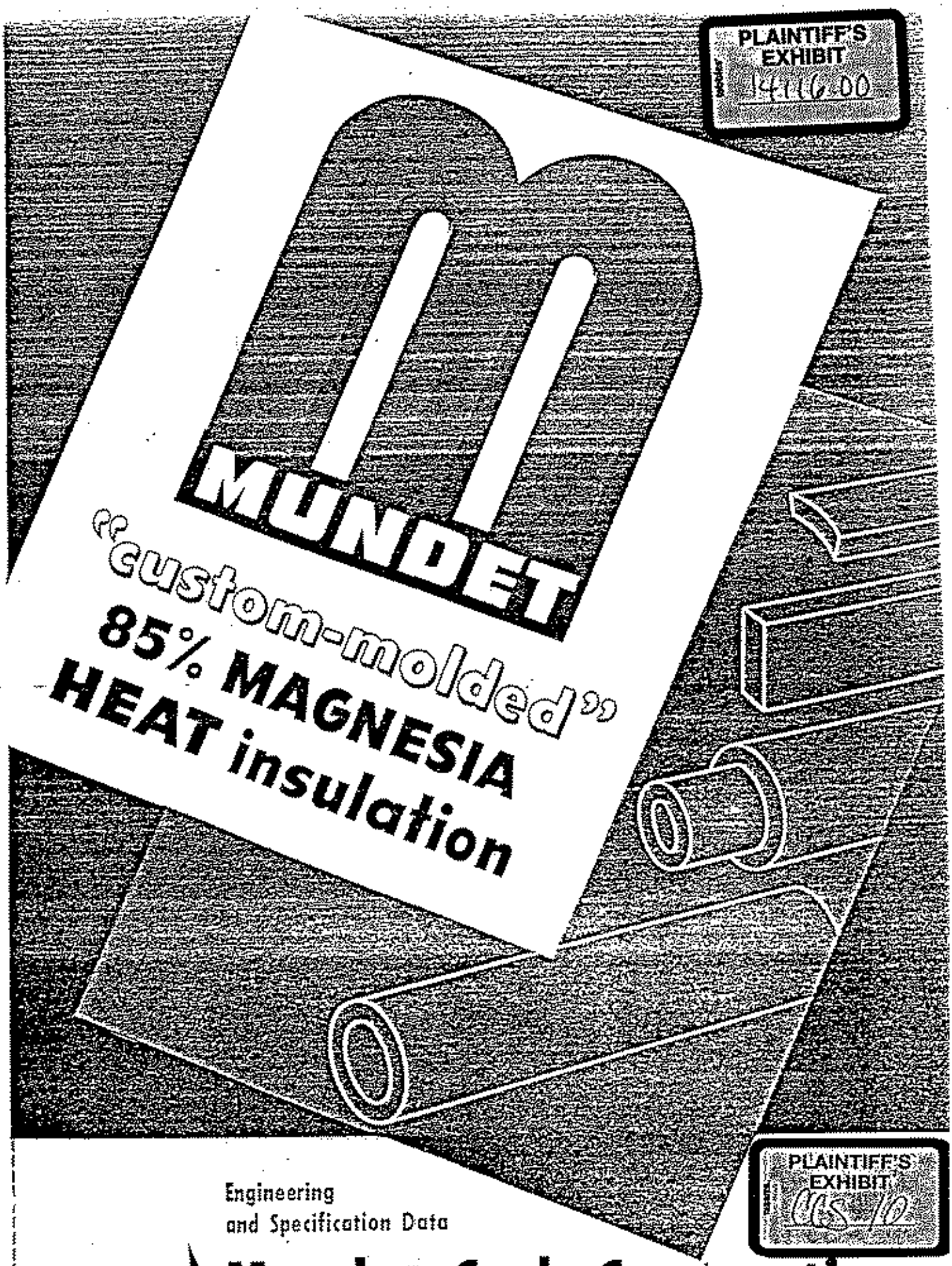
PLAINTIFF'S EXHIBIT 14666.00



PLAINTIFF'S EXHIBIT 665-10

Engineering
and Specification Data

Mundet Cork Corporation

85% magnesia heat insulation

MUNDET

some of the many advantages

controlled uniformity

Precision manufacture on the latest type of automatic equipment insures uniformity of product in all the important qualities affecting insulating performance as well as that of density to within a tolerance of ±½ lb per cubic foot.

thermal conductivity

Following is report of test of Mundet "Custom-Molded" 85% Magnesia pipe covering prepared by United States Testing Company, Inc. Copy of report will be sent on request.

determination of thermal conductivity (k) factor through *the mean temperature range 100°F to 500°F*

mean temperature °F	thermal conductivity (k) btu/hr/sq ft/°F/in
100	0.338
200	0.363
300	0.408
400	0.454
500	0.500

smooth finish

Mundet "Custom-Molded" 85% Magnesia is molded to exact finished size and thickness; it is not molded oversize and then milled or machined to size. This method produces a smooth finish on the inner and outer surfaces, thus adding to the appearance and effectiveness of the insulation.

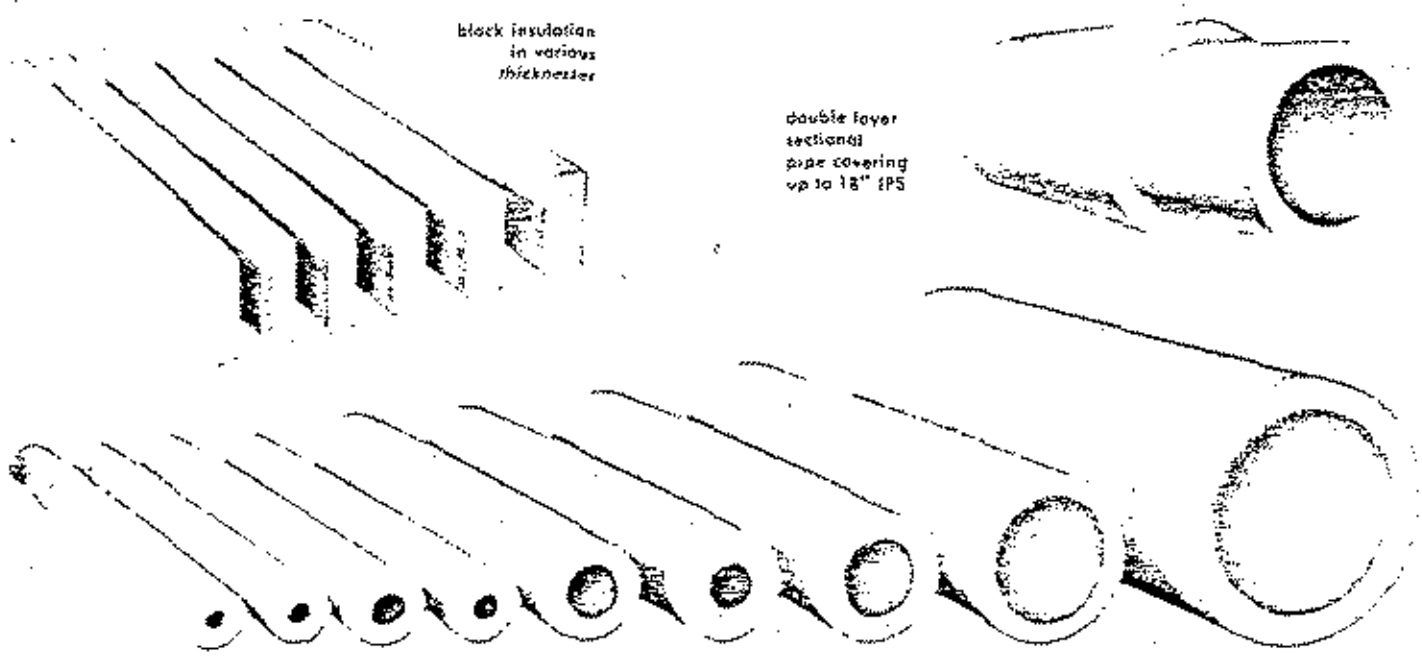
precision pipe fit

Each size and thickness is accurate and identical. No spaces are left for the escape of heat. The whole heated surface is snugly enclosed; longitudinal and end joints butt tightly.

other advantages

Under "physical characteristics" (page 5) other important advantages of Mundet "Custom-Molded" 85% Magnesia are outlined.

