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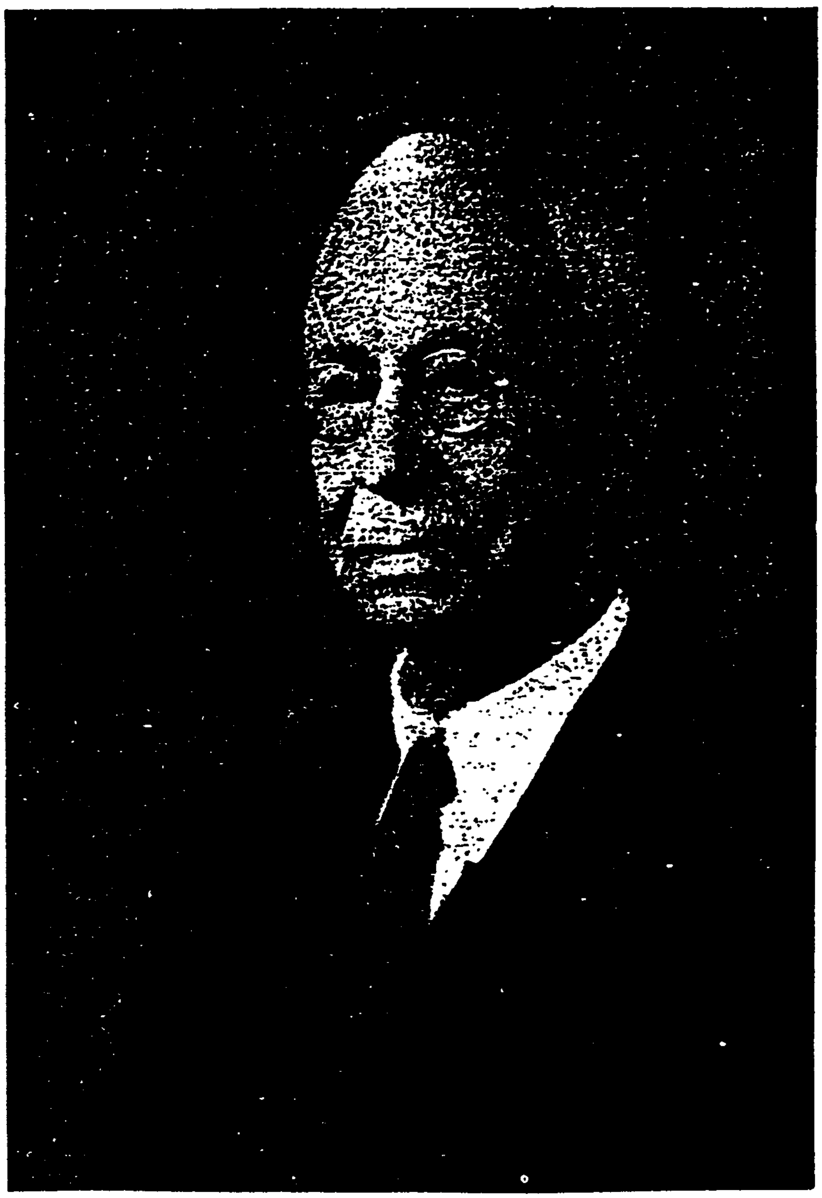

DAVIS BROWN
1944

special machine (see Fig. 6). Norton wheels ME 35588 or ME 36438, 100 S-M-100, 4 by $^{3}/_{16}$ by 0.503 inches, are used. The wheel is run at 4711 surface feet per minute; 0.0005 to 0.0001 inch is removed per revolution of the gauge blank. Soluble oil is used during grinding. Some types,

