FILE NAME: Power Generation (POW)

DATE: 1950 Jan

DOC#: POW010

DOCUMENT DESCRIPTION: Published Article from Trade Journal

POWER

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CROSS-INDEX OF SUBJECTS FOR THE MONTH

JANUARY 1950 · VOL 94 · NO. 1

PLANT OPERATING METHODS, MAINTENANCE AND SAFETY
STEAM GENERATION, FUELS, FIRING AND COMBUSTION
TURBINES, ENGINES, AUXILIARIES; HYDRO POWER
DIESELS, GAS ENGINES AND ACCESSORIES
AIR CONDITIONING AND REFRIGERATION
ELECTRICAL EQUIPMENT, ELEVATORS
PIPING, VALVES AND SPECIALTIES
TRANSMISSION, LUBRICATION
STEAM SERVICES, HEATING
INSTRUMENTS, CONTROLS
PUMPS, COMPRESSORS

Cover photo, courtesy of Nordstrom Valve Div, Rockwell Mfg Co

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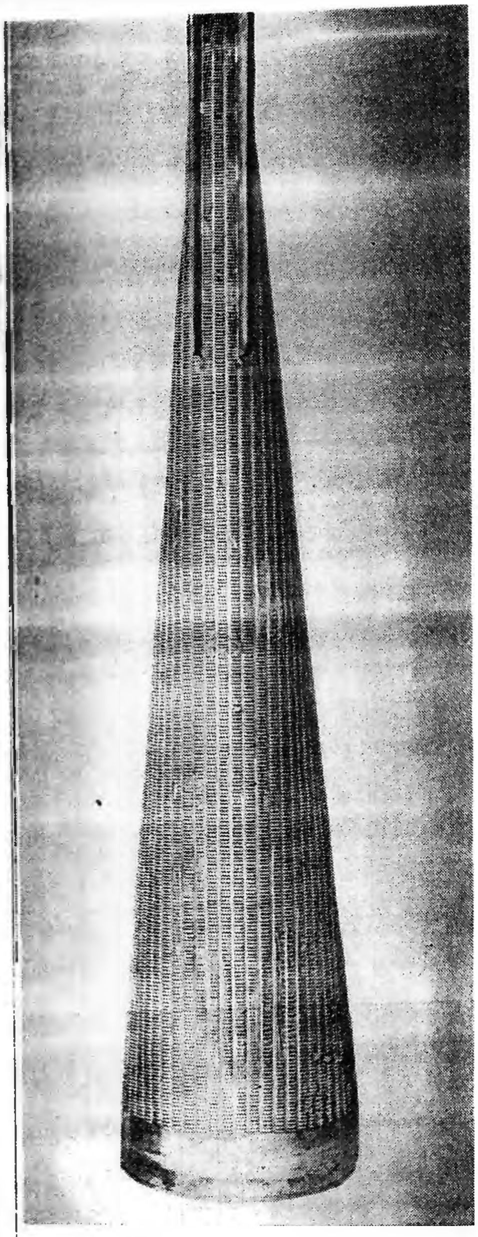
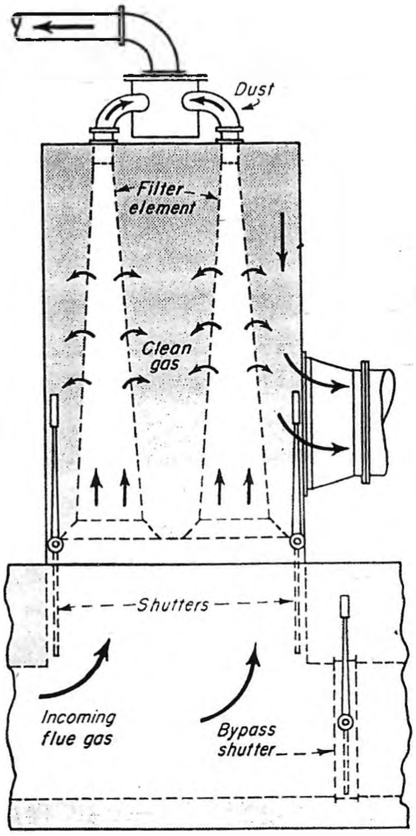


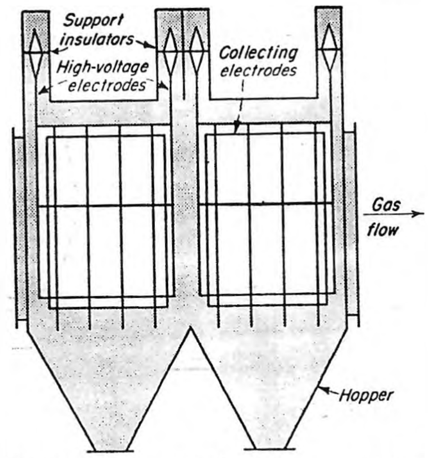
1 Cone-shaped laminated-steel dust separator takes flue gas in at wide end

MECHANICAL SEPARATION

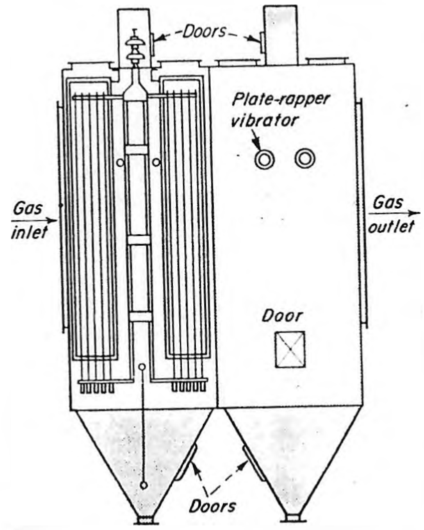


2 Flue gas can pass through laminations, above; dust is pulled out narrow end

ELECTROSTATIC DESIGN...



3 Simplified electrostatic collector shows basic relation of electrodes



4 Horizontal flow unit has perforated plate electrodes; 8¾ in. centers

5 Twc troc

Here Are the Working Tools for Flu(

By L N ROWLEY, *Executive Editor*
And J C McCABE, *Associate Editor*

Keeping your plant stack within the nuisance limits of today's smoke ordinance means intelligent use of the dust collectors on the market. This conclusion of a 2-part survey helps you make your selection

► We began our discussion of dust-collection methods and designs available back in November Power, pages 78-81. We had progressed from the simple mechanical baffle and cinder traps to the latest in cyclone-style collectors.

