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Heavy Sheet Lead Construction Applied to Dome of Pennsylvania State Capitol Building

LEAD has for centuries been the preferred roofing and flashing material for monumental buildings. Its permanence and freedom from discoloring or staining corrosion products make its use desirable on the structures which are intended to become both the physical and historical landmarks of government and faith. It is entirely in keeping therefore that lead has been selected as the covering material for extensive repair work which is now under way on the dome of the Pennsylvania State Capitol building at Harrisburg, Pennsylvania.

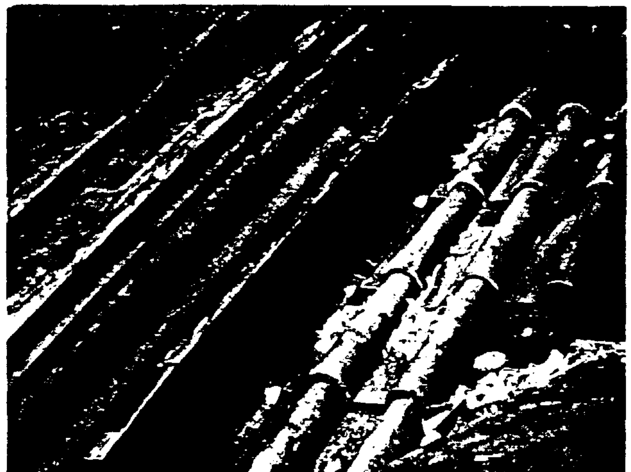
The structure of this dome is expressed on the exterior by sixteen heavy vertical ribs. As originally built these ribs and the lantern above were of terra cotta. After many years of exposure to severe climatic conditions this material showed signs of weakening so it became necessary to replace it or to substitute another more weather resistant material.

Mr. C. M. Woolworth, secretary and Mr. A. Judson Warlow, chief engineer of the Department of Properties and Supplies together with Mr. William Gehron, the architect chose the second alternative and selected lead as the most durable and permanent material available.

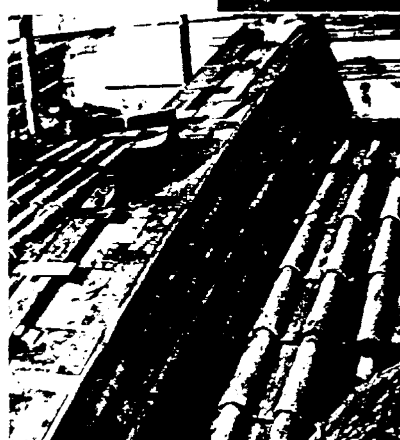
The application of the lead is typical of proper installation practice for sheet lead work. The material being used is soft lead sheet in weights of 6 and 8 lbs. per sq. ft. Since soft lead is relatively low in strength it is essential that the individual pieces be well secured at short intervals in a manner which will allow freedom for the natural thermal expansion and contraction. This is accomplished by providing a built up wood core for each rib to which the lead sheets, in relatively short pieces, are fastened by means of metal cleats.

The profile of the rib, designed for suitability to sheet lead construction, is slightly different from the original masonry rib. Each rib tapers from bottom to top and the mouldings member with a horizontal moulding around the base of the lantern. The lead is applied in courses of overlapping sheets along the ribs, each course lock seamed to the preceding lower course.

First course of lead applied to wood rib core showing cleats hooked over top flange, also cleats at bottom of overlap.



Moulded course in place showing bottom edge loose locked to first course, also cleats securing top edge.



Rake miter where rib joins base of lantern. Moulding on rib at left is bossed to right angle and lies along horizontal moulding under coped section. Loose locked seam in process at right center. See finished rib on front cover.

PHOTOS BY W. H. HINES

The first course of 6 lb. lead lies vertically against the side of the rib, turning out at the bottom over the adjacent tile. Each piece of sheet lead is 24 in. long and is fastened to the wood at the upper end only and secured at its top edge with metal cleats folded over a turned out flange. Each successive piece overlaps the preceding one 4 in. and the two are held against the wood at the bottom by another cleat at each overlap. The second course is a preformed ogee moulding of 8 lb. per sq. ft. sheet lead which is applied and secured at its top edge by cleats in the same manner as the first course and the two courses are joined by a lock seam lengthwise of the rib. The construction to this point is clearly shown in the photographs.