Mundet "Custom-Molded" 85% Magnesia pipe covering and blocks



single layer pipe covering up to 18" IPS shows unsplit and uncompressed

85% magnesia heat insulation

physical characteristics

compressive strength

Compressive strength is psi to produce ¼" compression in 1½" thick sample 75-85 lbs.

ductile strength

Through the use of long asbestos fibres running longitudinally, greater strength is built into Mundet "Custom-Molded" 85% Magnesia. It exceeds the modulus of rupture requirements of the U.S. Navy Specifications, indicating fully adequate "machine test" strength. It does not "powder," settle or disintegrate even under heavy vibration. It withstands handling and may be removed and reapplied if necessary.

light weight

Mundet 85% Magnesia weighs only 11 lbs per cubic foot = ½ lb. Its light weight makes even the larger sizes and thicknesses easy for one man to handle, thus simplifying and speeding up application.

easy to apply

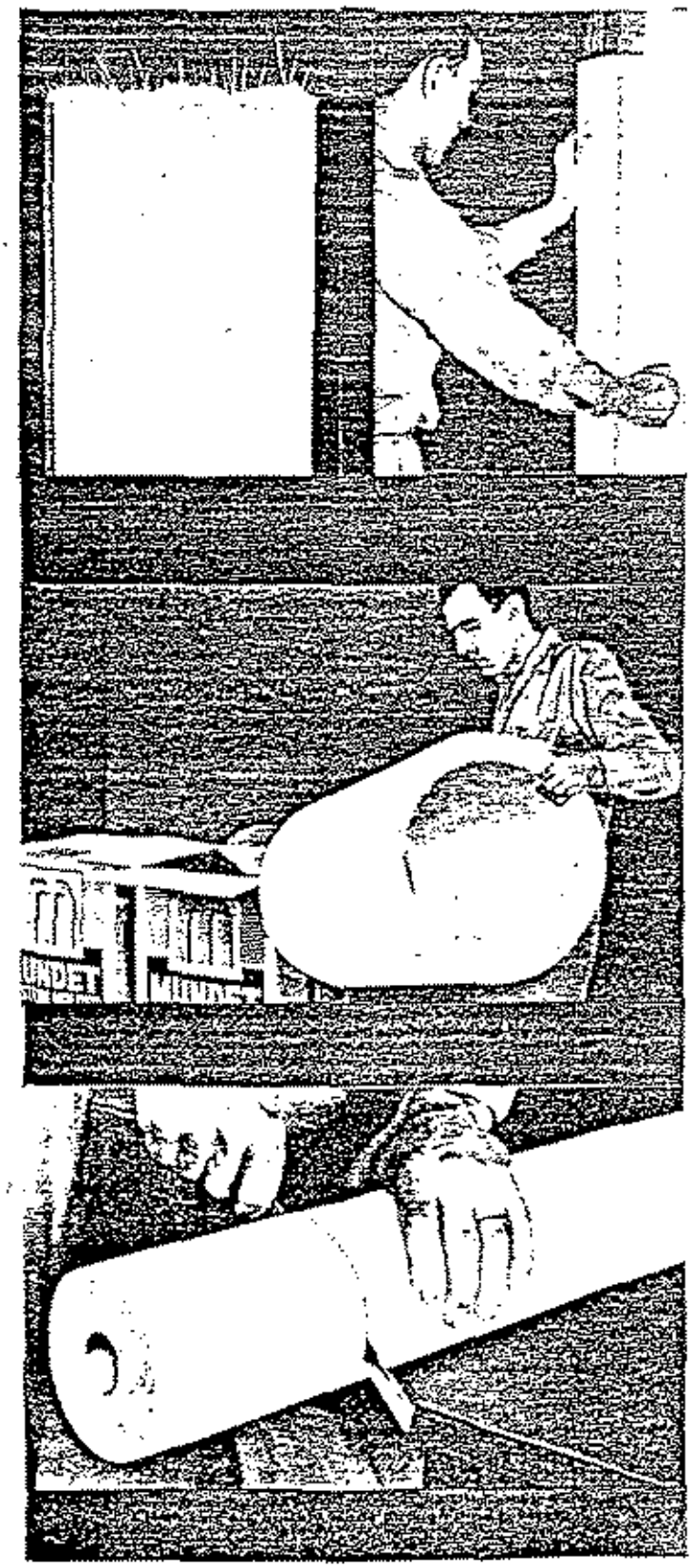
It cuts easily and cleanly, even without canvas support. No chipping or crumbling. Blocks score clean, easily, thus reducing time necessary for application.

minimum shrinkage

Steam or water leakage does not affect the structural characteristics. (Linear shrinkage — 24 hr soaking period at maximum useable temperature 1-2%; volume shrinkage — 24 hr soaking period at maximum useable temperature 5-6%.)

guarantee

The Company unqualifiedly guarantees that its material and workmanship are of the best and agrees to make good, without cost to the customer, any defect that may be chargeable to inferior material or workmanship as indicated in its contract form.



Mundet Cork Corporation

85% magnesia heat insulation

Mundet "Custom-Molded" 85% Magnesia segmental pipe covering

Mundet segmental pipe covering can be furnished in all conventional sizes, thicknesses or types, including double layer (double standard) and curved radius blocks. The segmental pipe covering is molded in segmental form to a predetermined standard radius. Only the edges are milled so that the segments will conform precisely to the required diameter. The inner and outer surfaces are left with their original smooth molded facing. These are designed for pipe covering applications where sectional (2-piece) pipe covering cannot be used due to size limits.

All pipe sizes larger than 18 inches, and all other pipe sizes not listed on page 6 are furnished in segmental form.

The following table shows the number of segments per section of pipe covering for all thicknesses of segmental pipe covering.

nominal pipe sizes inches	number of segments	nominal pipe sizes inches	number of segments
19	10	24	12
20	10	26	13
21	11	27	14
22	11	28	14
23	12	30	15

Mundet 85% magnesia cement

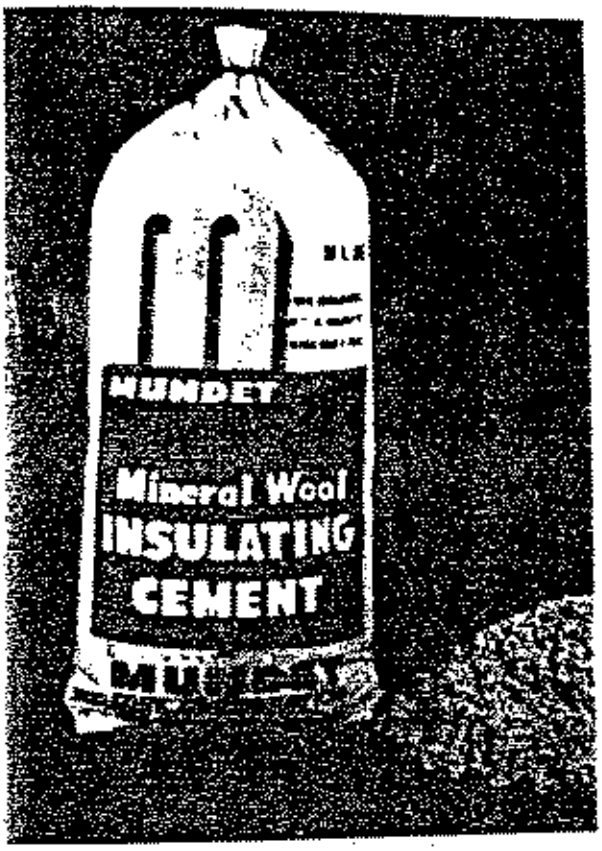
Mundet 85% magnesia cement is used for filling joints and cracks in 85% magnesia pipe covering and blocks. It is a highly efficient insulating cement, recommended for temperatures up to 600°F. It is not recommended for hard finishes.

This cement is mixed with water to the proper consistency, and usually applied in layers of ¼ in thickness over 85% magnesia blocks where the insulated areas are to be finished with canvas or mastic.

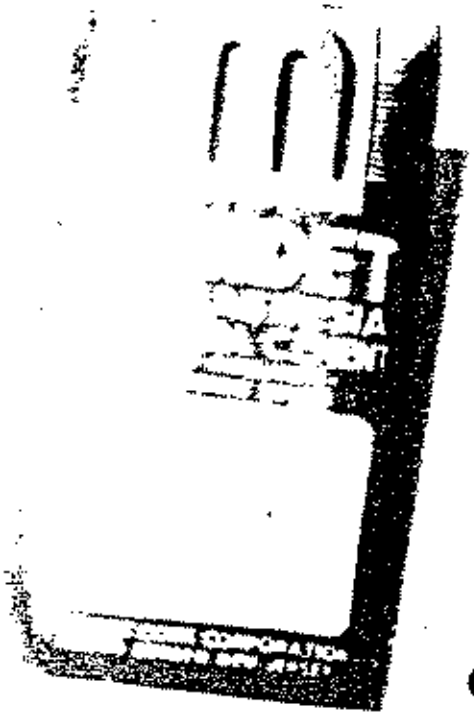
The conductivity of Mundet 85% magnesia cement averages approximately 10% higher than this material in molded form due to the cement being of higher density upon application.



furnished in 50 lb. 3 ply paper bags.
Covering capacity: approximately 30 sq ft. 1 inch thick, per bag.