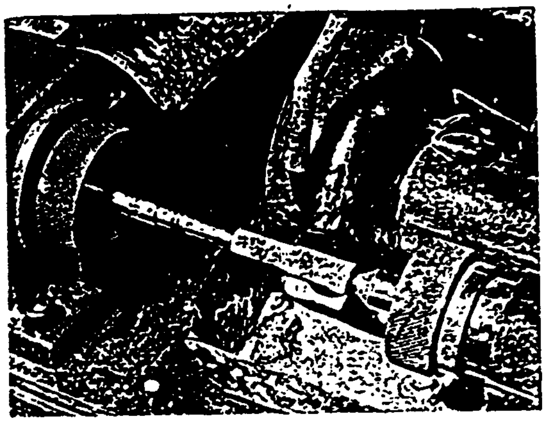

Fig. 6.—Method of grinding a ceramic gauge with a diamond grinding wheel.

such as ring gauges, may also require lapping or polishing with rouge, alumina, silicon carbide, or diamond dust.

V. Conclusion

Ceramic materials of various kinds are a wartime substitute for critical tool steel in gauges. The use of ceramic gauges has indicated that they have special advantages in some applications which should make their use profitable after the war.

The Electric Auto-Lite Company
Toledo, Ohio

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DUST REMOVAL AND COLLECTION*

By R. R. Robinson

Abstract

The reasons for dust collecting in plants are (*a*) to protect the health of the workers, (*b*) to protect machinery and equipment, and (*c*) to conserve the dust for its economic value. Methods of dust removal and collection are also discussed.

I. Introduction

From the beginning of the industrial revolution in England, during the latter part of the eighteenth century, the presence of fumes and dust in the atmosphere of mines and manufacturing plants has been a cause of as much unrest among employees as has any other single working condition. This is due to the fact that such foreign bodies as dust particles (and many so-called fumes are clouds of minute dust particles) when entering the respiratory organs are not only eventually dangerous to health, but have an immediate irritating effect.

For more than a century, there has been a determined attempt by humanitarians to interest mining and industry in a movement to create clean atmospheres within working spaces. Within the last decade, that action has taken hold of the minds of employers so that today the question is not whether the air should be cleaned, but how shall it be done. In fact, many problems are not solved simply because the management of a specific industry is unacquainted with the best methods of procedure.

It seems appropriate at this time to give reasons for removing dust from working spaces, methods of eradicating dust and fumes, and the disposition of those foreign substances after they have been removed. Although the subject has been discussed in former meetings of The American Ceramic Society, the discussions have been closely confined to the toxic effects produced by dusts. In the present discussion, no attempt will be made to prove a necessity for dust removal. The dangers to human health are too well known by informed management to require explanation.

Dust may be defined as finely divided particles of or-

* Presented at the Forty-Sixth Annual Meeting, The American Ceramic Society, Inc., Pittsburgh, Pa., April 5, 1944 (Materials and Equipment Division). Received July 13, 1944.

ganic and inorganic solids. Drinker and Hatch[1] have stated:

> If 1 cc. of quartz is crushed into particles 1 cubic micron in size, there will be 10^{12} particles within a total surface area of 6 square meters as compared with 6 sq. cm. for the original block. Assuming a dust concentration of 100 million particles per cubic foot of air, the 1 cc. of material will be dispersed in an air volume of 10,000 cu. ft.

Thus it can be seen that the dispersion of dust particles from manufacturing processes may soon fill an atmosphere to such an extent that visibility may be reduced, and if the dust is dangerous to human life, toxic effects may result, or if the dust is of a carbonaceous nature, violent explosions may result. The following reasons could, therefore, be given for the removal of dust particles from working spaces: (1) the toxic effects of dust on the human body, (2) the effects on visibility in the atmosphere, (3) the explosive effects of carbonaceous dust, (4) the abrasive effects on machinery, (5) the adulteration of products in process of manufacture, and (6) the general cost of cleaning the premises.

The toxic effects of dust are discussed in a bulletin published by the Commonwealth of Pennsylvania Bureau of Industrial Hygiene.[2]

In many factories, even today, visibility is often destroyed, or at least seriously impaired, by dust particles floating in the air. This has been the cause of many accidents. It is hardly necessary to make any further remarks on this phase of the subject.