There is still another mechanical removal method, Fig 1, 2. Separating element is a series of laminated-steel plates made up in a cone. This cone goes into a steel casing normally placed between boiler flue-gas outlet and induced-draft fan, Fig. 2.

Dust-carrying gas can then enter the cone's wide opening. Once inside, gas escapes through the laminations and proceeds to inlet of induced-draft fan. But to pass through laminations, gas has to change direction sharply. Entrained solids stay behind in the cone under influence of the motion from the entering gas stream.

As the dust particles approach the top of the cone they are caught up in the suction of a secondary fan and pulled out at the top. This fan delivers flue dust either to a secondary separator or to a recirculating system for return to the furnace zone.

Electrostatic Precipitation. A widely used method of flue-dust removal, particularly for pulverized-coal furnaces, is the electrostatic precipitator, Fig. 3-7. This device performs several basic functions: It (1) electrically charges dust particles traveling in the gas stream

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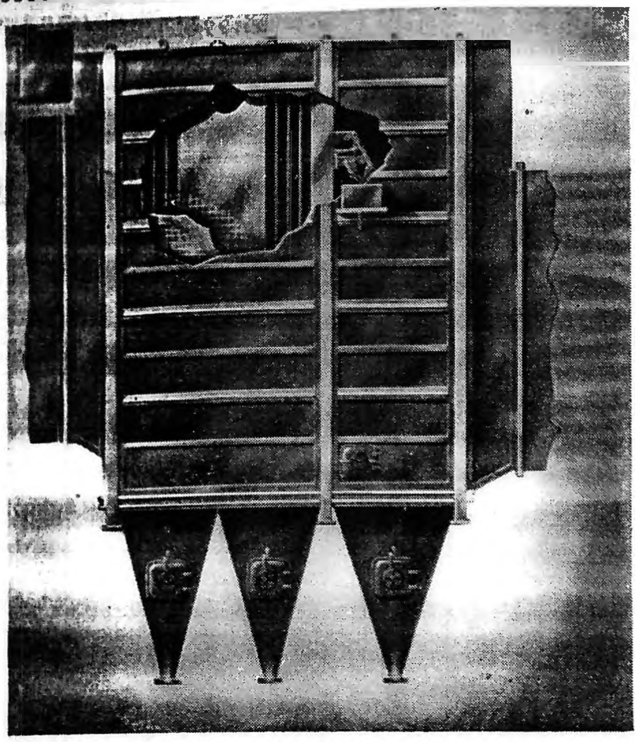
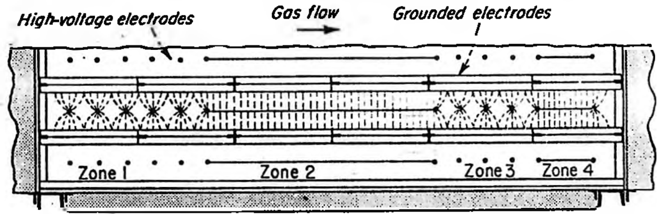
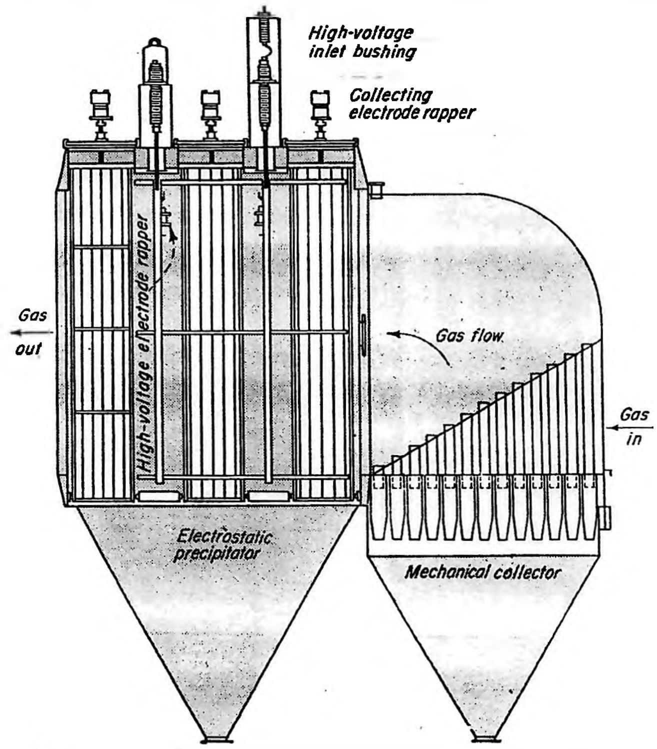
...HAS LONG RECORD OF HIGH-EFFICIENCY COLLECTION ON LARGE-SIZED BOILERS



5 Two-stage unit has high-voltage wire for charging electrode; flat plate for precipitating; screen for collecting



6 First stage, Fig. 5, builds up particle charge rapidly; the next has uniform field to speed precipitation of dust



7 Series combination of mechanical and electrostatic collectors has become quite important in many applications

CLEAN AIR

A JOB FOR THE POWER ENGINEER

Flue-Dust Collection—Part II

(2) drives them to a ground or collecting electrode, where it discharges them (3) removes collected material from electrodes.

Performing all these operations on a fast-moving gas stream is not easy. A high unidirectional voltage has to be set up. Opposite the high-voltage discharge electrode, usually a small-diameter wire or a twisted square steel rod, is a grounded or collecting electrode. These are bare essentials, Fig. 3.

For any given wire diameter and electrode spacing there is a critical voltage. Above this voltage, an electrical discharge forms in the air or gas surrounding the high-voltage element. A bombardment between gas molecules begins. Electrons are torn loose from gas atoms or molecules. Once loose, the electrons combine with other atoms to produce negative ions. These follow electrostatic fields of force to the grounded electrode.

Any suspended dust particles in the gas stream become a target for these loose ions because the particles have a higher dielectric constant than gas or air. So the ions attach themselves to these dust particles and in doing so give them a negative charge.

Once you establish a sufficient charge on a particle the electrostatic field force regulates its movements. Force exerted is proportional to product of charge on the particle and electrical-field strength between high-voltage and grounded electrodes.

