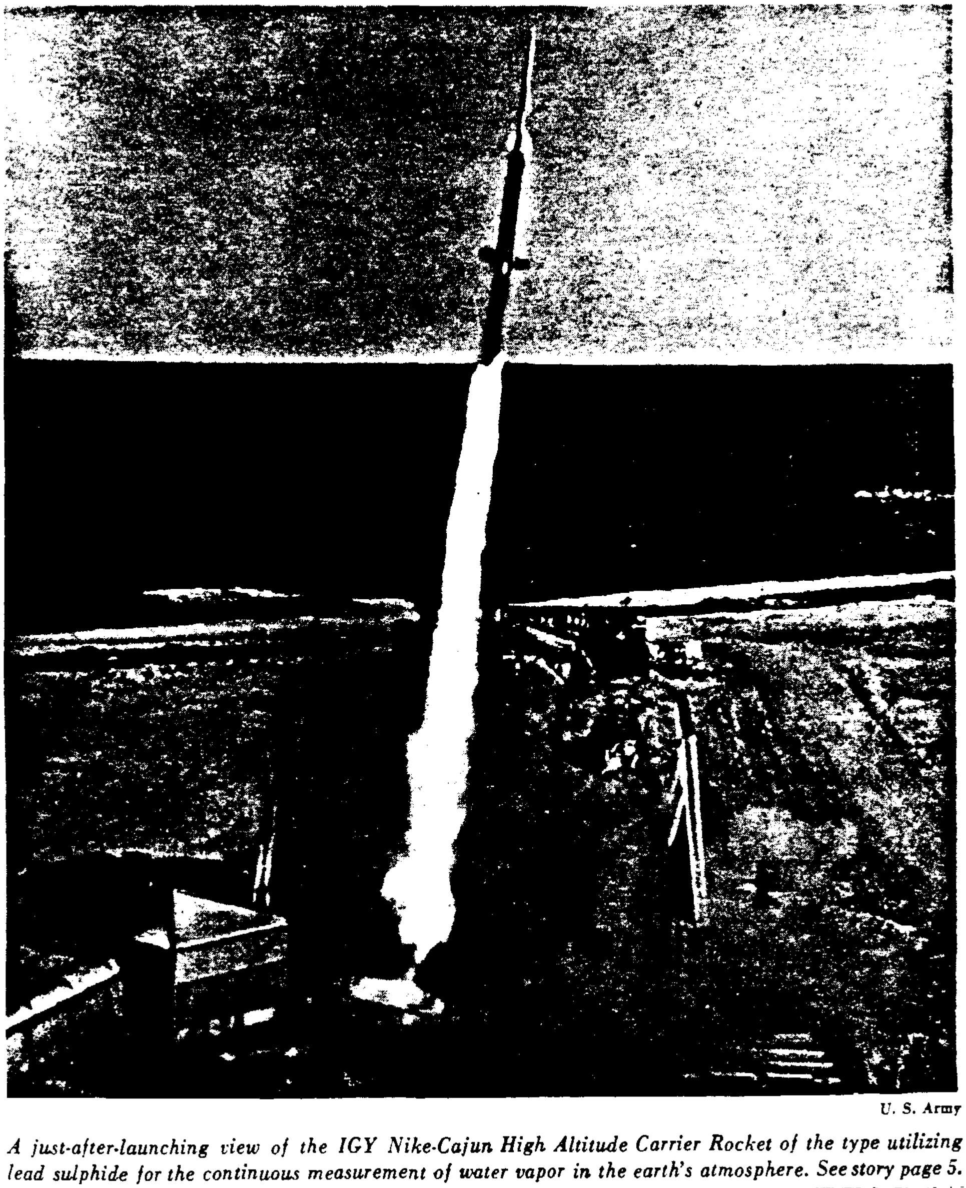
Lead

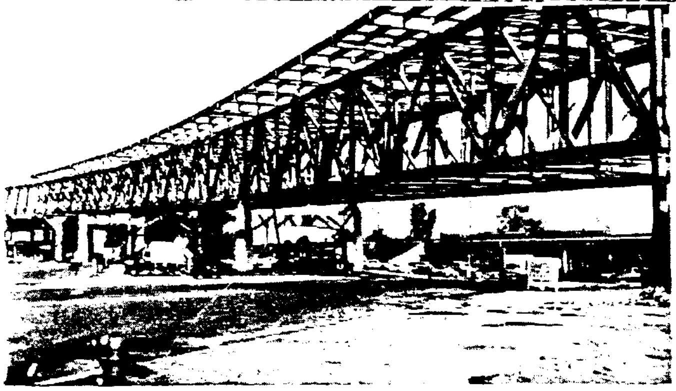
VOLUME TWENTY-TWO 1958 NUMBER ONE



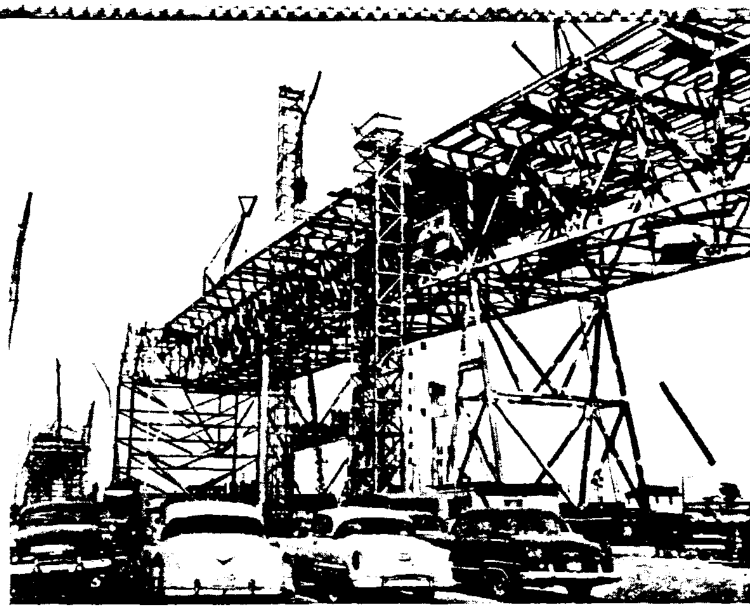
U. S. Army

A just-after-launching view of the IGY Nike-Cajun High Altitude Carrier Rocket of the type utilizing lead sulphide for the continuous measurement of water vapor in the earth's atmosphere. See story page 5.

INDUSTRIES ASSOCIATION
2nd STREET, NEW YORK 17, N.



A part of the 4 miles of red lead primed structural steel used on the Calumet Skyway.



The approaches, shown here under construction, to the three-span cantilever-type Calumet Skyway Toll Bridge will rise 125 ft. over the Calumet River.

The Calumet Skyway

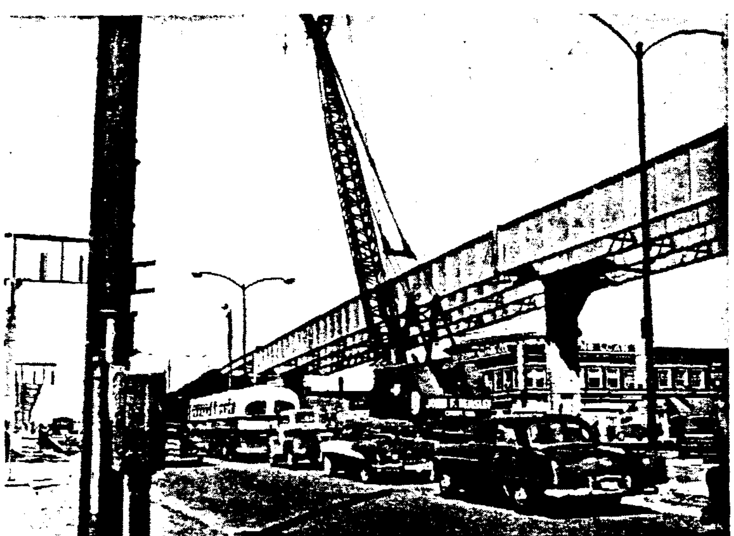
THE Calumet Skyway, the final link in the tollway stretching from New England and New York to Chicago, will, when completed, carry traffic from the connection with the Indiana Toll Road toward the heart of the city. When opened some time this spring, motorists will be able to travel from many of the major cities on the East Coast to Chicago, a distance that will average around 1,000 miles on safe and comfortable super highways.

The project, officially called the Calumet Skyway Toll Bridge, will be seven and three-quarter miles long. From the connection with the Indiana Toll Road, the Skyway will rise toward the high-level, three-span cantilever bridge over the Calumet River, the main span of which will be 650 ft. and adjacent spans 325 ft. A vertical clearance of 125 ft. is provided over the river. The descent from the bridge will be made on steel structure, then onto embankments which will be continued except for structural steel overpasses and main ramp connections throughout the rest of the Skyway.

Almost 4 miles of the Skyway will be on structural steel that has all received a prime coat of red lead paint to protect it from the ravages of weather and the industrial atmospheres inherent in any large city. The red lead paint formulation used in the Skyway's steel was in accordance with Specification M-72, Type I of the American Association of State Highway Officials, with the exception that ⅓ to ½ boiled linseed oil, the balance raw oil be substituted for the raw linseed oil in the vehicle.

This major engineering project was constructed under the supervision of the Bureau of Engineering, Department of Public Works, city of Chicago, Dick Van Gorp, Chief Engineer and George DeMent, Commissioner. DeLeuw, Cather & Company, Chicago, Ill., are the consulting engineers responsible for the design and construction of the entire Skyway. Administration engineers for the city's Department of Public Works are John G. Duba and A. L. Tholin.

The completion of this final link of super highway from the East Coast to Chicago also completes the link of red lead primed steel throughout this entire toll highway system. No matter what the environment, sea coast, rural or urban, the structural steel for those roads in the states of New York, New Jersey, Pennsylvania, Ohio, Indiana and on into the city of Chicago received a prime coat of rust-inhibitive red lead paints.



The red lead primed steelwork for the main ramp connection from the "Skyway" to Stony Island Ave.