The manner of finishing the rib is shown in the drawing. The center pans are applied as before in 24 in. lengths, each one supported by a long cleat hooked into the turned back upper end of each pan. The sides of the pan are flanged in and held in place by the other end of the same cleat that holds the moulded section. Finally a cap course is applied, again in 24 in. lengths fastened at the upper ends as before and lock seamed over the flanges of the pan and moulding. The entire operation is identical on both sides of each rib.

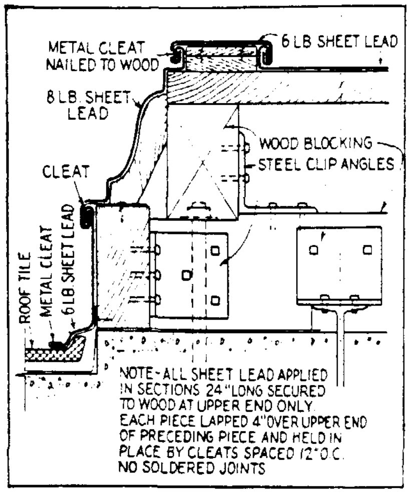
Of particular interest is the rake miter where the rib moulding joins the horizontal moulding at the base of the lantern. Here the malleable nature of the lead enabled the lead

Center pan of rib in place showing lap joint, hanging cleat and edge cleats not yet bend over edge.

moulding on the sloping rib to be dressed to a right angle to extend approximately 4 in. along the horizontal moulding. The preformed horizontal moulding was then coped to the miter forming a weatherproof lap joint.

In addition to the ribs and the lantern roof which will be described in our next issue there are two new coping-flashing courses of lead at the base of the dome. The lower one covers the existing cornice and extends back under a new cut stone moulding to form a thru wall flashing. It is of two courses loose locked together and the lower edge is hemmed back over a continuous cleat fastened to the stone. The upper coping covers the new stone moulding and extends back to form a flashing under the existing tile. The copings are also installed in short lengths and all transverse joints are loose locks.

Every consideration has been given



Detail cross section of rib showing method of securing sheet lead to structure with metal cleats.

to allowances for thermal expansion and to the weight-strength relation of the material. All portions of the lead in contact with masonry or concrete are coated with asphalt paint to protect it from free lime until the cement is thoroughly cured.

It is planned in our next issue to continue this discussion with descriptions and pictures of the lantern roof and the finished dome. We are indebted to the architect Mr. Gehron, the general contractor McClosky & Co. of Philadelphia, and the lead work contractor, the J. Edward Linck Sheet Metal Works, also of Philadelphia, for their cooperation and assistance in obtaining the above data and the photographs.

(To be continued)

Coping-flashing courses at base of dome showing longitudinal and transverse loose lock seams.

Lead Pipe Provides Dependability For Essential Water Services

THE photograph on page 4 shows the installation of a large water service pipe in the City of Yonkers, N. Y. It is in a 2-in. line and serves to illustrate the practicality of the new designations established under Federal Specification WW-P-325.

This specification issued Sept. 6, 1944, has adopted the terminology Class 50, Class 75 and Class 100 to designate the three standard weights of lead pressure pipe which have previously been called A, AA, and AAA in the eastern part of the country and S, XS, and XXS in the west. This new classification refers to the safe working pressures of 50 lb., 75 lb., and 100 lb. per sq. in. of the respective classes of pipe and establishes a direct relationship between commercial designation and working pressure. The allowable pressures, dimensions and weights of the various classes remain generally in conformance with the previously established commercial standards published by the Department of Commerce, National Bureau of Standards.

The City of Yonkers, situated on the east bank of the Hudson river, is located on hilly terrain and as a result water pressures in some areas are comparatively high. The service pipe shown supplies water to an industrial plant located in a high pressure area. It is of 2 in. lead pipe Class 100 bearing the Lead Industries Association Seal of Approval. The service is approximately 40 ft. long and the pipe weighs 19½ lb. per ft. An extra long swing in the gooseneck was used to provide ample allowance for expansion. Entrance to the basement is through a sleeve set in the wall which is packed with oakum and calked with lead wool. The use of such a sleeve performs the double function of protecting the pipe from abrasion as well as from the action of any free lime that might be present in the masonry of the basement wall.

It is of utmost importance to many industrial plants that the water supply be constant and reliable to avoid delays in production and spoilage of material. Service pipes which are subject to corrosion and stoppage are dangerous and expensive. The use of lead service pipe is the best insurance against such expense and inconvenience since it is not subject to corrosion and scaling with their resultant clogging or stoppage.