In the case of dusts of an explosive nature, it has been found advisable and, in fact, necessary to reduce the dust count to the lowest possible minimum. Buildings which house machinery from which carbonaceous dust or other explosive particles are exuded have been equipped with special dust walls and windows which serve as escape valves in the event of explosions. Reference can be made to the numerous bulletins published by the Department of Agriculture of the United States Government covering this subject.

One of the bad effects of dusty atmospheres is that of abrasion of bearings. There are little data to show the amount of damage that is done, but there is no doubt that if the data could have been collected, it would be found that such damage costs industry many times the value of the equipment necessary to clean the air in working spaces.

Another serious danger from dust is that of adulterating products manufactured in the plant. All the manufacturers of whiteware in the ceramic industry are fully aware of the expense that is incurred due to foreign bodies becoming mixed with the clays used in their work. Within a few hours, the dust which permeates the atmosphere of a whole plant could discolor or in other ways affect the quality of the ware so as to increase the number of rejects to such an extent that the loss would be of considerable value.

The cost of cleaning plants due to the presence of dusts is another item of considerable expense. One plant, manufacturing a material from which a very abrasive dust was discharged, did employ, until the outbreak of World War II, a great number of men whose duty it was to clean the automobiles parked on the plant grounds. It is easily seen that in such a plant the cost of cleaning offices and other buildings where cleanliness is necessary would be quite an item of expense.

II. Methods of Removing Dust

To keep the removal of fumes or dust particles at the lowest possible cost, it is always best to arrest the materials and remove them before they get into the general atmosphere of the plant. Whenever possible, hoods should be placed over the machines or at the source of dust. It would be practical and very profitable to align the machinery so that duct systems could be extended in as straight lines as possible or so that separate rooms could be constructed to confine the dusts or fumes and to make possible the removal of these with the least amount of power and machinery. When it is impossible to hood machines, jet velocities of air may be directed toward the source of the dust with collecting hoods placed at a strategic position from which the dust-laden air may be exhausted. In many cases, water sprays may be used or water may be poured over the machines in such a way that the water may mix with the dust and the mixture drained off so that there is no dispersal of the dust particles into the atmosphere.

In almost every case, the removal of dust requires careful engineering. Good engineering may mean the difference between success and failure.

III. Collection

The removal of the dust from a working space is only part of the problem. The management must decide whether this dust shall be discharged into the open air outside the plant, whether it shall be collected, and, if collected, what means shall be taken to dispose of the residue.

If the material is such that it has an economic value which will pay for expensive apparatus, then the dust may be used in process work. In many cases, it may be necessary to grade the dust for particle size. In other cases, the dust may be of little value, but of such a nature that it cannot be discharged into the air without some assurance that it will not be carried over the neighborhood by the winds.

There are many types of dust-collecting equipment which can be used and which are employed for various purposes, depending upon the ultimate disposition of the material. Generally speaking, these collectors may be classified as follows: (1) the mechanical type, which includes those making use of cyclonic air action, (2) those which make use of the principal of elutriation, and (3) those of the filter type.

The filter-type collectors are of many kinds known as the bag collector, the soft material filter collector, and the screen cloth collector. Under nearly all of these machines there is placed a hopper into which material ultimately drops and from which it is taken for final disposal.

Within the last twenty to twenty-five years, there has been a great development in the electrical-precipitation type of collector. The action of these collectors depends upon the fact that dusts can receive and retain an electrical

[1] Philip Drinker and Theodore Hatch, Industrial Dust. McGraw-Hill Book Co., New York, 1936. 316 pp.; *Ceram. Abs.*, 17 [4] 166 (1938).

[2] "Study of Silicosis in the Silica Brick Industry," *Penn. Dept. Health, Bur. Ind. Hyg.*

charge and can be attracted to plates or electrodes when given the proper kind of electrical charge. It is generally conceded that the electrical-precipitation type of collector is much more effective than any other type, but its use has been restricted largely by the cost of investment.