Let's say now that all dust particles in the flue gas carry a charge and are being pulled out of the gas stream. Next step is to collect the dust. Usually when the charged particles reach the grounded or collecting electrodes the charge leaks off to ground. Dust hangs on by mechanical adhesion.

Some designers, Fig. 5 and 6, feel the jobs of charging dust particles and then collecting them should take place separately. So they divide the precipitator into zones. High-voltage zone is designed to give maximum charge to all particles as fast as possible. Then the collection zone can be engineered for a uniform high intensity to give effective collection at reduced power.

The higher the voltage applied, the more thorough the charge saturation on the particles and the stronger the electrical field—all of which means the shorter the time needed. But there is a definite practical limit to how high applied voltage can go. Some of the limiting factors, in addition to electrode spacing, are temperature, density, chemical composition of gas passing through collector.

How do you go about producing required unidirectional high voltage? It has to be anywhere from 30,000 to 100,000 v. Besides a high-voltage transformer, input ac energy has to be rectified. Here there is a choice of rectifier methods—mechanical or electronic.

Mechanical rectifier usually consists of a disk of insulating material. On the disk are 90-deg conducting arcs set 180 deg apart. Four stationary contacts, 90 deg apart, are: one high-voltage precipitator cable terminal, one grounded terminal, a pair of transformer secondary terminals. Disk is motor driven at synchronous speed so voltage at the stationary high-voltage terminal is rectified.

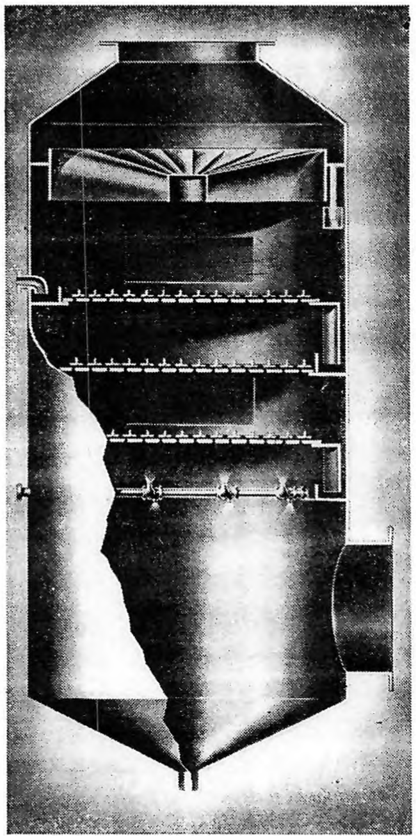
Electronic rectifier employs the high-voltage Kenotron tube. For large precipitators a 4-tube high-vacuum hot-cathode diode circuit is often used. Designs on the market, based on long tube life with certain circuit safeguards, assure good tube performance.

Practical Aspects. Now that we have the elements of an electrostatic precipitator, how about practical angles? One of the most critical needs for good performance is uniform gas-velocity distribution through the collector. A small section of a precipitator operating with a gas flow considerably above rating suffers because already-collected particles are swept back into the gas stream. Other areas handling a gas velocity below rating and turning in excellent performance cannot make up for this loss.

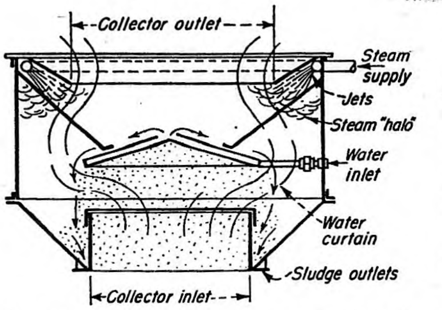
Suitable design overcomes two other inherent difficulties of electrostatic precipitators: their failure to collect or hold particles that (1) are large (2) have high carbon content.

The answer to the large-particle problem is to: (1) allow enough time in the precipitating field for the electrostatic force to overcome the inertia of the particle in the direction of gas flow (2) design a collecting electrode to prevent the large particle from "balling up" with its neighbors and rolling along the electrode and out through the unit.

The high carbon-content particle presents quite another problem. Here the job is largely one of holding the carbon particle when first precipitated.



MOST GAS SCRUBBERS...



9 Low-cost flue-gas scrubber directs gas through water before discharge

8 Multistage gas scrubber *(left)* has gas flow counter to the scrubbing water

Since carbon is somewhat of an electrical conductor, the carbon particle takes on its charge quickly enough. In fact, its saturation charge approaches three times that of a normal ash particle.

But because the carbon is conducting, it behaves far differently from normal collected dust. Carbon loses its charge rapidly to the grounded electrode. But the now uncharged particle is still under the influence of the high-voltage elements opposite. Result is the carbon particle gives up some of its own negative ions to the grounded electrode. This action, charging by induction, leaves the collected carbon particle with a slight positive charge.

This weakly charged positive particle feels the pull of the negative high-voltage electrode. So it leaves the grounded electrode and reenters the gas stream, where it comes into a field filled with negative ions. Once again the particle takes on a negative charge, returns to the collecting electrode. But the same charging-by-induction phenomenon occurs and the cycle begins again. This zigzag path of the carbon particle may continue until it passes completely out of collector.

Solution for this difficulty—charging by induction—must be through some method of reducing influence of high-voltage elements on the collected particle. Reduction may be either through a reduced field intensity in the collector element's neighborhood or a collector element that makes reentrainment physically impossible.

The reentrainment problem is most aggravated when time comes to remove any collected material from the electrodes. Today's power plants can't shut down just to clean out dust collectors. Yet the material must be constantly removed to permit top collection efficiency.

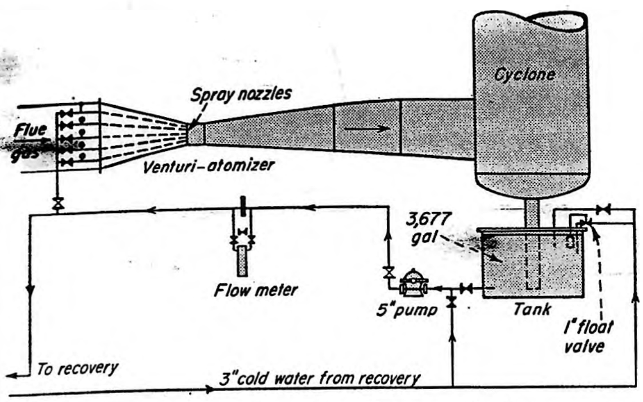
Both high-voltage and collector electrodes take on coatings of flue dust. The high-voltage element, if a wire, has its effective diameter increased by the coating. This reduces the effective corona discharge and lowers operating efficiency. In addition, dust build-up increases normal rate of flashovers within the precipitator.

