA, 50 East Broadway
CHARLOTTE, N. C., 210 East Sixth St.
CHICAGO, ILL., 113 North May St.
CLEVELAND, OHIO, 3950 Prospect Ave.
COLUMBIA, S. C., 915 Lady St.
DALLAS, TEXAS, 409 Browder St.
DES MOINES, IOWA, 218 W. Second St.
DETROIT, MICH., 547 Harper Ave.
DULUTH, MINN., 308 W. Michigan St.
EVANSVILLE, IND., 201 N. W. First St.
FLINT, MICH., 1314 N. Saginaw St.
FORT WORTH, TEXAS, 501 Jones St.
GRAND RAPIDS, MICH., 507 Monroe Ave., N. W.
GREENVILLE, S. C., 200 River St.
HOUSTON, TEXAS, 1903 Ruiz St.
①INDIANAPOLIS, IND., 137 S. Pennsylvania St.
JACKSONVILLE, FLA., 37 South Hogan St.
LOS ANGELES, CALIF., 905 East Second St.
MADISON, WISC., 1022 E. Washington Ave.
MIAMI, FLA., 1036 North Miami Ave.
MEMPHIS, TENN., 366 Madison Ave.
MILWAUKEE, WISC., 546 N. Broadway
MINNEAPOLIS, MINN., 215 South Fourth St.
NEWARK, N. J., 49 Liberty St.
NEW HAVEN, CONN., 240 Cedar St.
zNEW YORK, N. Y., 150 Varick St.
NORFOLK, VA., 254 Tazewell St.
OAKLAND, CALIF., Tenth & Alice Sts.
OKLAHOMA CITY, OKLA., 10 E. California St.
OMAHA, NEB., 117 North Thirteenth St.
PEORIA, ILL., 104 East State St.
PHILADELPHIA, PA., 1101 Race St.
PHOENIX, ARIZONA, 315 West Jackson St.
PORTLAND, OREGON, 134 N.W. Eighth Ave.
PROVIDENCE, R. I., 66 Ship St.
RALEIGH, N. C., 322 S. Harrington St.
READING, PA., 619 Spruce St.
RICHMOND, VA., 301 South Fifth St.
ROANOKE, VA., 726 First St., S. E.
ROCHESTER, N. Y., 240 St. Paul St.
ST. LOUIS, MO., 1011 Spruce St.
ST. PAUL, MINN., 145 East Fifth St.
①SACRAMENTO, CALIF., 20th and R Sts.
SALT LAKE CITY, UTAH, 235 West South Temple St.
SAN ANTONIO, TEXAS, 1201 E. Houston St.
SAN FRANCISCO, CALIF., 260 Fifth St.
SEATTLE, WASH., 558 First Ave., South
SIOUX CITY, IOWA, 1005 Dace St.
SPOKANE, WASH., 152 So. Monroe St.
SPRINGFIELD, MASS., 46 Hampden St.
SYRACUSE, N. Y., 961 W. Genesee St.
TAMPA, FLA., 417 Ellamae St.
TOLEDO, OHIO, 812 Lafayette St.
TRENTON, N. J., 245 N. Broad St.
TULSA, OKLA., 303 East Brady St.
UTICA, N. Y., 113 N. Genesee St.
WASHINGTON, D. C., 1216 "K" St., N. W.
WATERLOO, IOWA, 328 Jefferson St.
①WICHITA, KANSAS, 233 So. St. Francis Ave.
WILMINGTON, DEL., 216 E. Second St.
WORCESTER, MASS., 24 Southbridge St.
YORK, PA., 143 S. George St.

* Sales Office † Service Shop x Works ✱ Warehouse °First Class Mail Only § Merchandising Products Only z Headquarters ‡Apparatus Products Only
①Changed or added since previous issue.

July, 1937