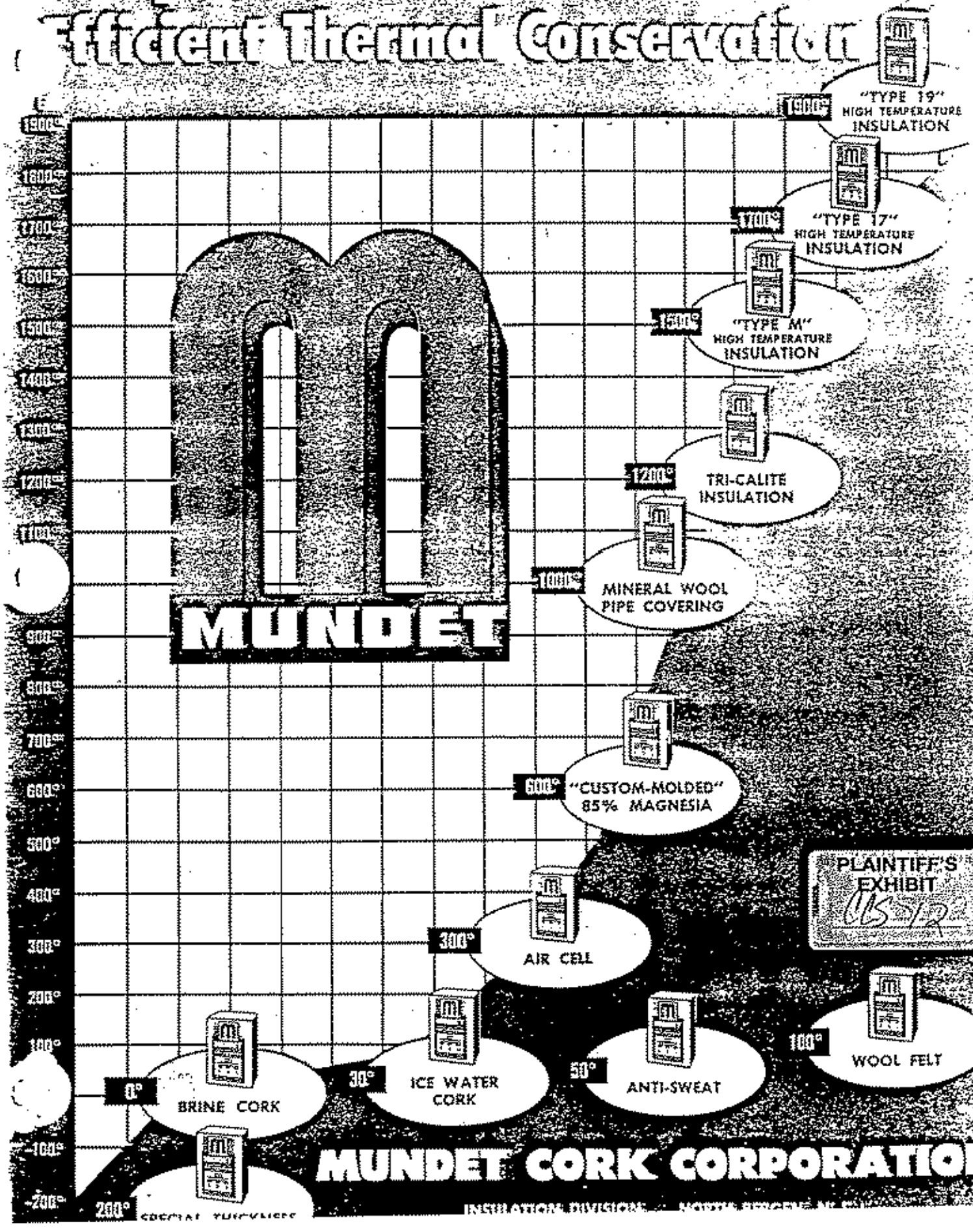

MUNDET
Mineral Wool
INSULATING
CEMENT


MUNDET
"Ne Plus Ultra"
Mineral Wool
FINISHING
CEMENT



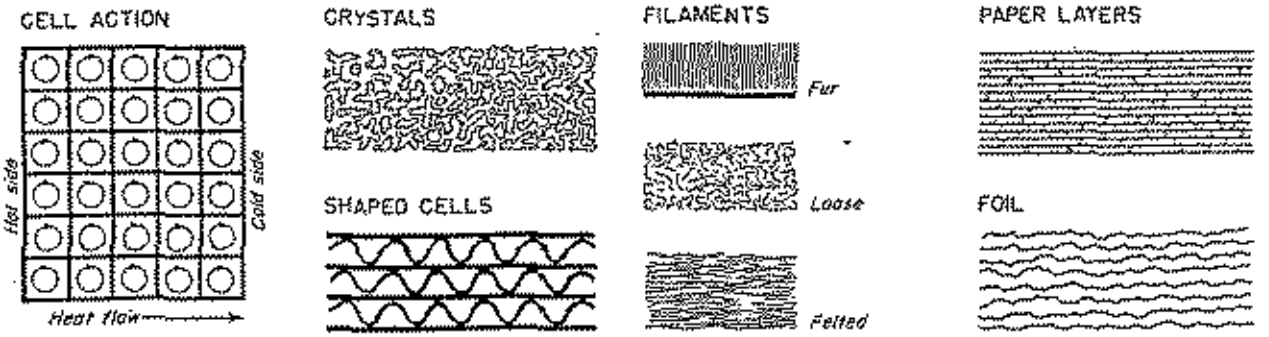

MUNDET
PLAINTIFF'S
EXHIBIT
US-11

Complete Service for Efficient Thermal Conservation



PLAINTIFF'S EXHIBIT
CLS 13

ALL INSULATION TRAPS DEAD AIR IN TINY POCKET



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, convection currents can't really get going and resistance is high

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% magnesia calcines if applied direct to pipes hotter than 600 F. Even asbestos, often viewed as a near *refractory, loses* strength far below red heat.

Table on facing page roughly classifies insulations by substance and shape. Complete consistency isn't possible in this sort of table. To avoid confusion and reduce generalities to a strictly *practical level, future articles* will consider properties of magnesia, mineral wool and other insulations—also methods of applying them to various surfaces and equipment types.

Also, special problems in insulating cool and cold surfaces will be covered *in a separate article.*

Here are a few high-spot comments:

Organic Fibers. Fibers of hair, and of wool, can be felted (loosely interlaced). This felt can be formed into sectional pipe covering, blocks, or into sheets pliable enough to fit over curved or irregular surfaces. This organic insulation should not be used at temperatures above 200 F.

Asbestos Air Cell. This low-cost insulation (layers of corrugated asbestos paper) is used chiefly on domestic steam and hot-water lines—rarely for permanent industrial lines. Seldom used above 300 F.

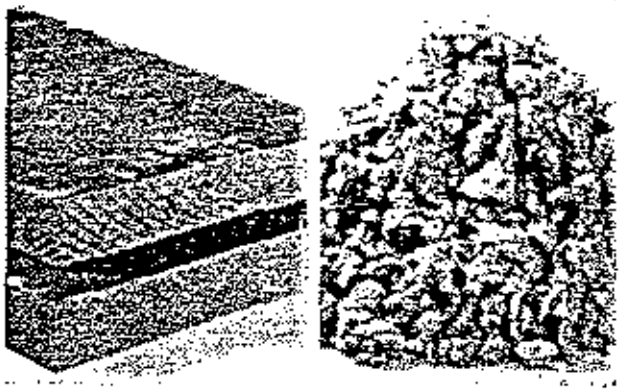
Other Asbestos. Asbestos fibers may be "felted" to form sheets and blocks and pipe covering. Any of these shapes can be made stiffer and stronger by adding binder, but always at the ex-

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 nodular 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.