Standard Specification for

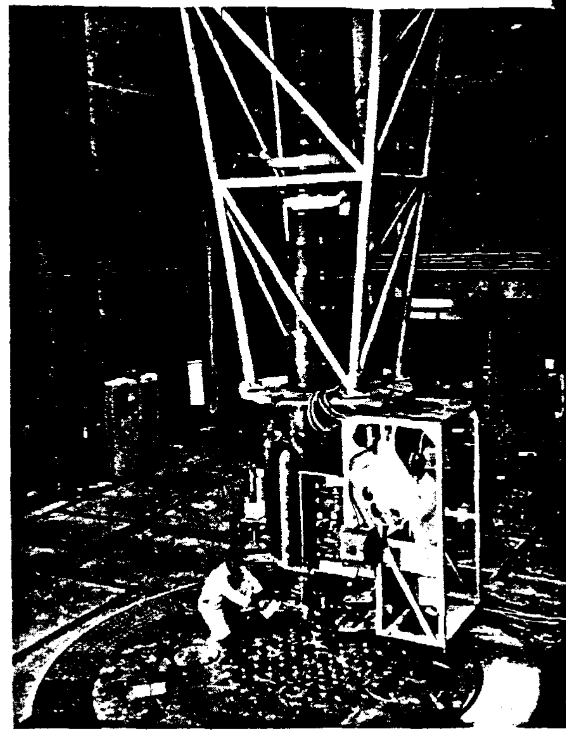
RED LEAD READY-MIXED PAINT

AASHO Designation M72-51, Type I

	Per Cent by Weight	
Pigment	*Min.*	*Max.*
Red Lead (97% Pb_3O_4)	99.6	—
Aluminum stearate	0.3	0.4
	100.0	
Vehicle		
Raw linseed oil	90.0	—
Volatile thinner and drier	—	10.0
	100.0	
Pigment (per cent by weight)	77-80	
Vehicle (per cent by weight)	20-23	
Weight per gallon (pounds)	24.5	
Drying time: (hours)		
Set to touch	6	
Dry through	36	

LIA26133

Lead's Use In Commercialized Atomic Power



A huge, lead-shielded chamber for loading and unloading uranium fuel for Southern California Edison's sodium reactor hovers over the "core" sunk deep beneath the ground.

As a typical instance of the extent of one company's utilization of lead shielding in commercialized atomic power, two specific yet in most part technically unrelated applications may be cited—Southern California Edison Company's Sodium Reactor Experiment (SRE) and a low-priced miniaturized laboratory reactor — both designed by Atomics International, a division of North American Aviation, Inc.

The SRE, located in the Santa Susana Mountains about 30 miles northwest of Los Angeles, was designed and built for the Atomic Energy Commission by Atomics International as a part of the Commission's program to develop economically competitive civilian power from nuclear energy. It can be noted that lead shielding played no minor part in the experiment, which marks the first time a non-military atomic energy reactor has produced power for the generation of electricity by a private utility company. Now operating at full power, the reactor is designed to produce 20,000 kw. of heat from which the Edison equipment will generate approximately 6,500 kw. of electricity.

The significance of lead may be laid to the need for safe mobile means for loading uranium fuel into the reactor and removal of any hot elements penetrating into the reactor core and transporting them to cleaning, storage, or hot cell facilities located in the reactor building. The accompanying photograph shows this conveyor, a huge, lead-shielded chamber hovering over the "core" of the reactor preparatory to removing a hot gamma-active component.

From mobile gamma shielding, the more usual use for lead in commercialized or military atomic power, Atomic International engineers drifted to the unusual properties of lead as a reflector shield in a small 5-watt laboratory reactor. The reactor, designed for schools, medical and industrial laboratories, has as a unique feature a 6-in. thick lead neutron reflector-primary shield weighing approximately 3,800 lbs., which surrounds the core vessel containing aqueous uranyl sulphate, homogeneous fuel suspension. It is purportedly the first reactor to employ lead as the only reflector material.

The advantages that result from the selection of lead for this purpose are:

1. When the secondary shield water tank is drained, access to the interior of the tank is permitted, since the lead acts as an effective shield against residual gamma radiation from the core. This feature allows ready modification of the experimental facilities and the installation of new beam tubes or special exposure experiments in the water shield region. The number of beam tubes can be easily doubled at little expense if the number of laboratory groups wishing to utilize the reactor simultaneously proves too large for the normal complement of facilities.

2. The lead acts as an essentially infinite reflector. This means that experimental apparatus installed at or near the reflector surface will not perturb the neutron balance in the core itself and no hazard is presented by movement of equipment during operation in the vicinity of the reflector surface.

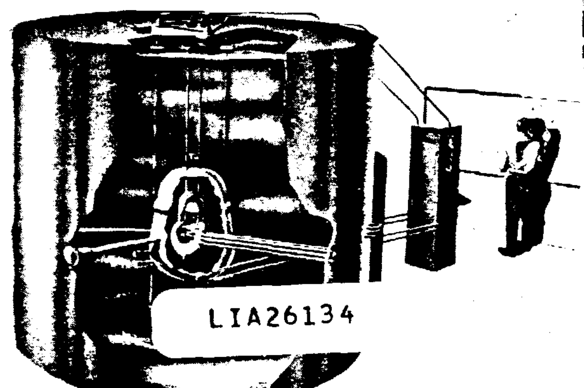
3. Pressure resistance of the core vessel against sudden surges arising from any source is greatly increased. The lead is cast around the core vessel in one operation and is actually bonded to the core during the casting.