Just how to effect this removal is the subject of much research. In general, electrodes, both high-voltage and collecting, are rapped. But methods, areas rapped and controls over reentrainment vary considerably.

Proper vibration of electrodes can remove practically all dusts. So they must not be too rigid or too heavy in cross section. Any rapping must be timed so successive impacts do not interfere with electrode vibrations already set up. This means automatic rapping, by air- or motor-driven rappers. Contactors or motor starters can be so set that no two electrodes are rapped together. Or dampers can be closed to isolate sections undergoing rapping.

Fig. 3 shows the bare essentials of a horizontal gas-flow collector. The high-voltage ionizing electrodes are supported by insulators so there is no danger of arcing over to the precipitator casing. Further, these electrodes are accurately centered between collecting electrodes so peak voltage and peak

...SERVE WELL IN WET COLLECTION OF GAS-BORNE SOLIDS



10 Venturi scrubber, Fig. 9, applies controlled water spray at throat, and separates moisture and gas in the cyclone

performance can be maintained. Should the high-discharge electrode be closer to one collecting electrode than to its neighbor, there is danger of too frequent arcing over.

Thus, it is important that the supporting structure be stable. So single- and 2-point suspension is sometimes used by hanging weights on the bottom ends of the discharge electrodes. These weights prevent swinging.

Collecting electrode has several designs. It must not buckle or warp because this defect reduces electrical clearance, causes the same trouble as a swinging high-discharge electrode. Physical shapes of collecting electrodes vary widely: (1) rod-curtain designs made up of curtains of small-diameter pipes hung vertically in a horizontal-flow precipitator (2) corrugated-plate curtains of corrugated sheet iron (3) dual plates made by welding steel sheets to the two sides of a frame with retaining holes punched out in the sheets (4) pocket electrodes with V-shaped strips hung vertically so the V's apex faces the gas stream (5) special high-duty collectors using bent steel strips hanging from each side of a frame to make a dust spout between electrode's sides.

Still another design, Fig. 5 and 6, has its pocket electrode employ a flat plate with a 1½-in. mesh screen spaced 1½ in. from plate. This arrangement permits concentrating the electrostatic lines of force on the screen. As a result, field intensity between collecting electrode plate and screen runs much less than outside the screen. So the tendency of carbon particles to be charged by induction is prevented and their reentrainment stopped.

Series Arrangements. A growing tendency combines mechanical with electrostatic collectors, puts them in series, Fig. 7. There is considerable discussion over which should lead—mechanical or electrostatic. Here are pertinent facts.

At the moment the strongest single point in favor of the mechanical collector as a leader is that it works on the "whole" dust and at typical dust grain loadings. So its performance is as good as the mechanical collector alone. Then the electrostatic need handle only that dust portion on which it is most capable—the fines. Further, during soot blowing when grain loadings reach 200 to 300 gr per cu ft the mechanical collector operates at about the same efficiency. It again relieves the electrical unit, which then does not have to supply the required negative ions for adequately charging the heavier dust loading.

One difficulty this arrangement, Fig. 7, creates is emptying out the electrostatic precipitator hoppers. Dust is so fine it may bridge, but proper hopper design can correct this.

With the electrostatic unit trailing the mechanical, material lost during rapping may be emitted from the stack. This is the strongest claim made by those who advocate putting the mechanical collector in the "back-up" spot. How important this consideration may be depends on the way the rapping is carried out and how much of a problem, if any, it creates.

Gas Scrubbers. Fig. 8-10 show equipment employing a very different system for cleaning up a gas stream. In these the dirt-laden gas is passed through an apparatus designed to trap suspended solids in a scrubbing liquid, usually water.

In each scrubber, there are one or more basic principles: (1) impingement of gas stream against water droplets or wetted surfaces (2) centrifugal action to separate particles from the gas stream (3) a breaking up of gas into small streams. Separation then occurs.

Fig. 8 receives gas at lower section of scrubber. The gas rises through a curtain of water created by a number of low-pressure sprays. These humidify the gas, strip it of coarse dust. Then the impingement plate (600 to 3000 holes per sq ft) and baffles above each plate receive the gas.

As the gas goes through the perforations it speeds up and at the highest velocity it strikes the water-shielded baffle. Here the greatest cleaning action takes place. All suspended matter tends to travel in a straight line and impinges against the under surface of the wetted baffle. It is then trapped in the scrubbing water and carried out.

Fig. 10 illustrates a newcomer to the gas-scrubbing field — the venturi scrubber. It offers a means for injecting a low-velocity scrubbing liquid into a high-velocity stream of dirty gas.

The gas impinges upon and disrupts the rather large jets of liquid so the drops of liquid accelerate and disrupt still further. Some liquid atomizes, at least briefly. Then the gas and vapor mixture slows down and the two are separated in an eliminator, Fig. 10.

Four collection methods are possible in the venturi setup: (1) collision (2) diffusion or molecular bombardment (3) electrostatic effects (4) condensation. Collision and diffusion, the manufacturer feels, are the most important.

Relative velocities of suspended particles to the water droplets go from 125-400 fps at first impact. This drops rapidly as the water accelerates and opportunities for collision are excellent. Downstream in the expansion section the gas slows down. Water droplets may for a time have higher velocities than the solids, which increases opportunity for collision. The droplets coalesce and much of the liquid leaves the venturi as solid water, the rest as fog or vapor.

As soon as gas impinges on the liquid, and right afterward, resulting turbulence produces 5 to 25 sq ft of droplet surface per cu ft gas. This makes collection by diffusion an important part of overall performance. Further, these liquid droplets are known to be charged; hence electrostatic action plays some part.

Although no installations of this equipment have been made on boiler flue gas, the manufacturer feels such an installation can be made economically.

Fig. 9 represents a relatively low-cost method for scrubbing a boiler flue gas. Here water runs over a plate through which the gas passes. The water then continues over the sides, making a fairly solid water curtain, within which the entering flue gas is channeled. A steam spray is introduced near the outlet to overcome draft loss through the collector.