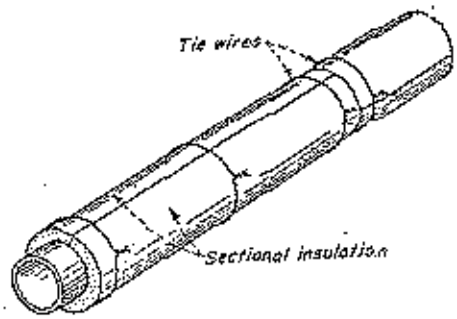
High-temperature diatomaceous silica insulations are made up to 1200 F—even up to 1900 F. Insulating refractories are obtainable (for backing furnace firebrick) for temperatures up to 2300 F.

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								✓	

PLAINTIFF'S EXHIBIT 0514

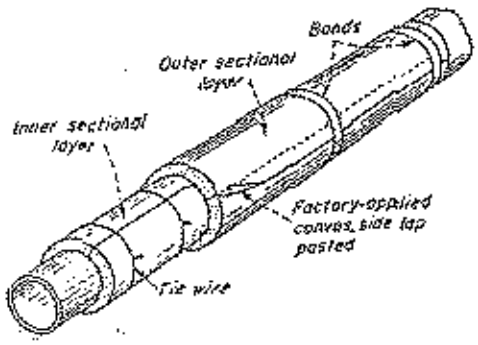
How to Apply 85% Magnesia Heat Insulation

By PHIL SWAIN, EDITOR



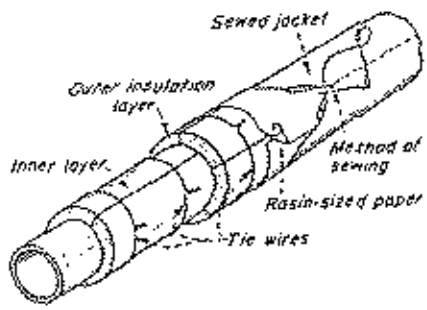
WIRED SECTIONAL

Here factory canvas is removed. Use at least 3 annealed iron wires per section. Twist wire ends together, bend over and press into insulation for protection. Stagger lengthwise joints. Point up all joints with 85% magnesia cement. An alternate method omits wiring, pastes down *laps on factory* canvas and applies metal bands



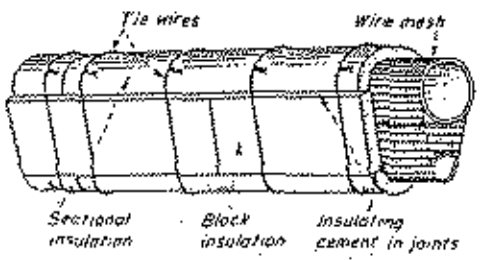
DOUBLE LAYER

Handle inner layer as before. Apply outer layer with all *joints staggered. Outer layer* may be wired without canvas like inner layer, or may be finished by pasting down factory canvas and banding



SEWED CANVAS JACKET

If cost of better looking, more durable job is warranted, remove factory canvas. Apply layers as above, followed by rosin-sized or sheathing paper. Stretch 8-oz canvas over paper, sew in place, coat with glue sizing, paint as de*sired. To avoid scorching canvas* finish by heat from nearby flanges or other uninsulated surfaces, stop canvas and paper a few inches short of insulation end. Finish exposed ends with asbestos cement



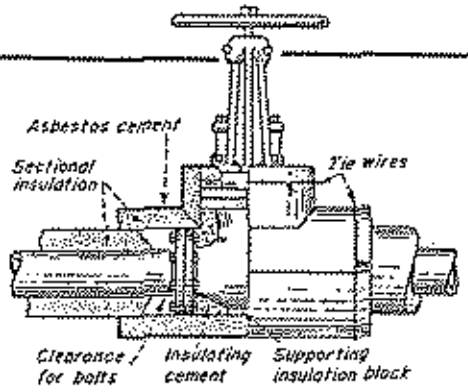
PARALLEL PIPING

Where two parallel pipes are too close for convenient separate insulation, or where a steam pipe must protect a water pipe from freezing, or keep oil line warm, arrangement pictured is convenient and practical

Practical know-how in convenient form. Drawings and condensed instructions summarize standard procedures in the 85% *Magnesia Insulation Manual*, published by the Magnesia Insulation Manufacturers' Association, of Washington, D. C.

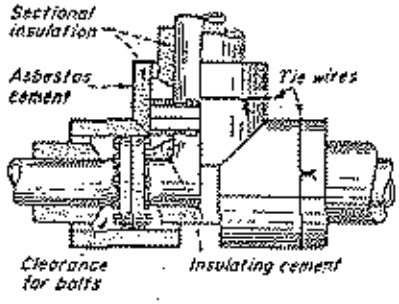
LARGE VALVES

To insulate valves of 4-inch pipe size or larger, build cover of block or sectional insulation of any convenient shape. Tie together with wires. Seal crevices with insulating cement. Use solid insulation half-inch thinner than pipe insulation to allow for cement finish. Then build to full thickness with asbestos cement, 2 coats.



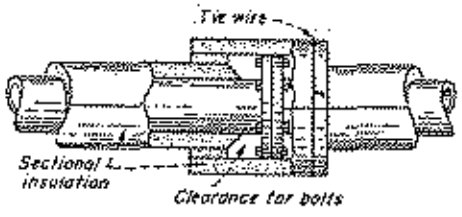
LARGE FITTINGS

Treat fittings, 4-inch and up, same as valves. Note: For valves and fittings under 4-inch, cover directly with asbestos cement in several half-inch layers to bring total thickness up to that of pipe covering. Allow each coat to dry before applying the next



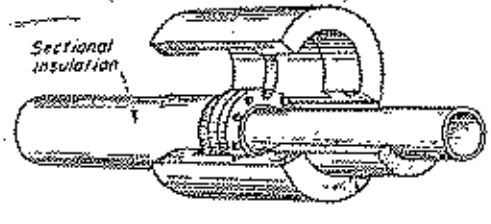
PERMANENT FLANGE INSULATION

Wire sectional insulation or blocks firmly in place and cover with asbestos cement. Extend flange insulation at least 2 inches over adjacent pipe insulation. Fill open space (in overlap) with insulating material. Cut back and bevel pipe insulation to allow removing bolts

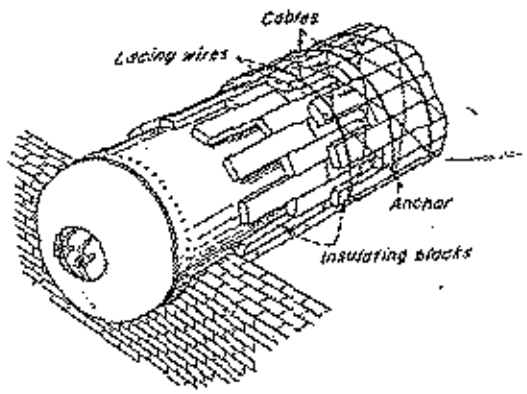


REPLACEABLE FLANGE INSULATION

Design pictured can be removed and replaced. Wrap sectional insulation with wire mesh and finish with asbestos cement. Or build wire mesh in two halves, cover with blocks. Cover this with wire mesh and cement inside and out

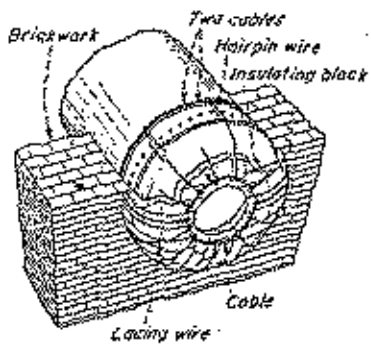


For more insulation facts, turn page→



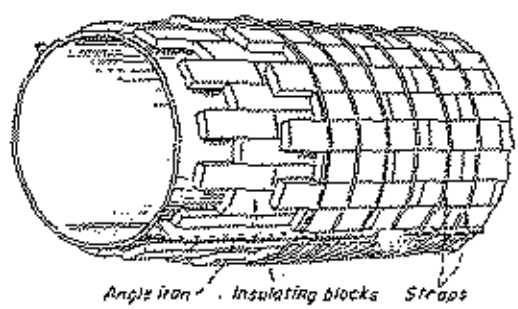
STEEL DRUMS

Where full circumference is not exposed, as with boiler drums, install firm anchorages. Fit blocks to cylinder, staggering joints, and bind firmly with annealed iron wire laced through steel straps or wire cables



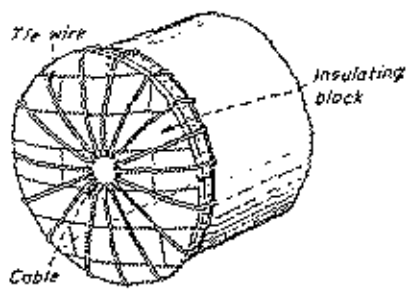
DRUM HEAD

Secure job requires anchoring blocks in manner shown, or equivalent. Since curved blocks are not available to fit round end of tank, pieces of flat block are used. These are held in place by network of wires. Finish with asbestos cement in one or several layers.