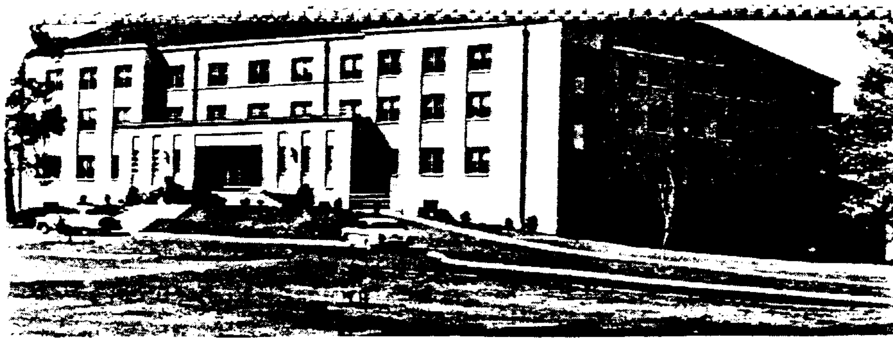
Information on other ramifications of the design may be had by referring to "Educational Uses of the Small 5-Watt Laboratory Reactor," by John W. Flora, Reactor Kinetics, Atomics International, Paper No. 57—NESC-73, 2nd Nuclear Engineering and Science Conference, March 11-14, 1957, Philadelphia, Pa., published by the American Society of Mechanical Engineers.

All in all, where mobility is important, lead for shielding purposes offers the best over-all combination of design properties as its use in core loading-unloading and compact "shippable" research reactors testifies.

Operation of this miniaturized atomic energy research reactor, only 8 ft. high and 8 ft. in diam., is underway at Atomics International.

At right, a cutaway of the miniaturized reactor showing the 3,800 lb. pear-shaped lead reflector shield.





The new Gilbert-Addoms dormitory at Duke University has gutters lined with the new 3-lb. hard sheet lead.

The new dormitory, in the foreground, blends well with the older buildings on the beautiful Duke University's campus.

Hard Sheet Lead Used For Gutters Of New Duke University Dormitory

THE blending of the new with the old, architecturally speaking, was the problem found and successfully overcome by architects, Six Associates, Inc., Asheville, N. C., in the design of a new women's dormitory on the campus of Duke University, Durham, N. C.

In doing so, the architects have utilized every possible concept of modern construction design, materials and methods, within cost limits, of course, while maintaining, as the accompanying photographs illustrate, an outer facade that blends well with the neighboring structures.

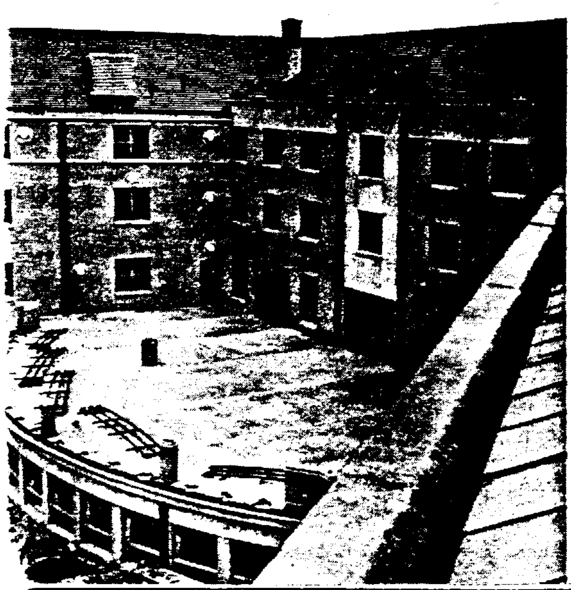
This latest addition to the beautiful Duke University campus, the Gilbert-Addoms Dormitory, will house 200 coeds with dining facilities for 350. Cooling and ventilation of this 770,000 cubic feet structure is accomplished by six large fans located within lead-coated copper sheathed dormers on the back slope of the roof.

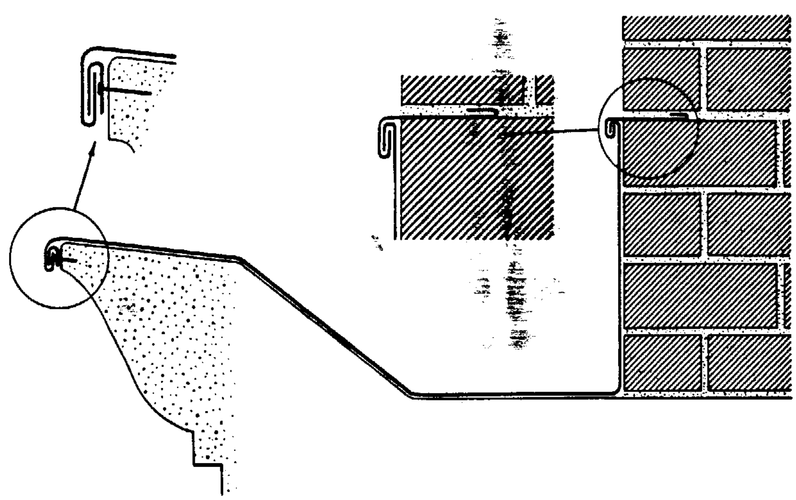
Among the newer materials used was 3-lb. hard sheet lead for lining the more than 600 linear feet of limestone gutters. Hard sheet lead, a development of modern metallurgy, is made from an alloy of lead with between 6 and 7.5 per cent antimony that is stronger than soft lead and as a result may be used in thinner, lighter sheets while retaining the well-known resistance of lead to corrosion. The non-staining properties of lead are also maintained.