IV. Conclusion

The question of cleaning the atmosphere is becoming one of the most widely discussed questions among manufacturers of the present day. The human being breathes at the rate of approximately 56 pounds of air per day while at rest and many times that amount while at work; it is important, therefore, that the atmosphere which we must use constantly be kept as clean as we can possibly make it.

ROBINSON VENTILATING COMPANY
ZELIENOPLE, PENNSYLVANIA

DISCUSSIONS OF ROBINSON PAPER ON DUST REMOVAL AND COLLECTION

(A) DUST COLLECTION*

BY T. J. BARRY

I. Introduction

The elimination of dust generated in any industrial operation involves, as a general rule, (1) its removal from the point of generation, (2) transportation to the point where it is to be separated from the gases in which it is suspended, (3) its actual separation from the gases, and (4) the disposition of the gases and the collected material.

This is usually taken care of by properly designed hoods located at the point of generation, a duct system, a dust collector, and a fan.

The air and dust must be removed from their source at a velocity sufficiently high to insure control of the dust.

The type of dust separator or collector to use depends on many factors, such as the type of dust, moisture content of the gas, temperature, size of particle, location of the collector, and space available.

II. Classification of Dust Collectors

Dust collectors can be classified generally into settling chambers, cyclones and other inertial apparatus, viscous filters, gas washers, cloth collectors, and electrostatic precipitators.

(1) Settling Chamber

A settling chamber is simply a chamber in which the gas velocity is reduced to a point where the dust will fall out of the gas by gravity. Naturally this will only remove the very coarse particles and has a limited application.

(2) Cyclone Collector

The cyclone type of collector depends upon the centrifugal forces acting on the dust particle to separate it from the gas. In general, the higher the gas velocity and the smaller the radius, the higher the efficiency of the cyclone.

There are many variations in the design of commercial cyclones which materially increase their application in dust-collection work. They are limited, however, as is all equipment. There is a definite field for each type.

A simple cyclone is perfectly satisfactory for separating shavings, sawdust, etc., from a woodworking shop, but it is not worth much on a job where the dust particles are small and the dust is readily "air-borne."

A "high-efficiency" cyclone is well adapted to those jobs where the temperature is a factor, such as fly-ash collection and collectors for driers and kilns.

There are many designs of these collectors which have a definite place in the scheme of things.

The mechanical separator, of the type in which the fan serves the dual purpose as the source of suction or pressure and a cyclone collector, is subject to the same limitations as the cyclone itself and has a bad feature in that all of the dust-laden air goes through the fan. If it is an abrasive material, the fan wheel takes a beating and causes high maintenance.

(3) Viscous Collectors

The viscous type of collector, where the dust-laden gas passes through a labyrinth filter and the dust particles are caught or trapped by the viscous surface, is limited in application and cannot be considered for the collection of industrial dusts.

(4) Wet Collectors

The wet separator or washer has been built for many years and is made in many designs, such as the tower washer, the disintegrator, and scrubbers.

Blast-furnace gas and coke-oven gas are frequently cleaned by this type of equipment. During the past few years, the wet collector has been applied to other fields, such as foundry dust and dust from metal grinding.

Water is usually the fluid used, although it has been found that many dusts cannot be removed by the water alone and other materials must be added to promote the wetting of the dust particles.

The wet systems are limited in application and require attendant equipment, such as pumps and sludge-removal equipment, which add to the operating cost of the system.

(5) Cloth Collectors

Cloth collectors are made in several designs and are the simplest means of separating the dust from the gas. Their field of application is wide and their limitations are quite well known.

Cotton cloth can be used on the gases when the temperature is below 150°F. The life of the cotton decreases rapidly as the temperature goes higher. Wool cloth can be used up to 250°F.; above this temperature asbestos cloth is used.

The bags and screens made of glass have not been too successful.

If the gas temperature goes below the dew point, trouble is likely to develop with cloth arrestors. In many cases, this can be overcome by heating the gas or by insulating the casing of the collector.

The principle of operation of the cloth separator is well known and the factors affecting its design are primarily (1) type of dust, (2) temperature of gases, (3) moisture content of the gases, (4) dust loading, (5) intermittent or continuous use, and (6) method of removal of the dust from the hoppers.