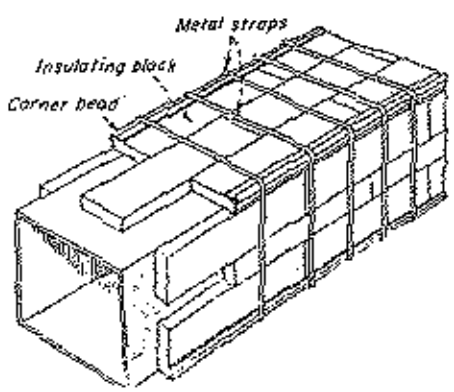
HORIZONTAL TANK

Horizontal tank pictured is completely encircled by insulation. Note that insulation in lower half tends to sag from tank, so must be more firmly held in place. Angle irons shown are one way. Asbestos cement finish



HORIZONTAL TANK END

Anchoring method, much like that for boiler-drum end but with more gradual curve, may allow use of full-size blocks. Asbestos cement finish

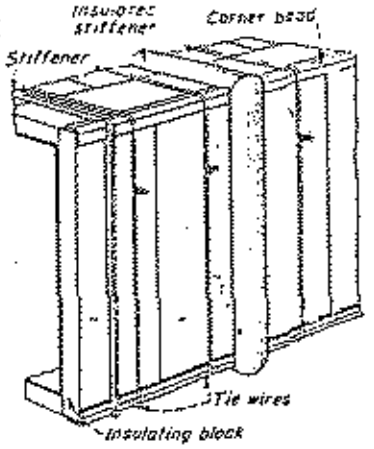


DUCTS WITHOUT STIFFENERS

Case pictured: breeching, duct or flue with no stiffeners or other projections. Nor is any provision needed for expansion. Blocks applied directly to surface and held by wire cables or metal straps. Metal beads protect corners

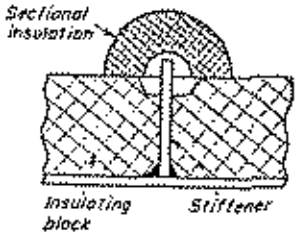
DUCT SURFACE WITH STIFFENERS

When projections are far apart and there's no need to allow for expansion and contraction, wire blocks directly to surface and insulate stiffeners as pictured below



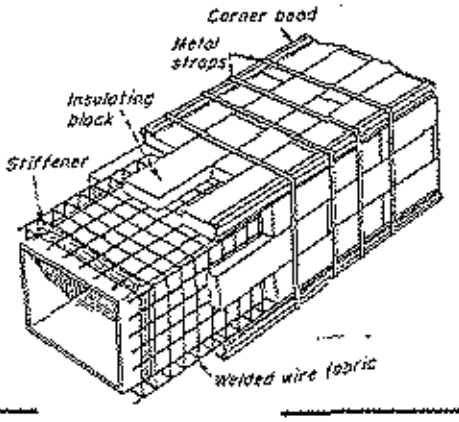
STIFFENER INSULATION

Half sections may be used to insulate stiffeners or other projections on ducts, shown above



DUCTS WITH PROJECTIONS

Where stiffeners or other projections are closely spaced, or where you must allow for expansion or contraction, stretch heavy-iron-wire fabric over the projections to form a foundation. Then wire blocks in place and finish with asbestos cement in the usual manner



Facts to Remember About 85% Magnesia

► As the name suggests, 85% magnesia contains not less than 85% of magnesium carbonate. To this white, crystalline, extremely light insulating material, the makers add 15% of asbestos fiber as a binder.

The wet mixture of magnesium carbonate and asbestos fibers is shaped first by molding and drying, then (usually) by machining to commercial dimensions. Usual commercial shapes are split shells—called sectional insulation—for piping, flat blocks, also curved blocks—segmental insulation—to fit large piping and tanks.

The K Factor

In a recent test of a commercial block of 85% magnesia, the U.S. Bureau of Standards measured the density as 13.2 lb per cu ft. The K value (Btu transmitted per hr per sq ft for a temperature gradient of 1 deg F per inch of thickness) was 0.39 at 130 F mean temperature. This compares with MIMA values of 0.39 at 100 F mean temperature, 0.45 at 300 F, and 0.51 at 500 F.

85% magnesia insulation withstands temperatures up to 600 F without damage. Above 600 F the material begins to calcine. It withstands repeated wetting and drying.

For heated surfaces operating above 600 F, an 85% magnesium outer layer is customarily applied over an inner layer of high temperature insulation—usually "diatomaceous silica," molded with a binding component of asbestos fiber.

Commercial thicknesses of sectional insulation and blocks include 1½, 2, 2½, and 3 in. Sectional insulation is also available in graded sizes known as "standard" and "double standard." See table below:

Insulation Thickness: Standard (S) And Double Standard (DS)

Pipe size, nominal	*S*	*DS*
⅜ to 1-½	7/8	1-29/32
2 to 3-½	1-1/32	2-3/32
4	1-⅛	2-⅛
5 & 6	1-⅛	2-5/16
8 & 10	1-¼	2-½
12 and over	1-½	3

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25 September 19[illegible]
SUPERSEDES
SPL-2819-3[illegible]
27 November 19[illegible]

PAGE 5/4[illegible]

QUALIFIED PRODUCTS LIST
OF
PRODUCTS QUALIFIED UNDER MILITARY SPECIFICATION

MIL-I-2819

INSULATION BLOCK, THERMAL

This list has been prepared for use by or for the Government in the procurement of products covered by the subject specification and such listing of a product is not intended to and does not constitute endorsement of the product by the Department of Defense. All products listed herein have been qualified under the requirements for the product as specified in the latest effective issue of the applicable specification. This list is subject to change without notice, revision or amendment of this SPL-2819 or issued as necessary. The listing of a product does not release the supplier from compliance with the specification requirements. Use of the information shown herein for advertising or publicity purposes is expressly forbidden.

The activity responsible for this Qualified Products List is Naval Ship Engineering Center

GOVERNMENT DESIGNATION	MANUFACTURER'S DESIGNATION	TEST OR QUALIFICATION REFERENCE	MANUFACTURER'S NAME AND ADDRESS
Class 1	Thermalite	EES 1[illegible]	Baldwin-Ehret-Hill, Inc. Trenton, N. J. Plant: Valley Forge, Pa.
Class 1	Thermasil	EES 610249	Baldwin-Ehret-Hill, Inc. Trenton, N. J. Plant: Valley Forge, Pa.
Class 1	Super Caltemp	EES 610551	Fibreboard Corp. Pabco Industrial Products Div. 475 Brannan St. San Francisco, Calif. 94119 Plant: Emeryville, Calif.
Class 1	Caltemp	EES C-3636	Fibreboard Corp. Pabco Industrial Products Div. 475 Brannan St. San Francisco, Calif. 94119 Plant: Emeryville, Calif.
Class 1	Pabco	EES S-33	Fibreboard Corp. Pabco Industrial Products Div. 475 Brannan St. San Francisco, Calif. 94119 Plant: Emeryville, Calif.
Class 1	JM	EES C-3551	Johns-Manville Sales Corp. 22 East 40th Street New York 16, N. Y. Plants: Waukegan, Ill. Manville, N.J. Watson, Calif.
	Thermobestos Thermobestos	EES 1A2741[7] EES 010301	
Class 1	Kaylo	EES C-383	Owens-Corning Fiberglas Corp. Toledo, Ohio 43601 Plant: Berlin, N.J.
Class 1	Kaylo 20	EES 010346	Owens-Corning Fiberglas Corp. Toledo, Ohio 43601 Plant: Berlin, N. J.

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Q1044

DPL-2819-34
29 November 1966
SUPERSEDING
QPL-2819-33
8 April 1966

MSC 5641

QUALIFIED PRODUCTS LIST
OF
PRODUCTS QUALIFIED UNDER MILITARY SPECIFICATION

MIL-I-2819

INSULATION BLOCK, THERMAL

This list has been prepared for use by or for the Government in the procurement of products covered by the subject specification and such listing of a product is not intended to and does not constitute endorsement of the product by the Department of Defense. All products listed herein have been qualified under the requirements for the product as specified in the latest effective issue of the applicable specification. This list is subject to change without notice, revision or amendment of the specification will be issued as necessary. The listing of a product does not relieve the supplier from compliance with the specification requirements. Use of the information shown herein for advertising or publicity purposes is expressly forbidden.