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FEBRUARY 1950 • VOL 94 • NO. 2

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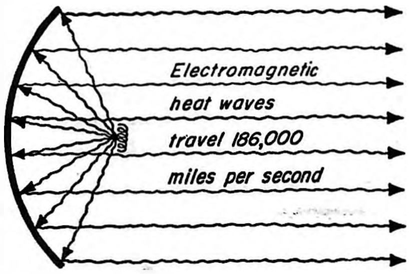
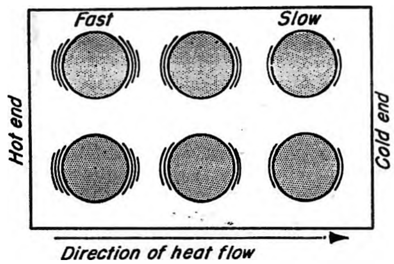


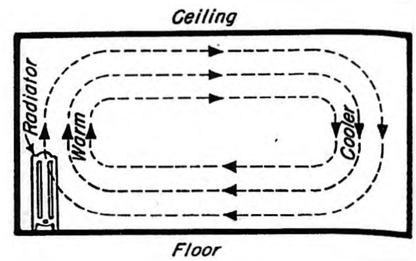
RADIATION

Radiant heat waves, exactly like radio waves but much shorter, travel through air or vacuum with the speed of light



CONDUCTION

Heat flows through a solid by conduction only. Fast-moving molecules at hot end speed cold ones by bumping process



CONVECTION

Hot air is lighter than cold, so air heated by radiator at left rises, then cools and falls again to floor

Insulation Handbook: Part I—

This handbook, to be published in six parts, starts with the fundamentals of heat flow. Later articles answer practical questions—What kind of heat insulation meets specified conditions? How thick? What saving? How applied? How protected?

By **PHILIP SWAIN**, *Editor*

► THIS SERIES serves as a condensed handbook of heat insulation for power engineers. It will help them save heat units and dollars by the intelligent selection and application of heat insulation to the hot and cold surfaces of piping, tanks and many other types of power-service equipment. Before turning to this practical side, here are a few scientific fundamentals.

Heat Flow. Throughout these articles we shall measure heat in Btu, but remember that heat can be measured in other units as well.

For example, one kilowatt-hour is 3413 Btu. Therefore, one watt hour is 3.4 Btu. Thus any insulation completely surrounding a 40-watt electric lamp bulb will necessarily transmit 3.4 x 40 = 136 Btu per hour after the lamp and the insulation have warmed up to a steady state.

And this will hold true regardless of the thickness or efficiency of the insulation, since the lamp is a constant-rate source of energy.

Heat Travels Through Vacuum. Heat can traverse a vacuum, as from the sun to the earth, in one way only — by electromagnetic radiation, exactly like radio waves and light waves in kind, except that the waves are much shorter than the shortest radio waves. All speed through space at the rate of 186,000 miles per sec.

This radiant heat will pass through air, as it will through a vacuum, but it has no need for the air. You might say radiant heat flows *in spite of the air* and loses something through absorption by the air.

Heat Flow Through Solids. Just as heat can flow in one way only (by radiation) through a vacuum, so also there is only one way for it to flow through a solid—that is, by conduction. In any solid, at any temperature above absolute zero (− 460 F), the molecules are in constant vibration. The higher the temperature, the faster they vibrate. Each molecule bounces back and forth within a limited range of its normal position, as though it were fastened to a stake by a rubber cord.

Each moving molecule is constantly bumping into its neighbors. Naturally, when fast-moving molecules bump into slow-moving ones, the fast are slowed down and the slow are speeded up, on the average. That is how heat flows by conduction from the hotter parts of the solid to the cooler parts. Thus temperatures tend to equalize throughout the solid object unless heat is constantly supplied to the hot points, and taken away from the cold points.

Convection. Convection, the third way to transmit heat, commonly occurs in liquids, gases and vapors, but never in solids.

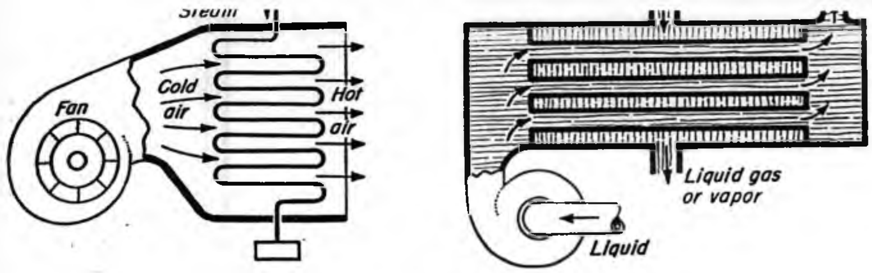
In convection the liquid or gas (or vapor) actually moves from the hot surface, where the heat enters, to the cold surface where it is removed. Thus the heat is carried bodily from one point to another.

Of course, convection always involves some conduction also, at the points where the heat is "loaded" into and "unloaded" from the moving fluid.

This convection movement may be produced "naturally" by temperature differences, or by a pump or fan. The air circulation set up by a radiator in a room (see sketch above) is a common example of natural circulation, as is the circulation of water heated by a submerged steam coil. In both cases, the heated fluid expands and then rises because it is lighter than the surrounding air or water. Later it cools, becomes heavier and falls, thereby completing the convection circuit.

Much higher fluid-flow rates are obtainable with forced circulation by fans or pumps, and much is gained by the increased flow. In fact, the flow of heat increases much faster than the flow of gas or water. Not only is more fluid circulated, but its high velocity scrubs away the surface film, and thereby reduces the resistance.

That is why fans are widely used in industry to blow air over heating coils and pumps to push water or other



FORCED CONVECTION SPEEDS UP HEAT TRANSFER

Forced convection, by fans or by pumps, scrubs away much of the insulating fluid film that retards the flow of heat, thereby greatly increasing the heat-transfer capacity of steam-coil air heaters, liquid heat exchangers and similar equipment

How Heat Flows

liquids at high speeds through heat exchangers. In this way a given investment in heating surface can transmit far more per hour than would otherwise be possible.

Most of the practical applications of heat transfer and heat insulation involve a combination of two or three of these methods of heat moving—conduction, convection and radiation.

The role of true radiation in heat transmission is often misunderstood. It may be important, or it may be unimportant, depending largely on the temperature levels involved, because the heat radiated from the surface varies as the fourth power of the absolute temperature. The rate at which these fourth powers build up is truly astonishing (see sketches at right).