The operation simply consists of having a material in the cloth that will stand the temperature and permit a filter cake of dust to build up on the cloth so that the dust will be filtered out of the air by this combination. A micron particle is $^1/_{25,400}$ of an inch in maximum dimension, so that when we speak of a particle $^1/_{10}$ of a micron in size, it is only $^1/_{250,000}$ inch in its longest dimension.

The filter cake of dust therefore really does the filtering of the small particles, and, as a result, the accumulation of dust must be periodically removed; otherwise the pressure drop through the collector will build up until the flow of air or gas ceases.

The three general type of cloth arrestors are (1) the screen type, where the cloth is held on wooden or metal frames by one of several methods, (2) the envelope type, where the cloth is more or less in the form of an envelope and fits over a frame to hold it in position, and (3) the bag type, where inverted bags are attached to a plate between the dust hoppers and the bag section and are supported from the top, usually by springs attached to the shaking device. In this type, the dust-laden gas enters under the

* Received July 13, 1944.

bag plate, flows through the bags into the baghouse, and the cleaned gas is pulled out by means of a fan.

In the design of a system using this type of equipment, the ratio of air flow to cloth is an important factor and receives a great deal of attention from the designer and should receive a lot more attention from those who install the equipment, as the life of the filtering material and the pressure drop through the collector are vitally affected by this factor. On some types of dust a ratio of 1 cubic foot of air per square foot of cloth must be used. A dust of this type has a flat surface, such as the flaky-type metal dust. With carbon black and similar materials, the ratio should not exceed 2 to 1; with foundry dust and clay dust, 3 to 1. When these figures are exceeded, maintenance is invited.

A continuously operated arrestor is made in two or three sections. It should be made in three sections for best results. Periodically, each section is cut out of the system and the bags are shaken to remove the excess filter cake. This operation is generally taken care of automatically by a timer.

A classifier section or planum chamber is usually built into the cloth arrestor to drop out the heavier material by a reduction of velocity and also to insure uniform distribution of the dust-laden gases to the cloth section.

If the arrestor is used with a grinding or buffing system and there is a possibility of sparks or fire being carried over, a spark arrestor is installed ahead of the bag section.

If the dust is explosive (and many are), the cloth should be positively grounded to eliminate the possibility of a static spark igniting the dust.

(6) Electrostatic Precipitation

Electrostatic precipitators will be discussed later by Mr. Begoon.

III. Conclusion

A dust condition in a plant is a cause of expense. If it is a health hazard it should be eliminated regardless of cost. If it is not a health hazard, it is a nuisance which causes excessive equipment maintenance, rejected products, and dissatisfied workers, and, as a result, a lower quality of workmanship.

The question of whether or not to recirculate the air from a dust collector has caused much discussion. The air should never be recirculated unless it is certain that it does not contain toxic material and that it is entirely free from all harmful dust at all times.

A plant with an adequate supply of fresh air (although it costs more to heat in the winter months) will have fewer lost-time accidents than the plant where the air becomes "dead" after a few hours. The results will more than pay for the extra cost of heating the air.

The writer has tried to keep this discussion as "nontechnical" as possible and to refrain from comments as to whose or what type equipment is the best for any particular job.

Dust collecting is a combination of art and science. It involves the proper design of the entire system from the point of dust generation to the final disposal of both the collected material and cleaned gases.

There is more engineering in doing a good job than meets the eye. When one sees so many jobs where the lines are too big and fill up with dust or are too small and do not get enough of the dust away from the source and the equipment inadequate or of the wrong type, it makes one wonder just how to paint the picture so that it can be seen that a properly designed system will pay dividends even though it seems to be "just a dead operating cost."

Park Building
Pittsburgh, Pennsylvania

(B) ELECTRIC AIR CLEANING*

By G. F. Begoon

I. Introduction

Electrostatic air cleaning as applied in ventilating systems is a new and revolutionary electronic development. Why is there any need for air cleaning, let alone electric air cleaning?