The activity responsible for the Qualified Products List is the Bureau of Ships.

GOVERNMENT DESIGNATION	MANUFACTURER'S DESIGNATION	REF OF QUALIFICATION REFERENCE	MANUFACTURER'S NAME AND ADDRESS
Class 1	Thermalite	BBS 1627413	Baldwin-Ehret-Hill, Inc. Trenton, N. J. Plants: Valley Forge, Pa.
Class 1	Thermahill	BBS 610945	Baldwin-Ehret-Hill, Inc. Trenton, N. J. Plants: Valley Forge, Pa.
Class 1	Super Calwemp	BBS 610551	Fibreboard Paper Products Corp. Fabco Industrial Insulation Division 475 Brannan St. San Francisco 19, Calif. Plants: Emeryville, Calif.
Class 1	Calwemp	BBS C-3536	Fibreboard Paper Products Corp. Fabco Industrial Insulation Div. 475 Brannan Street San Francisco 19, Calif. Plants: Emeryville, Calif.
Class 1	Fabco	BBS C-32	Fiberglas Paper Products Corp. Fabco Industrial Insulation Div. 475 Brannan Street San Francisco 19, Calif. Plants: Emeryville, Calif.
Class 1	JM	BBS C-3531	Johns-Manville Sales Corp. 22 East 40th Street New York 16, N. Y. Plants: Waukegan, Ill. Manville, N.J. Marion, Calif.
	Thermoberlex Thermoberlex	BBS 1627417 BBS 610955	
Class 1	Kaylo	BBS C-382	Owens-Corning Fiberglas Corp. Toledo, Ohio 43601 Plants: Berlin, N.J.
Class 1	Kaylo 20	BBS C-10344	Owens-Corning Fiberglas Corp. Toledo, Ohio 43601 Plants: Berlin, N. J.

Q1048

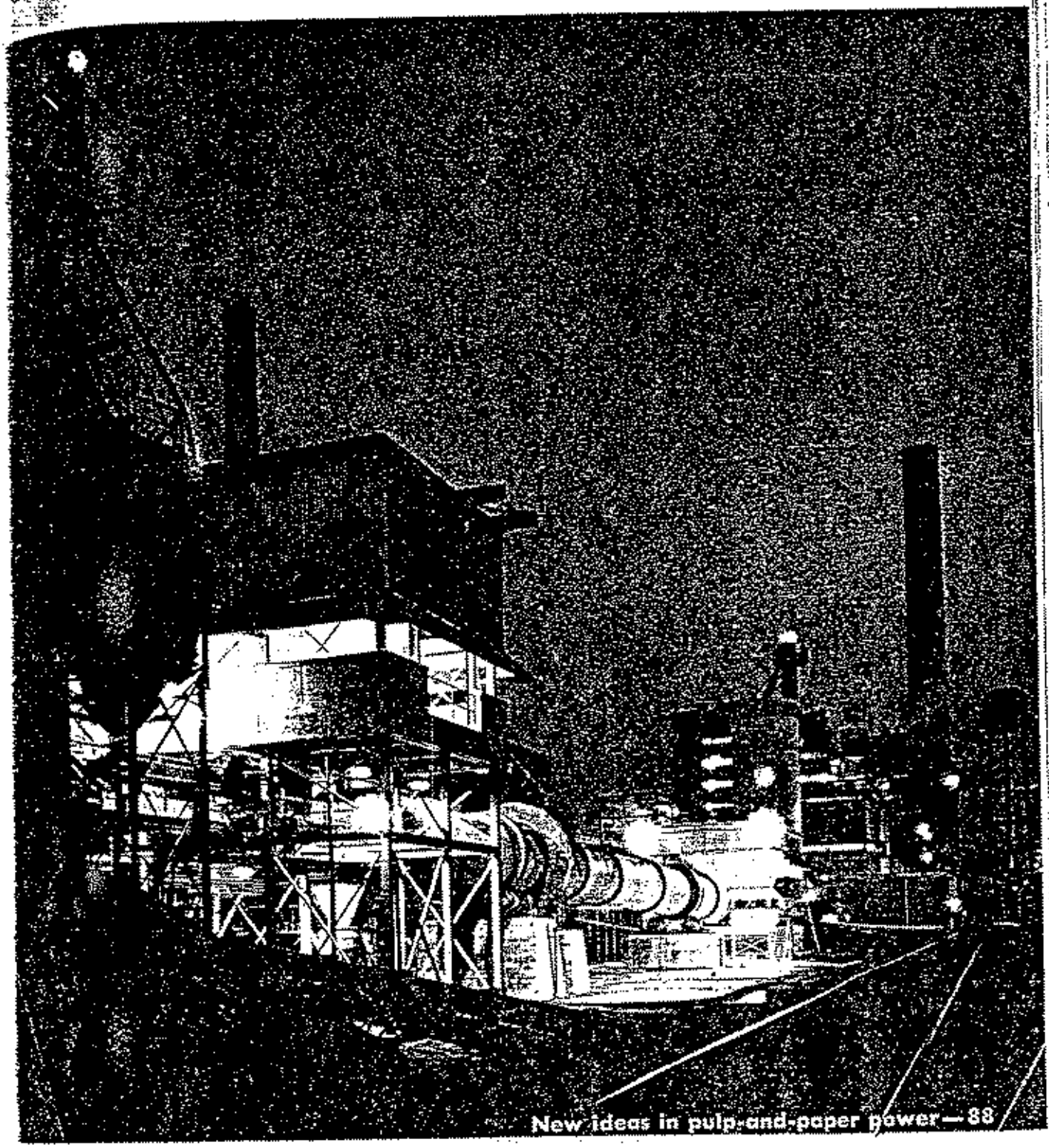
...ION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

BOILER INSURANCE · 83
HIGH-PRESSURE HOT WATER · 94
MAINTENANCE TIPS · 115

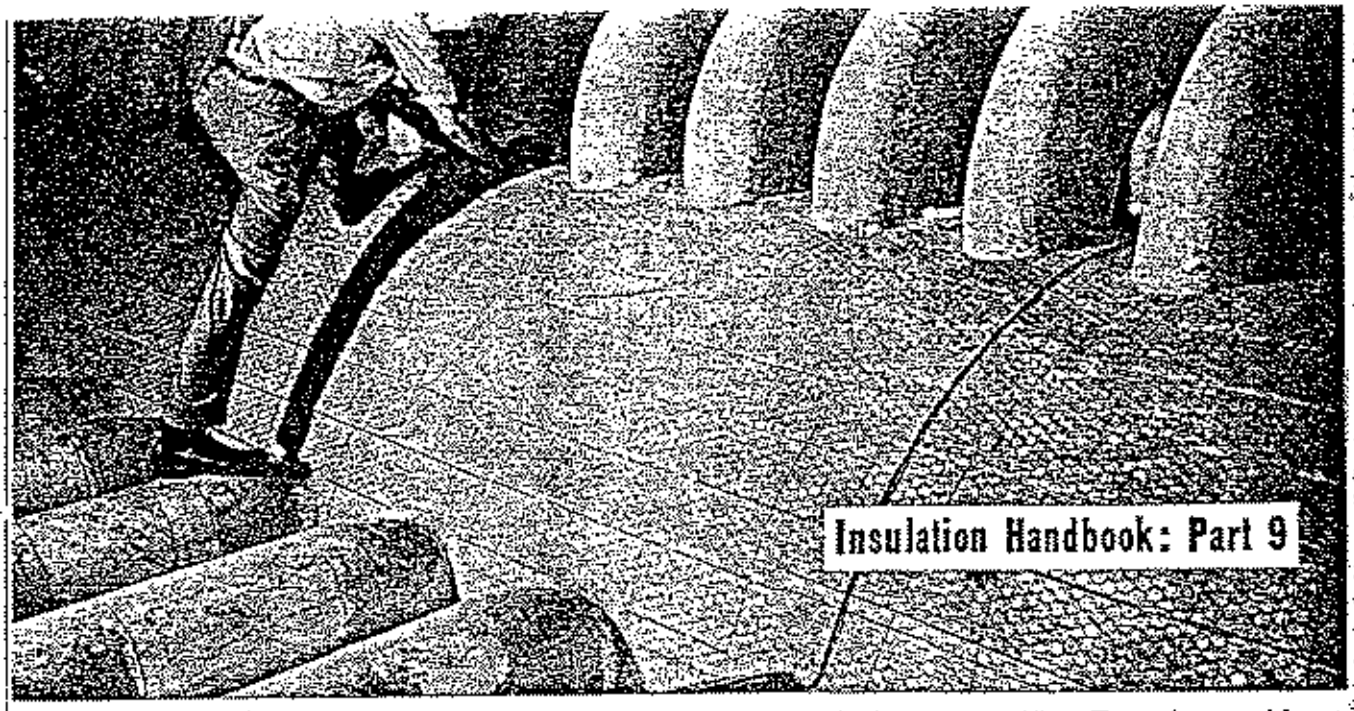
power

May
1952 · 50¢

A McGRAW-HILL PUBLICATION



New ideas in pulp-and-paper power—88



Insulation Handbook: Part 9

INSPECTOR looks over calcium silicate insulation on large steam drum. Structural strength of this insulation permits moderate loads without crumbling. The workmen and inspectors walk on covered parts, don't worry about damaging them

Insulation Roundup: A Quick Look Into the Future

The first eight parts of this handbook covered many insulations used today. Now we wind up with condensed facts that predict future trends

By PHIL SWAIN, *Editor*

► TODAY YOU NO LONGER ASK yourself, Is there an insulation for my job? Instead, the question is, What's the best insulation for it? That's because there are modern insulations for every temperature range in power and industrial work.