The Pickard Roofing Co. Inc., Durham, N. C., installed the 3-lb. hard sheet lead gutter linings that varied in width from 3 to 7 ft. The lead sheets were formed on the ground and hoisted to position. As shown in the accompanying detailed drawing, a copper cleat anchors the lead on the limestone fascia and a continuous hard lead strip embedded in the brick mortar loose-locks with the vertical section of the gutter lining. Loose-locked cross-seams, made in the direction of flow, are filled with non-hardening compound and are provided at not more than 8 ft. intervals.

More than 2,400 sq. ft. of 3-lb. hard

The 3-lb. hard sheet lead-lined-limestone gutters on the reverse roof slope of Duke University's new dormitory are shown below, along with detail showing method of installation. The dormers shown are sheathed with lead-coated copper.

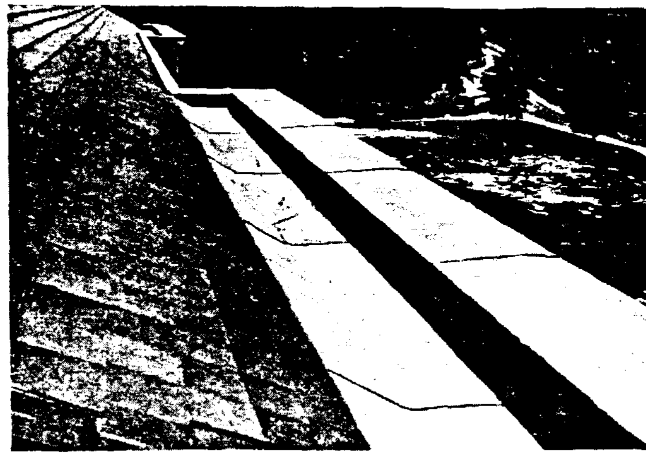




lead was required for the entire gutter lining and, according to the roofer, the cost of installation was competitive with other high quality materials.

For more specific information on the details of installing the new hard sheet lead for roofing, flashing or gutter linings, refer to the 1958 Sweet's Catalogs, Architectural File 8b/Le, the Light Construction File 2a/Le, or write directly to the Lead Industries Association.

The exceptionally wide gutters on the forward roof slope of Duke University's new dormitory are also lined with the new 3-lb. hard sheet lead.



Lead Compound Semiconductors

LATEST developments in the uses of lead compounds lend emphasis to their unusual capabilities. Some of these developments are completely unheralded and extremely provocative and indicate that only the imagination limits the extent to which they can be employed.

For example, the essential material or component in a system developed for the U. S. Army's Nike-Cajun Rocket is lead sulphide, which is being used to obtain data on naturally-occurring water vapor in the earth's gaseous envelope, an International Geophysical Year experiment (IGY). The Nike-Cajun nose cone contains the components and electronic instrumentation required for exact continuous measurement of water vapor present at various altitudes in the course of the missile's flight — upwards of 100 km. at its summit. The function of lead sulphide as a device for measuring water vapor content depends on its ability to control electrical energy under the influence of radiation. By using the sun as a radiation source, water vapor acts to reduce its intensity at varying altitudes to varying degrees, depending on its content and accordingly induces varying proportionate outputs from the lead sulphide photoelectric cell. The resulting output, so to speak, is monitored at a control station on the ground for the information contained. Actual tests or shoots are slated to begin in a few months at the Missile Center, White Sands Proving Grounds, New Mexico, and will be an important addition to the total make-up of the IGY investigative program.

Other down-to-earth uses for PbS would include subminiature photosensitive resistors, their over-all size being comparable to that of a crimped paper staple. Such components are available in complex and exact arrays and mosaics for a multitude of uses. Their signal to noise ratio is excellent, particularly in infrared, and vibration does not affect them.

Also, lead sulphide photoconductive cells, in combination with infrared lighting, form an integral part of a process for superimposing an optical-magnetic sound recording on motion picture film without affecting the optical track, a process gaining in versatility. To put it simply, magnetic strip passes infrared rays which are modulated by the optical track system utilizing PbS, a method which may foster multilingual films. The Army is already using this technique and CBS-News is switching from optical to magnetic sound tracks in 16-mm. news and documentary films.

However impressive, PbS does not eclipse other lead compounds which are slated for use in electronic refrigeration and power generation. It may be that future household refrigerators will depend on lead telluride's ability to cool under the influence of voltage change. The Russians have already developed a small radio based on lead telluride, powered by a kerosene lamp; this is converse to electronic cooling or the production of electrical energy as a function of temperature change.

All this indicates then that lead compounds are remarkably able to keep pace with changing technology and are very much the subject of continued scientific attention.