We have falling upon our cities today, at the amazing rate of 1950 tons per square mile per month in Pittsburgh, 1530 tons in Chicago, 1450 tons in Baltimore, and comparable figures in other cities, dirt particles which have become the source of great economic waste and maintenance expense. Within our homes and places of business they blacken and damage paint, wallpaper, drapes, and decorations, soil fabrics, cause excessive maintenance of industrial machinery, etc.

The size of these particles is measured by a minute metric unit known as the micron. A micron is equal to one thousandth of a millimeter, or $^1/_{25,000}$ of an inch.

Generally speaking, the miscellaneous dusts, pollen, and other particles larger than 1 micron tend to settle from the air unless it is in motion. Inasmuch as we are interested in air in motion, we are concerned with the particles it carries. These range from heavy industrial dusts of 8000 microns down to tobacco-smoke particles as small as $^1/_{10}$ micron. This is pretty small, when it is considered that a 10-micron particle is about the smallest that can be seen with the naked eye.

Until recently, no practical method had been devised to really clean the air of the very small particles. Although mechanical filters are effective in removing the larger dirt particles, i.e., from about 5 microns up, they are practically useless in attempts to catch the very fine particles which comprise 80 to 90% of the total and are less than 1 micron in diameter.

II. Electrostatic Precipitation

The only effective method known today for removing these very fine particles from an air stream is electrostatic dust precipitation, the principles of which have been known for many years and applied successfully in such applications as boiler stacks, smelters, and cement mills, and are known as Cottrell precipitators. The high voltage used in the Cottrell system (from 30,000 to 100,000 volts) causes such a high generation of ozone, however, that the air thus treated is not safe for breathing purposes and hence not suitable for ventilating systems.

This is the problem that was solved by scientific research in perfecting the electric air cleaner that operates at voltages which generate so little ozone that its concentration is in the order of that found out of doors on a bright sunny day.

The voltages used are 13,000 for ionization and 6000 for collection. These are obtained by means of a rectifier or power pack. The house voltage of 115 volts, 60-cycle, single-phase, is stepped up to about 6000 and rectified to direct current by two electronic tubes. By means of a modified voltage doubling circuit the proper ionizer and collector plate voltages are obtained.

By 1937, the electric air cleaner had reached the point of practical use, and a few installations were made as the air-cleaning component of air-conditioning or ventilating systems in offices, stores, banks, and other commercial buildings. These installations were made to obtain relief from annoying and costly air-borne dirt, dust, soot, and smoke which soil and damage merchandise in stores and shops and cause frequent redecoration and excessive cleaning expense.

In subsequent years, further installations were made in similar establishments and many other types of businesses, such as cleaning the air in pharmaceutical and chemical plants where the slightest microscopic specks cause imperfections in products and processes.

The electric air cleaner is used to clean the ventilating air for large rotating electrical machinery in steelmills, power plants, and substations. Failures of these machines

* Received June 22, 1944.

often caused by excessive temperature rise or leakage over the insulation due to dirt on the windings.

In telephone exchanges, electric air cleaning is used to help maintain delicate relays by removing the microscopic dust particles which cause faulty operation and noise in the circuits.

In textile mills, electric air cleaning has been applied to eliminate soot, smoke, dirt, and dust during winding, spinning, weaving, and drying operations. These microscopic particles damage the yarn and fabric to such an extent that about 15% of the total production has to be sold as inferior products. Mills equipped with the electric air cleaner have reduced this to about 6%.

Other establishments, such as hospitals, restaurants night clubs, radio stations, libraries, and laboratories have found that investments in electric air cleaning pay big dividends.

When the war came along, many of our materials were placed on the critical list and purchases were subject to priority control, which brought to an end the peacetime business. On the other hand, the necessity for clean air in many wartime production problems opened the door to new markets.