There is no such simple mathematical rule for heat transmitted by convection. True, figuring heat delivery would be easy if we knew not only the rate of air circulation but also its temperature leaving and returning for a new load of heat. In that case heat moved would be the weight of air moved, multiplied by the temperature difference and by the specific heat of air.

The practical difficulty is that of predicting just how much air will flow (in the case of natural circulation), and (in all cases) what its initial and final temperatures will be.

The field of convection heat transfer is so full of theory and guesswork that the average practical man is often forced to solve his heat-transfer problems by cut and try. He adds or subtracts heating surfaces until he obtains the desired heat-transfer rate.

But we must not jump from this fact to the unwarranted conclusion that it is difficult to make a reasonably close estimate of the heat loss from insulated surfaces. The opposite is true. The reason is that film resistance on the steam and air sides of a metal plate, as well as the resistance of the plate itself, becomes less important when the surface is insulated.

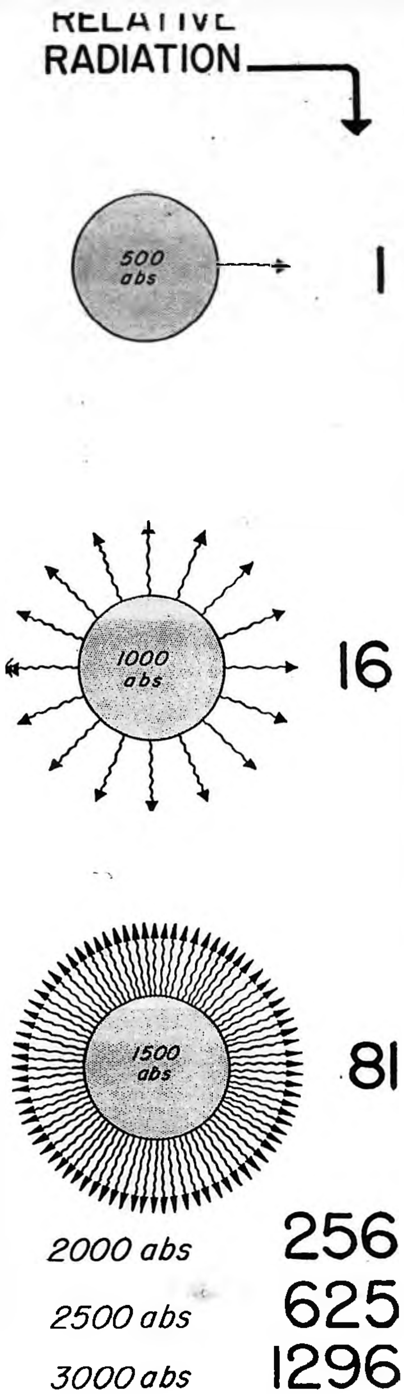
For example, the heat loss from a bare heated surface may vary considerably, depending on the position, and on the nature of the surrounding air currents because both have a big effect on the outside air film. Yet as soon as the insulation is applied, air currents and position become relatively unimportant (see final illustration on p 116). That is why the heat loss through insulated surfaces can be accurately figured from the known properties of the insulation.

Conduction. In practically all cases where insulation is applied in substantial thicknesses, conduction through the insulation itself is the controlling factor in heat transmission.

Here, fortunately, the theory is simple. Consider (sketch, top p 116) a square slab of a given insulating material, 1 ft square and 1 in. thick. Assume one face is one degree hotter than the other.

Then heat will flow from the "hot" face to the "cold" face, and its amount, in Btu per hour, will be the so-called K factor, or *conductivity*.

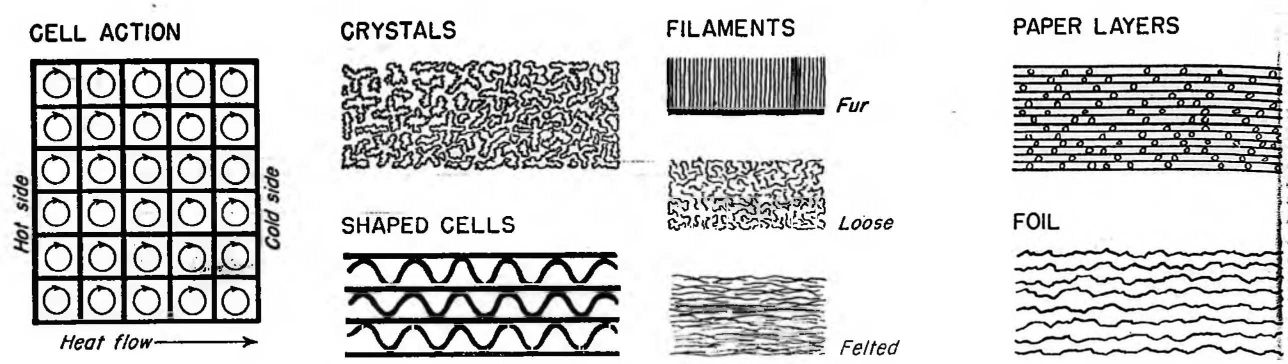
Once the K factor is known for a given material, it is easy to figure how much heat will be transmitted through any thickness of it over any area and with any temperature difference. Total heat flow will be in direct proportion to



RADIATION SKYROCKETS AS FOURTH POWER OF ABSOLUTE TEMPERATURE

For example, take 500 abs (40 F) as standard of comparison. If you double temperature to 1000 abs, radiation jumps to $2 \times 2 \times 2 \times 2 = 16$ times. At triple temperature (1500 abs) radiation is $3 \times 3 \times 3 \times 3 = 81$ times that at 500 abs, and so on, as indicated above. That is why radiant heat is far more important at the higher temperatures

ALL INSULATION TRAPS DEAD AIR IN TINY POCKETS



DEAD AIR SPACE DOES THE JOB in most types of insulation. Primary path for heat transfer across an air space is by convection. If air spaces are tiny, and there are many, co vection currents can't really get going and resistance is hig

Insulation Handbook: Part 2

Types and Shapes of Heat Insulation

Here Editor Phil Swain explains how insulation does its job, lists data on forms, temperature limits. Future articles will cover heat loss, economic thickness, selection, application

► THIS ARTICLE EXPLAINS why certain materials are good insulators. Then it briefly describes materials and shapes in common commercial use for insulating heated surfaces.