LEAD COMPOUND SEMICONDUCTORS AND THEIR APPLICATIONS

		Bond Separation ev. (T = 300° K)	Mobility (T = 300° K) cm^2/volt-sec: electrons	Mobility (T = 300° K) cm^2/volt-sec: holes	Melting Point, °C	Application
PbTe		0.3	2,000	1,100	920	Infrared Detectors; Thermoelectric Refrigeration and Power
PbSe		0.26	1,200	600	1,080	Infrared Detectors; Thermoelectric Refrigeration and Power
PbS		0.4	800	400	120	Infrared Detectors; Thermoelectric Refrigeration and Power
Bi_2Te_3	s	0.16	> 570	> 400	580	Thermoelectric Refrigeration and Power
ZnSb		—	—	—	563	Thermoelectric Refrigeration and Power
CdSb		0.5	—	> 400	456	Thermoelectric Refrigeration and Power
$Ag_2(Se, S)$	s	—	—	—	~ 860	Thermoelectric Refrigeration and Power
CuAgTe	s	—	—	—	~ 925	Thermoelectric Refrigeration and Power

> Minimum value ~ Approximately

LIA 26136

Lead Additions Improve Steel's Machinability

LEAD added to steel in minute quantities, 0.15 to 0.35 per cent, has materially increased steel's machinability while at the same time providing longer tool life — two significant advantages that have resulted in major economies wherever leaded steels have been used. These advantages are imparted to steel without materially affecting its mechanical (see Table I) or heat treating properties. An example of the economy that can be effected with leaded steel when used for a pump rotor is indicated in the accompanying illustration.

The capabilities of the steel in service are not materially affected, inasmuch as the leaded steels can be forged, machined and brazed in exactly the same manner as non-leaded steels and can be plated without any apparent effect on the bath composition. Leaded steels also have significant advantages in deep hole drilling, making possible depths never before possible.

The lead is added to the steel in the form of spherical shot, 1/32 in. in diameter, and literally sprayed into the steel by a gun under air pressure when the ingot is teemed. The lead does not alloy with the steel nor is it converted to a lead compound. It actually remains segregated in submicroscopic size and is uniformly distributed throughout the cross section. It is this even distribution that actually permits the lead to serve as a built-in lubricant, reducing friction between the tool face and chip, thus providing freer machining with increased tool life.

Table I
MECHANICAL PROPERTIES*
(Hot rolled, cold drawn A.I.S.I. 8620, 2⅝" round)

Property Tested	*Leaded*	*Non-Leaded*
Yield strength PSI	88,500	93,500
Ult. strength PSI	93,500	95,500
% Reduction of area	54.7	56.0
% Elongation in 2 in.	14.0	14.5
Brinell hardness	197	207
Izod impact—Ft.-Lb.	12	9
Grain size	7–8	7–8

* Source: Copperweld Steel Company

Table II
CONSTANT PRESSURE MACHINABILITY RATINGS FOR LEADED AND NON-LEADED STEEL CASTINGS*
(Leaded castings contain 0.18 per cent lead)

Sample	*Treatment*	*BHN*	*Average Machinability Rating*
1 PN	Non-leaded, normalized	163	81
1 LN	Leaded, normalized	165	116
1 PQ	Non-leaded, Q & T	252	87
1 LQ	Leaded, Q & T	252	116

* Source: Crawford Steel Foundry Co.

A more recent development is the addition of lead to steel castings, which have exhibited important increases in machinability along with increased tool life. A considerable improvement in surface finish has also been realized.

The technique used in introducing the lead into cast steels differs somewhat from the wrought steel and the special procedures that have been developed provide the same even distribution of lead in the steel casting. The lead content is, however, lower than in the wrought steels, averaging between 0.12 and 0.20 per cent.

Table II lists the average machinability ratings of five tests made in cast leaded and non-leaded steels. In this test, 1/8 in. deep turning cuts were made on 3.8 in. diameter sections, using peripheral speed of 40 fpm. and a tool thrust of 147 lbs.

The normalized samples were heated for 1 hour at 1,650 deg. F. and cooled in still air. Quenched and tempered samples were heated for 1 hour at 1,600 deg. F., water quenched, tempered at 1,000 deg. F. for 2 hours and air-cooled.

For maximum machining economies, it is important that the leaded steel casting be free of surface sand and properly heat-treated to eliminate hard spots.

An excellent treatise "A Literature Survey on Leaded Steels, PB111917" has been published by the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C., and is available from them at $1.00 per copy.

Castings requiring a lot of machining, such as these for large cranes, are where the machinability of the leaded steels shows to advantage.

The Iron Age

Copperweld Steel Co.

In the manufacture of this pump rotor, the use of leaded steels increased tool life by one-third while at the same time affecting production savings. A comparison follows:

	A.I.S.I. 8620	LEADED 8620
Pieces produced before tools must be ground	1,200	1,600
Number of times tools can be ground	6	6
Total pieces produced per tool	7,200	9,600
Total cost per piece	$0.0075	$0.0056

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LEADED
8620

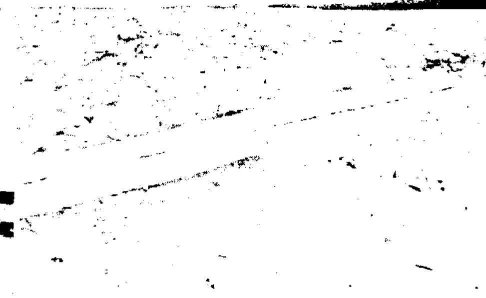
1,600

6

9,600
$0.0056

The extruded lead strip is gently hammered into the concrete joint until slightly above floor level.