As its contribution to wartime production, electric air cleaning is being applied where precision engine parts, instruments, lenses, and optical goods are manufactured, inspected, and assembled. Tiny unseen abrasive and corrosive particles that damage superfinished surfaces cannot be removed by mechanical filters, yet the electric air cleaner takes them out of the air and saves many costly rejects.

Electric air cleaning is applied to catch the oil mist and smoke generated from coolants on machine tools. This oil mist has become serious enough in some plants to (1) cause a fire hazard, (2) condense and drip from overhead beams, lighting fixtures, and pipes, and (3) lead to premature electrical insulation failures and make the working environment unpleasant. Precipitating the oil mist at its source not only eliminates these objections, but also recovers the cooling oil for reuse. Also some operators are now able to use a better grade of coolant oil, which results in better work and increased production.

Another use is the control of welding fumes and smokes. All the applications mentioned have been very successful.

The total installed electric air-cleaning capacity at the present time is about 50,000,000 cubic feet per minute, 75% of which is associated with air-conditioning systems. Even so, the surface has barely been scratched. These installations require only 15 watts of electric power per 1000 c.f.m. of cleaning capacity.

III. New Developments

In addition to the electric air cleaner as we have known it in the past, there are some new developments in the offing that should substantially increase the potentialities of this device.

Right now, work is being done on a combination cyclone dust collector and special-design electric air cleaner for boiler-stack smoke and fly-ash control. No official announcement has yet been made in this regard because it is only recently that WPB gave one of the power companies the necessary priority to continue the work. The results so far, however, look quite encouraging.

Another new development involves the home market. We are now making definite plans to provide electric air cleaning for home use, particularly in homes with forced-air heat. We have already built about 100 so-called home central units, the majority of which are now installed as pilot installations in homes around Pittsburgh. The results obtained, from the standpoint of keeping the house clean and contributing to the health of the family, particularly those suffering with hay fever, have been excellent.

We hope to provide a complete cabinet unit for homes which can be installed at a cost to the user of about $250. Market research indicates that, if this can be realized, there will be a strong demand to be satisfied for this type of unit for existing homes equipped with forced-air heat. The housewife will see to that.

For new construction, in addition to the self-contained unit just mentioned, we are working with the furnace builders to help them incorporate the cells as an integral part of the furnace. This will enable the home to have the advantages of electric air cleaning at much less cost.

Ceramic plants in which contamination of the ware is a serious factor may, in the near future, be using the electrical method of cleaning air, not only to prevent foreign materials in dust particles from spoiling work in process, but also to clean the atmosphere of workrooms without being obliged to heat great quantities of new outside air.

PRECIPITRON DEPARTMENT
WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
1216 WEST 58TH STREET
CLEVELAND 1, OHIO

RAW MATERIALS FOR PORCELAIN ENAMELS SURVEY OF CURRENT MARKETS AND ALLOCATIONS*

BY JOHN W. ILIFF

ABSTRACT

Although many raw materials for porcelain enamel have been restricted, either by market shortages or by WPB regulations, all important raw materials except tin oxide are currently available in at least moderate quantity. A group of materials warranting individual attention is considered.

I. Introduction

Conversion, steel, and man power have all put limitations on porcelain enameling to a far greater degree than shortages of enamel raw materials. Indeed, the relatively light demand for chemicals and minerals has been met with little trouble and with little need for the use of unsatisfactory substitutes. Nevertheless, it is prudent to keep a close watch over material requirements, especially on materials under allocation.

* Presented at the Forty-Sixth Annual Meeting, The American Ceramic Society, Inc., Pittsburgh, Pa., April 5 1944 (Enamel Division). Received August 13, 1944.

II. Availability of Raw Materials

(1) Mill Additions

Tin oxide may not be used (WPB Order M-43), but the zirconium opacifiers and Uverite can be used. Uverite has been available continuously in quantity adequate for consumption. So have the zirconium opacifiers, although in some cases it has been necessary to change types.

(2) Color Oxides

Both cobalt and cobalt-free blacks contain substantial amounts of chrome, which is restricted and in very short supply. Cadmium colors, comprising the bright reds,