Why Insulation Insulates. It is generally understood that insulation depends on "dead air," but just how dead air works is not always clear. Heat flow through air is mainly by convection because air is a poor conductor. That is why every good heat insulator must: (1) lock air in small pockets so convection can hardly operate (2) leave only very little solid material running in heat-flow direction.

The sketch at top left shows the ideal condition if the cells pictured are assumed to be microscopic in size, and the solid walls running in the direction of heat flow very thin.

View each cell as a hurdle the heat must overcome. At each cell the heat, after passing easily through the left thin wall must pass to the air in the cell, then circulate to the right wall by natural convection, and there give up its heat.

Repeating this operation many times per inch of thickness can build up a great total resistance to heat flow even if the material itself (as with aluminum-foil insulation) is a very good heat conductor. For aluminum, note that the bright reflecting surfaces are additional important barriers, this time to radiant heat.

Stiff or Efficient? Most commercial insulations are a compromise between insulating qualities and other qualities needed for specific applications. For example, where insulation is compressed, or binder added, to increase strength and stiffness, some insulating efficiency is almost always lost.

In general almost anything to increase stiffness and strength (other than some kind of protective shield) increases weight, reduces insulating value. Thus insulating brick and "hard-finish" asbestos cements have lower values than the usual 85% magnesia and mineral-wool insulations.

Every form of insulation has some upper temperature limit beyond which it cannot be used without shortened life or early destruction. Thus insulation of hair and wool is rarely used above 200 F. In ordinary "air-cell" asbestos insulation the binder often sets a safe upper limit of 300 F; 85% magne calcines if applied direct to pi hotter than 600 F. Even asbestos, oft viewed as a near refractory, lo strength far below red heat.

Table on facing page roughly cla fies insulations by substance and sha Complete consistency isn't possible this sort of table. To avoid confusi and reduce generalities to a stric practical level, future articles w consider properties of magnesia, mi eral wool and other insulations—a methods of applying them to vari surfaces and equipment types.

Also, special problems in insulati cool and cold surfaces will be cove in a separate article.

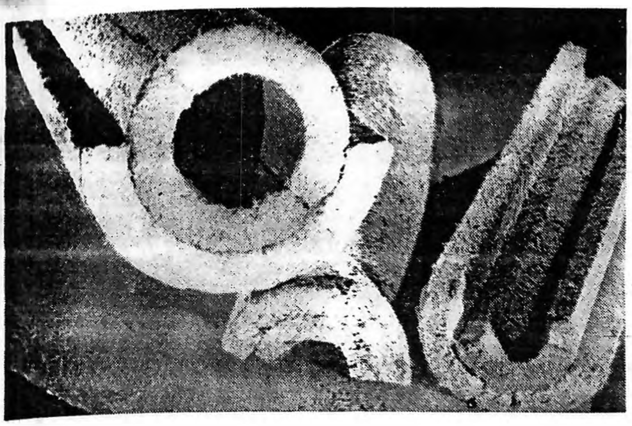
Here are a few high-spot commen

Organic Fibers. Fibers of hair, a of wool, can be felted (loosely int laced). This felt can be formed i sectional pipe covering, blocks, or i sheets pliable enough to fit over cur or irregular surfaces. This organic sulation should not be used at tempe tures above 200 F.

Asbestos Air Cell. This low-cost sulation (layers of corrugated asbes paper) is used chiefly on domes steam and hot-water lines—rarely permanent industrial lines. Seldom u above 300 F.

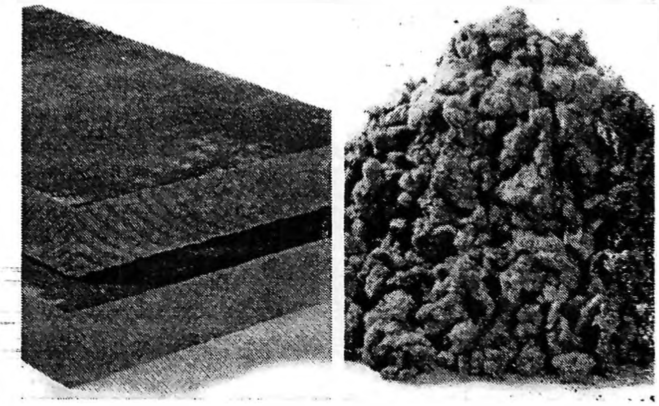
Other Asbestos. Asbestos fibers m be "felted" to form sheets and blo and pipe covering. Any of these sha can be made stiffer and stronger adding binder, but always at the

COMBINATION INSULATION



FOR STEAM PIPES above 600 F, diatomaceous-silica inner layer protects outer of more efficient 85% magnesia insulation

MINERAL WOOL



MINERAL WOOL is supplied in many forms, including boards, *left;* loose and noduled wool, *right,* blankets, batts, cements

pense of some loss in the efficiency.

The same holds true of asbestos cement. The greater its cementing quality (hardness, strength, weight) the poorer its insulating quality. Thus soft cements of high insulating quality are commonly given a thin finishing coat of hard-finish cement, applied mainly as a protection.

Mineral Wool is made by exposing a thin stream of molten slag (or glass) to a high-velocity steam jet. Primary product is a woolly mass of tangled mineral fibers. In this form—poured loose, laid out flat as a batt or blanket (a layer of mineral wool sandwiched between wire mesh or other supporting layer)—it has high efficiency. This efficiency is somewhat reduced when material is strengthened and stiffened by compacting, felting and by adding binder to form boards and blocks.