The lead burner is adding additional lead in those areas where the lead strip did not completely fill the joint.



The completed lead-filled contraction joint. This type of joint filler is recommended for heavy-duty floors.

Lead As A Concrete Joint Filler Reduces Chipping

AT the newly-renovated Meter Division plant of the Westinghouse Electric Corp. in Newark, N. J., more than 1,200 ft. of extruded lead strips were embedded in the contraction joints of the concrete floors of the structure. These were placed in the joints in those areas where heavy industrial traffic is anticipated.

Lead as a concrete joint filler, such as used on this job, materially reduces the possibility of chipping in the joint area. It is particularly recommended as a joint filler for industrial or other heavy-duty concrete floors where trucking is severe, especially of the steel wheel type. In its "Concrete Information" bulletin on these type floors, the Portland Cement Association states that "The lead gives more support to the edge of the concrete than does mastic and thus reduces chipping."

In the Westinghouse job, the tooled joints in the concrete were made to accommodate $\frac{1}{4}$ in. thick by 1 in. in deep extruded lead strips, the depth of the tooled joint being slightly less than 1 in. to permit $\frac{1}{16}$ to $\frac{1}{8}$ in. of the lead to extend above the level of the concrete. This is then hammered down carefully to roughly the floor level. At those points in the contraction joint where irregularities occurred and the lead strip did not completely fill the joint, additional lead, by means of the lead burning technique, was added. O. G. Kelly Co. of Elizabeth, N. J., installed the extruded lead strips.

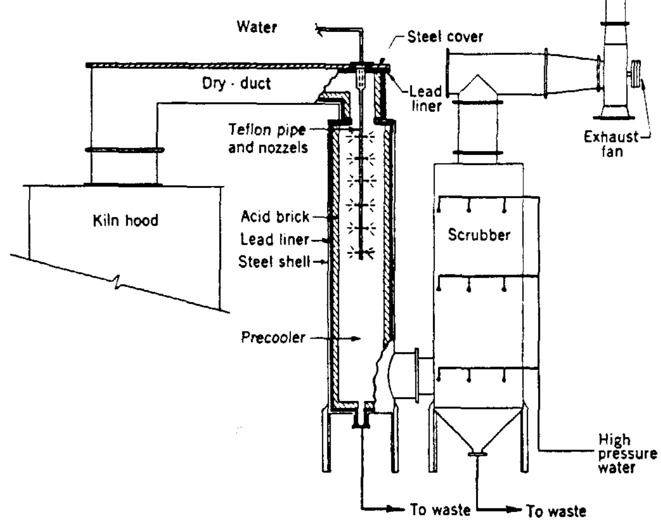
The advantages incurred in the use of extruded lead strips over the more conventional method of pouring molten lead into the joint are many. No great amount of heat is generated within the joint and, as a result, the possibilities of the concrete spalling during installation are avoided. Also, no special care is required to see that the joint is completely free of moisture before installing the lead strip.

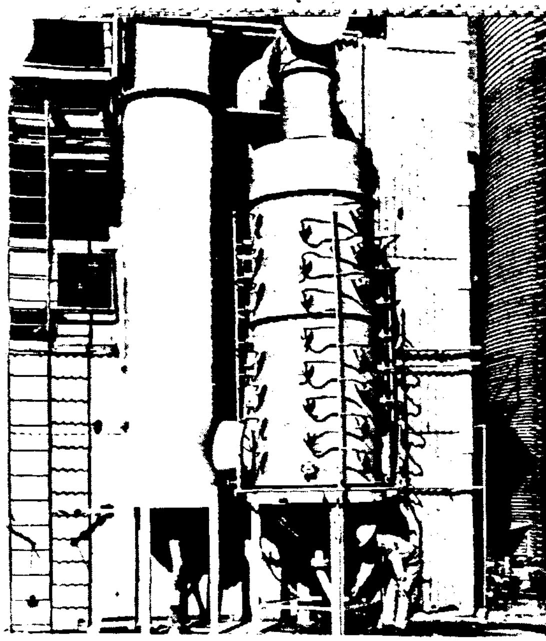
...ad-Acid-Brick Construction Solves Abrasion Problem

AN unique corrosion-abrasion problem was encountered by the Lithium Corporation of America at its new Bessemer City, N. C. plant, which was solved by the use of lead-acid-brick construction. This corrosion-abrasion problem occurred in a fog type scrubbing tower designed to wash exhaust fumes from a rotary kiln in which an ore-sulphuric acid mixture was to be roasted at temperatures in the vicinity of 500 deg. F.

Although corrosion resistant materials other than lead had been used in the original design, small quantities of abrasive dust were present in the exhaust fumes and the combination of the abrasive action of the dust with the high heat of the exhaust

ACID ROASTER SCRUBBING TOWER AND PRE-COOLER





The roaster gases enter the lead, acid-brick-lined chamber, at left in photograph, at 500 deg. F. where they are cooled prior to entering the scrubbing tower at right.

fumes caused premature corrosion failure of the equipment.