Insulation Choice. Let's say you have a 500-F pipe to insulate. Job specs permit you to use 85% magnesia, amosite asbestos, cellular glass, calcium silicate, or an equal. Since prices and efficiencies don't differ widely for materials usable at this temperature, other factors will influence your choice.

Installation cost, maintenance, dimensional stability, strength and weight are a few you must consider. So you'll find, for an industrial plant where dust is a nuisance in production areas, an insulation that doesn't flake or disintegrate is best. To get this property it may be worthwhile to sacrifice a few points in efficiency or pay a slightly higher price.

In other words, don't buy insulation on the basis of one property. Consider all properties in terms of your job.

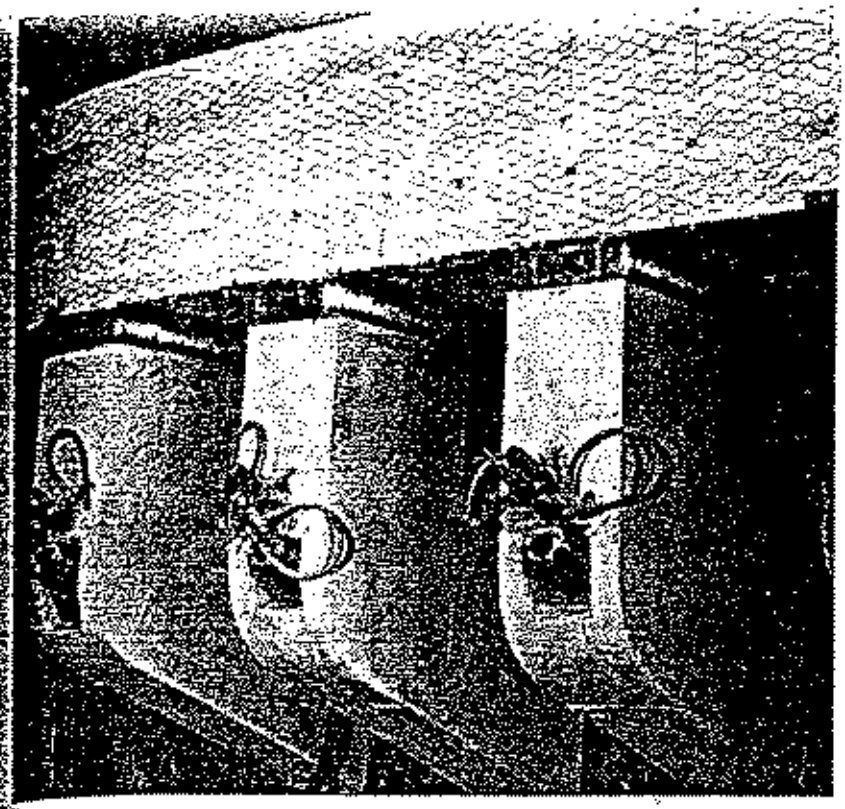
Higher Temperatures. Steam- and industrial-plant temperatures have been on the rise for years. We expect this trend to continue, with the rise in industrial power and process units accounting for much high-temperature piping.

You'll see more high-temperature insulation in industrial plants. It may be calcium silicate, diatomaceous silica, cellular glass or dual layers of other insulation with an inner high-temperature layer and an outer low-temperature layer. Then, thick mineral-wool blankets or other insulation may be used. Up to 700 F, asbestos-sponge-felt insulations will get greater play.

With higher process temperatures you'll need more small-tubing insulation. Tapes and seamless felted and braided insulations protect operators from burns, save heat.

Castables. For boiler and industrial furnaces more castable and plastic in- [illegible] the field.

PLAINTIFF'S EXHIBIT CCS 15

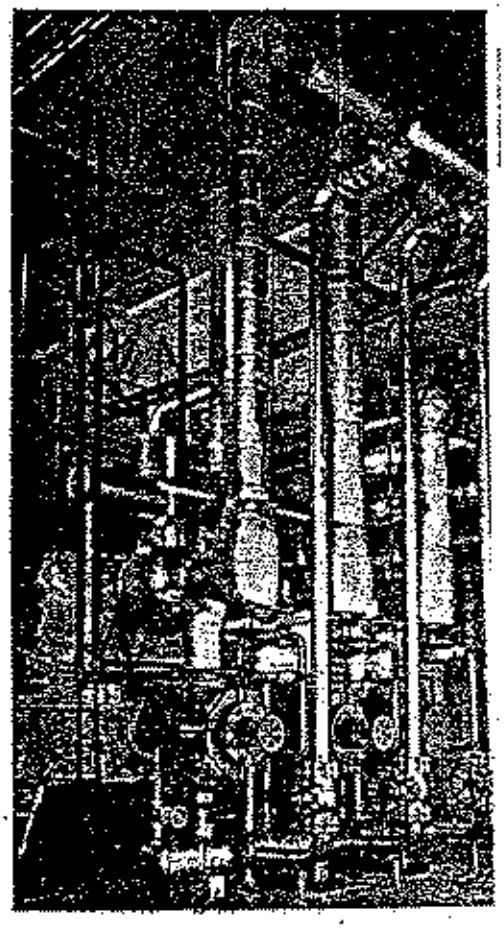


HOT-AIR DROPS to boiler low-load burner boxes are insulated with 1 in. high-temp and 2½ in. regular 85% magnesia finished with asbestos cement. Mesh on duct



CELLULAR-GLASS duct insulation, vapor-seal type, stops sweating of cool ducts

CORK for refrigeration pipes does fine job, makes a neat-looking installation



These, we believe, will gradually supplant preformed and prefabricated insulations on certain jobs.

Talking about castables, here's a kink that isn't new in oil refineries but some power engineers seem to have overlooked it. It is use of castable insulations in large-diameter pipes and vessels. Castable is applied in interior where it does a good job of protecting metal against high temperature and cutting heat loss. Castable insulations are also good for ducts carrying heated air or gas.

Simplified Dimensions. As material and labor costs rise, insulation manufacturers do their best to hold prices down. One way of keeping over-all cost down is to simplify installation so job is easier and fewer men can do it. Simplified dimensions are one answer.

Precision-made, nested insulation fits standard pipe sizes snugly, permits adding more layers at lower cost. Original layer isn't removed to install the second. This idea is bound to catch on with more manufacturers. Some day soon you'll find you're stocking fewer sizes of your favorite insulation because you don't need as many to do the same job when material can be nested.

Old Reliables. What about these? Are 85% magnesia, mineral wool, and other well-known insulations doomed, bound to die a quick death in a high-temperature industrial world? Answer is an emphatic no.

The better-known insulations have proven their worth over the years. In suitable temperature ranges they will continue to save heat. This means fewer of your operating dollars will be used for worthless heating of atmospheric air.

And the old reliables will improve. If not in efficiency, then in application and finishing methods. The heat-insulation field has never been static; research and testing labs are more active today than ever.