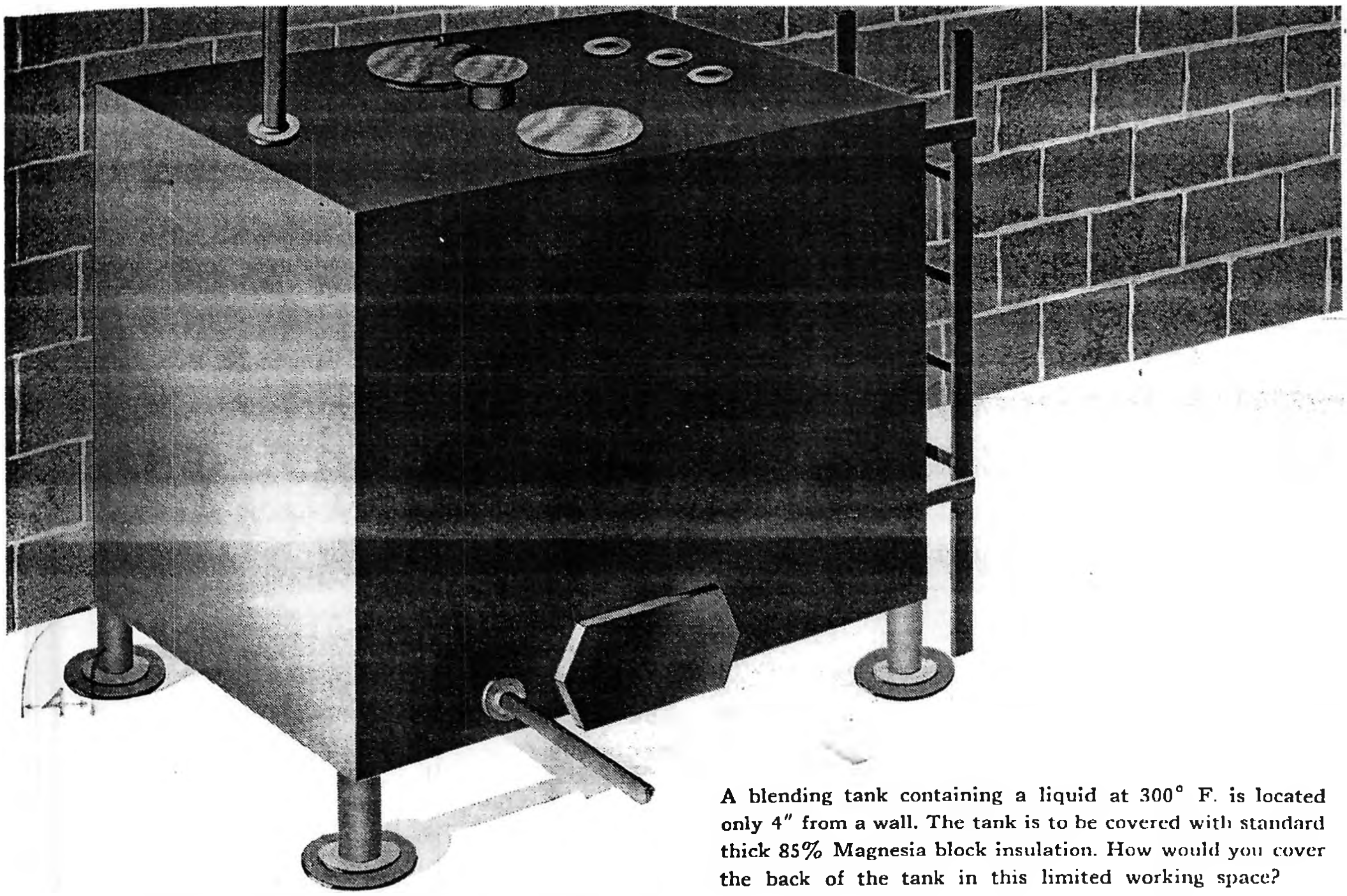
85% Magnesia, a nonproprietary product, consists of 15% by weight asbestos fiber reinforcement and 85% carbonate of magnesia, chemically derived from dolomite rock. Insulating value comes entirely from microscopic air spaces between magnesia crystals.

Because of its character 85% magnesia cannot be felted. It is formed by wet molding. Commercial forms are sectional pipe covering, blocks, segments and cement.

For pipe temperatures above magnesia temperature limit of 600 F insulation is applied in two sectional layers—inner layer of temperature-resisting diatomaceous silica, and outer of the more efficient 85% magnesia.

High-temperature diatomaceous silica insulations are made up to 1200 F—even up to 1900 F. Insulating refractories are obtainable (for backing furnace firebrick) for temperatures up to 2500 F.

KINDS AND SHAPES OF HEAT INSULATION FOR WARM SURFACES	Hair felt	Air-cell asbestos	Asbestos, fibrous	85% Magnesia	Sponge-felted asbestos paper	Mineral wool	Diatomaceous silica (calcined)	Diatomaceous silica (calcined brick)	Crumpled aluminum foil
Usual maximum temperature	200 F	300 F	750 F	600 F	700 F	1000 F	1900 F	2500 F	
Poured loose or granulated				✓		✓	✓		
Cement			✓	✓		✓			
Blankets or batts	✓	✓				✓			
Sheets (flexible)		✓	✓		✓	✓			✓
Boards or blocks (stiff)		✓	✓	✓	✓	✓	✓		
Molded segments				✓					
Shaped sections	✓	✓	✓	✓	✓	✓	✓		
Bricks								✓	



A blending tank containing a liquid at 300° F. is located only 4" from a wall. The tank is to be covered with standard thick 85% Magnesia block insulation. How would you cover the back of the tank in this limited working space?

HOW WOULD YOU INSULATE THE BACK OF THIS TANK?

HERE'S WHAT THE ARMSTRONG ENGINEER RECOMMENDED:

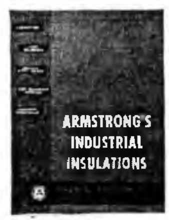
In this case, the tank was completely set up, with all pipe connections made, when the insulation men were called on the job. It was impractical to disconnect all pipes and move the heavy tank far enough from the wall to get behind it and apply the insulation. The 300° temperature held in the tank was critical, and omitting the insulation on the back would have made temperature control difficult.

To solve the problem of applying the insulation, the Armstrong engineer recommended that blocks of 85% Magnesia be wired to expanded metal lath, cut to the same size as the back of the tank. Then an angle was welded to the bottom of the tank back, and the insulation was slipped in place. The angle supported the weight, and wires were used to hold the insulation firmly in place.

This problem is typical of the many questions that arise on any heat insulation job. Armstrong engineers and installation mechanics experience them every day. That experience has taught them the answers to almost any insulation problem, large or small. When you have an insulation question you're in doubt about, consult an Armstrong engineer. The next time you need a heat insulation job done, try Armstrong's complete Contract Service, for dependable engineering advice, quality materials, and expert workmanship.

FREE BOOKLET

Send today for the new booklet, "Armstrong's Industrial Insulations." It describes completely the materials and services offered to users of insulations for all temperatures. Write today to Armstrong Cork Co., 7003 Maple Avenue, Lancaster, Pennsylvania.



ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS Ⓐ INSTALLATION

FOR ALL TEMPERATURES FROM 300° F. BELOW ZERO TO 2800° F.