In the redesign, the scrubbing tower and exhaust stack were lined with neoprene. It was necessary, however, to precool the exhaust fumes before they entered the scrubbing tower to protect the neoprene lining. The precooling chamber, therefore, and the duct work from the kiln had to be constructed of materials that would stand up against the severe corrosion-abrasion attack and the 500 deg. F. temperature of the exhaust fumes. For this vital part of the installation, lead-acid-brick construction was chosen. The redesign included a simple precooling tower measuring approximately 4 ft. in diameter and 18 ft. high of mild steel lined with 1/8 in. thick sheet lead for resistance against corrosion and one course of acidproof brick to protect the lead against abrasion and to act as insulation against extremes of temperature. A square horizontal duct of steel, lead and brick lined in the same manner as the precooler, connected the kiln exhaust hood to the precooler. Since dust was expected to accumulate in the horizontal duct, brick was used only on the bottom and sides, leaving the topside easily removable and the duct accessible for cleaning. This removable duct cover was made of mild steel plate protected on the underside with sheet lead. The lead was held in place with steel bolts and washers which in themselves were protected with lead patches burned to the lead lining. Precooling was obtained by a water spray occurring in the top half of the chamber.

This installation has proved very successful. The only maintenance to the duct and precooler in over two years of operation has been one replacement of the lead on the duct cover, which was done last July. The original installation required almost constant maintenance. What was once a continuous headache has now become an almost forgotten problem.

THE *Lead* LIBRARY
of Technical Information

The following articles and reprints contain information, drawings and specifications on the use of lead products helpful to architects, engineers and others interested. They are available free of charge except where otherwise indicated, upon request to the LEAD INDUSTRIES ASSOCIATION, 60 EAST 42nd STREET, NEW YORK 17, N. Y.

MATERIALS OF CONSTRUCTION ANNUAL REVIEWS—LEAD AND LEAD ALLOYS
Lead and lead alloys in design and construction including research progress, engineering applications, and technological advancements. With bibliography. 1957 and 1956 reviews (editions are not cumulative) available. Reprinted from "Industrial and Engineering Chemistry," September, 1957 and September, 1956.

INSPECTING LEAD LININGS
Latest methods of testing and inspecting sheet lead and bonded lead linings used in the chemical process industries are described. Reprinted from "Chemical Engineering," November, 1956.

BEST DESIGNS FOR LEAD INSTALLATIONS
A special report on the applications of lead and lead alloys in the chemical and metallurgical industries. Recommended practice for joining lead sheets, and the construction of wood stave tanks, launders, towers and flues where lead is involved are included. Reprinted from "Chemical Engineering," March, April and May, 1956.

PORTABLE RADIATION-SHIELDING MATERIALS
A special report on commercially available shielding forms that can be used to build readily assembled, hand stacked shielding walls. Prepared by the editors of "Nucleonics," May, 1955.

LEAD IN MODERN INDUSTRY
$1.50 Postpaid
A fully illustrated, 230 page, cloth bound book describing all phases of the production and use of lead, lead alloys and lead compounds.

LEAD WORK FOR MODERN PLUMBING
$1.50 Postpaid, $1.00 per copy in quantities of 10 or more
Profusely illustrated with over 140 photographs and drawings, the textbook presents clearly to the plumbing student the necessary tools, procedures and the methods required for lead work.

LEAD BUILDING CONSTRUCTION BULLETINS
A series of specifications for the use of lead in building construction. (Available separately.)

BULLETIN NO. 1
Specification for Lead Waste Connections for Plumbing Fixtures with Integral Traps (Water Closets—Pedestal Urinals—Service Sinks).

BULLETIN NO. 2
Specifications for Lead Shower and Safe Pans.

BULLETIN NO. 3
Specification for Lead Chemical Laboratory Drainage Systems.

LEAD WELDING
An informative as well as practical guide to lead welding. Reprinted from the "Welding Handbook, Third Edition" published by the American Welding Society.

LEAD FLASHINGS IN MODERN CONSTRUCTION
Lead flashings as used in an ultramodern house in Randolph, Vt. Reprinted from "National Roofer," October, 1954.

SHEET LEAD WORK FOR THE SMALL HOME
A specification for the use of the new 2½ lb. hard sheet lead on small homes.

THE STORY OF LEAD — MATERIALS THE RAILROADS BUY (Parts 1 and 2)
Lead from mine to finished product with special reference to its uses by the railroads. Reprinted from "Railway Purchases and Stores," December, 1954 and February, 1955.

RADIATION PROTECTION
The place of lead in shielding against radiation in X-ray and atomic energy applications. Principles of lead shielding construction. Reprinted from "Lead In Modern Industry."

RED LEAD TECHNICAL LETTERS
A series of technical letters containing red lead paint formulations. (Available separately.)

Technical Letter No. 11 — Recommended Surface Preparation of Steel for Red Lead Paints.
Technical Letter No. 12—Painting Highway Structural Steel.

FEDERAL SPECIFICATION FOR PAINT: RED-LEAD-BASE, READY-MIXED TT-P-86a
Covers four types of red-lead-base paints including two fast drying formulations. Many intended applications listed.

NEW LITERATURE

LEAD SUPPLY AND DEMAND IN THE UNITED STATES
A short resume of lead supply and demand in the United States in 1957 and the outlook for 1958. Reprinted from "Engineering and Mining Journal", February, 1958.

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