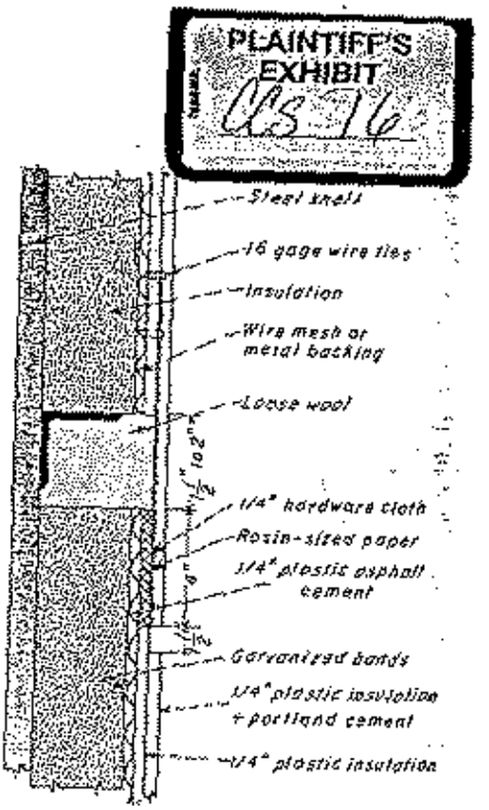
Reflective Insulations. Educational program for introduction of this type is about at an end. As recognition of this insulation grows it will find wider use. Research is now under way on multiple-layer aluminum foil for temperatures down to −70 F. If you're a refrigerating engineer, keep an eye on this material; it may save dollars for you in new and old plants.

Cold Jobs. Cork, mineral wool, cellular glass, hair felt and others are a few of the insulations that will continue strong for low-temperature work. Keep up with developments in application; that's where you'll be able to save most.

Lastly, keep up your study of all insulations. POWER will publish all the latest data; read them and you'll learn best ways to keep heat in its place.



STEAM MAINS being covered with high-temperature insulation



EXPANSION JOINT on a hot breeching or duct. Space between sections is packed with fibrous insulation

Double-layer high-temperature insulation means less maintenance, comfortable working temperatures and no fire hazard. Here's...

By MARSHALL F ALLEN, *Manager*
The Magnesia Insulation Manufacturers Assn

What you should know about

► STEAM PRESSURES and temperatures are rising constantly in order to produce more economical steam-generation equipment. Because of this, more plant engineers are coming to grips with high-temperature insulation problems.

Temperature limits. Insulation development has more than kept pace with increased temperature. Limits recommended by *MIMA for normal service* are:

Material	*Temperature limit*
85% magnesia	up to 600 F
Calcium silicate	up to 1200 F
Expanded silica	up to 1600 F
Diatomaceous silica	*1600 to 1900 F*

But selecting insulation by heat tolerance alone oversimplifies the problem. No one insulation is best for all applications. *Conductivity as a factor,* structural strength, resistance to mechanical damage, water resistance, compressibility, ease of application and workability must all be considered for each job.

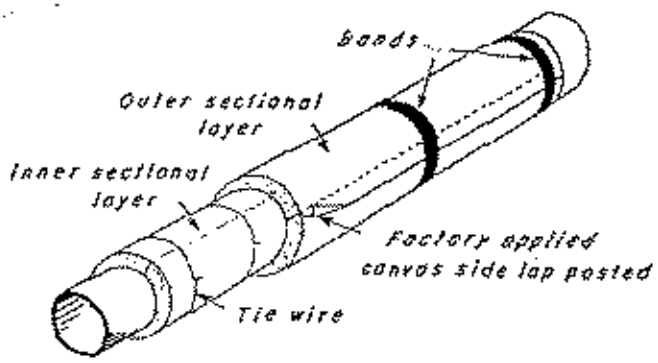
Thermal expansion. One byproduct of high-operating temperature is expansion of equipment and piping. This problem will be with us until someone *develops a metal that does not expand* at high temperatures.

Insulation problem is generally solved by using double-layer construction with staggered joints. Illustration, p 115. Through-joint openings from metal to air are eliminated, since joint separations occur in one layer only.

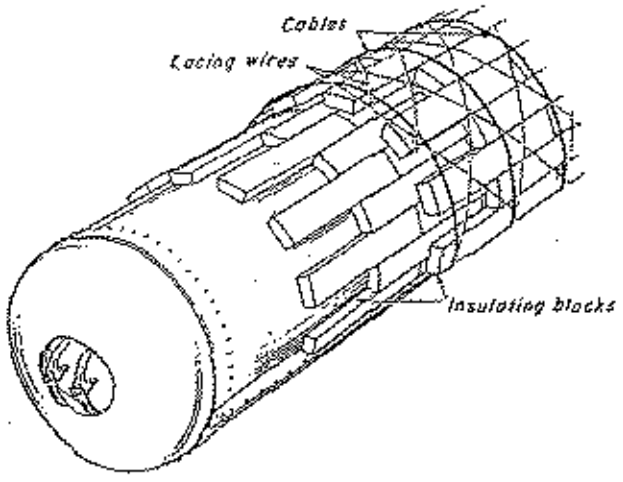
Typical combination is diatomaceous silica and 85% magnesia insulation. Diatomaceous silica is applied to the hot metal in a thickness calculated to reduce outer-surface temperature below *600 F. Then 85% magnesia* is applied in thicknesses needed to reduce heat loss to economical level. High heat resistance of diatomaceous silica and low conductivity of 85% magnesia combine to give an excellent *insulation.*

One vs two layers. Some engineers feel that two-layer insulation is *unnecessary with materials* like calcium silicate and expanded silica. Both insulations combine high heat resistance and low conductivity in a single layer. In addition, installation cost is lower.

But *single-layer construction* does not allow for thermal expansion of equipment and piping. In every *100 ft* of steel piping at 320 F there is about 8 in. of expansion bare metal between insulation joints. Multiply *that* by the many hundreds of feet of pipe in the



DOUBLE-LAYER sectional pipe insulation showing staggered joint construction to allow for thermal expansion of the pipe



CYLINDRICAL SURFACE of steam drum using double-layer insulation. Blocks are held by wire laced to anchored cable

h-t insulation

verage plant and you begin to realize hat a lot of heat is wasted.

Insulation jackets or other finishes re scorched and damaged at open oints calling for constant maintenance. Exposed hot pipe is a considerable fire hazard, particularly in plants handling lammable materials. In many cases, orking temperature is raised to an ncomfortable level.

Expansion joints, like the one on page 114, can solve some of these thermal xpansion problems. But the great num*er of joints needed for most piping* are xpensive to install and maintain. Best olution is double-layer construction herever there is appreciable thermal xpansion of piping and *equipment.*

Expansion joints are more often eeded at elevated temperatures on long uns of ducts or breeching and large pressure vessels. General practice is to leave an inch or two between every second or third insulation *block* or section for thermal expansion. This space is packed with fibrous insulation and covered by a sliding collar or shield.

Standard thickness is a holdover from the past that continues to plague engineers. It implies that there is a standard thickness for a given size of pipe. Use of this term was common before the days of the superheater when steam was only saturated. Avoid use of specifications that call for standard or double standard thicknesses. Aside from the fact that they are probably inadequate, they no longer exist.

Simplified thickness. MIMA has adopted new thickness schedules that list four insulation types by nominal half inches for ease of reference. For example, 2½-in. nominal thickness insulation on a 1-in. pipe is 2 21/32-in. thick. Actual thickness is used only for critical engineering calculations.

One advantage is that outside diameter of pipe insulation is then about the same as outside diameter of iron pipe sizes. It can be applied directly to pipe or as a second layer on smaller size insulation.

Another advantage is simplified in*ventory records for the plant engineer* who has to keep a stock of insulation for maintenance. Odd fractional-inch sizes do not have to be stocked.

Outdoor plants. Number of outdoor applications is increasing. Plastic asphaltic compounds with 1-in. wire mesh reinforcement and binder give good protection on smooth insulation surfaces. Flashing is needed to prevent seepage at conical tips of vessels and similar points. Good insulation will withstand repeated wetting and drying. But wet insulation will not effectively prevent heat loss.

Aluminum jackets give good protection and improve plant appearance. But corrosion inside the jacket presents a problem. One theory is that alkaline nature of most insulation has a catalytic effect on the aluminum. Another attributes corrosion to the use of scrap aluminum in producing sheet and/or improper alloy composition.

Extensive tests by both insulation and aluminum manufacturers prove that corrosion is generally independent of insulation type and aluminum quality. All you need is moisture. Since it is almost impossible to keep all moisture out of the jacket, the inner surface must be given a protective coating.

What's ahead? Insulation is available to handle most of today's industrial *temperatures. But the trend to higher* temperatures in nuclear and critical-pressure power plants spotlights the need for continued research. Since organic materials or binders *cannot be* used as basic ingredients, research is presently confined to known inorganic substances. Much has already been learned about basic theory of heat flow in insulation and basic materials are constantly examined for their effectiveness in formulating new insulations. Most of this research is based on the fact that the most effective material for barring heat passage is one with countless millions of microscopic air spaces. Efforts are directed at developing products with greater heat resistance, lower conductivity and greater durability.