Although lead is, at present, under stringent conservation orders the Office of War Utilities has issued an administrative letter to water utilities informing them that while they are requested to keep their consumption of lead service pipe to an absolute minimum, they will not be subject to prohibition of its use nor orders limiting the quantities allowable. This action indicates a recognition of the necessity of dependable water supply and the importance of using high quality durable material to maintain it.

Connecting 2-in. class 100 lead water service pipe to high pressure main.

Heavy Current For Electric Welding Furnished By Lead-Acid Storage Batteries

ONE of the most useful characteristics of the lead-acid storage battery is its ability to deliver great surges of current for short periods of time and receive its replacement charge at low rates between power demands. This property is in constant use in many applications, the most common one, of course, being the starting of automobile engines. A relatively new application of this characteristic is in resistance welding. It is now possible, by means of battery-operated welding equipment to do most types of resistance welding with a current demand of only a small fraction of that required by equipment connected directly to commercial power supplies. It is even possible to operate the equipment where no commercial electric power source is available by means of gasoline or other power operated charging units.

Heavy duty spot welding machine showing battery power supply in cabinet at left. Charging equipment on top maintains battery charge with small steady current demand.

Since resistance welding, unlike arc welding, is an intermittent operation, it is ideally suited to storage battery operation. The current discharged during the actual welding cycle can be replaced from the charging source between welds and during positioning of the welding equipment or material. The current demand on the power line is only that of the charging equipment which is not only small but steady. Equipment is available to do many types of work such as spot welding, roll seam welding, butt welding and other types. Automatic equipment can be driven by the same batteries by air or other power. Portable units are self propelled, operated by the batteries.

Operating costs of storage battery powered welding equipment are low because the efficiency is high, the peak line demand is low and special power line installations and transformers are not required. Installation costs are low because the necessary charging equipment can be operated on an ordinary 3-phase current supply. An extensive line of such equipment is manufactured by the Progressive Welder Co. of Detroit, Mich., who have developed many specialized machines as well as standard models.

The lead-acid storage battery is so widely adaptable that its uses are continually increasing. In the air it serves airplanes, weather observations, and radio; underground it mines coal and metals; under water it drives submarines. It may weigh tons or only a few ounces. It fires guns for the armed forces and lights the operating room for the surgeon. It is easy to care for and best of all it is dependable. Welding is just another important job which the storage battery has taken on in war which it will continue to do in peace.

The Town of Canaan In Northwest Connecticut

A Portfolio of American Landmarks

No. 30

THE town of Canaan in the extreme northwestern corner of the State of Connecticut was one of the early settlements in that area. The land rights were sold at auction at New London in 1738 and brought high prices from prospective settlers. Canaan was a pre-revolutionary center of the iron industry and slag dumps still remain as reminders of this activity. Samuel Forbes, ironworker, operated a forge there in partnership with Ethan Allen before that great patriot assumed his military role. Articles of Agreement between Forbes and Allen are still extant, preserved in the town records. Canaan is again associated with a young metal industry as the result of the establishment of a magnesium producing plant in the vicinity.

Canaan is a town of many fine houses, some of them very old. Most of them stand in spacious well kept grounds and the owners take pride in the excellent condition of their architectural landmarks. Pure white lead paint has been an important item in their maintenance programs and still serves admirably to protect them through the snows, rain and sunshine of Connecticut winters and summers.

The Rorabach house, built about 1825 by the grandfather of the present owner, J. Clinton Rorabach. Both the house and a smaller building on the grounds, used by the owner as a law office, are painted with pure white lead paint.

The "Yellow House" stands on ground that once was part of the Lawrence estate. Built about 1812, little of its history is of record. Recently restored by its owner, its present pure white lead paint is tinted the same soft yellow as the original coats.

The Lawrence Tavern, built about 1761 by Isaac Lawrence, who carved the names of his entire family on a great flagstone front doorstep. Its present owner, Mr. James Lyles, only last summer again repainted both house and stables with pure white lead paint.

PHOTOS BY HARDENBERGH

THIS IS NO. 30 OF A SERIES REPRESENTATIVE OF THE MANY AMERICAN LANDMARKS IN VARIOUS SECTIONS OF THE COUNTRY THAT ARE PRESERVED FOR THE FUTURE WITH PURE WHITE LEAD AND OIL PAINT. MANY OF THEM HAVE ALWAYS BEEN PROTECTED WITH THIS RELIABLE MATERIAL ACCORDING TO AVAILABLE RECORDS.

Striking Demonstration of Superiority Of Pure White Lead Paint

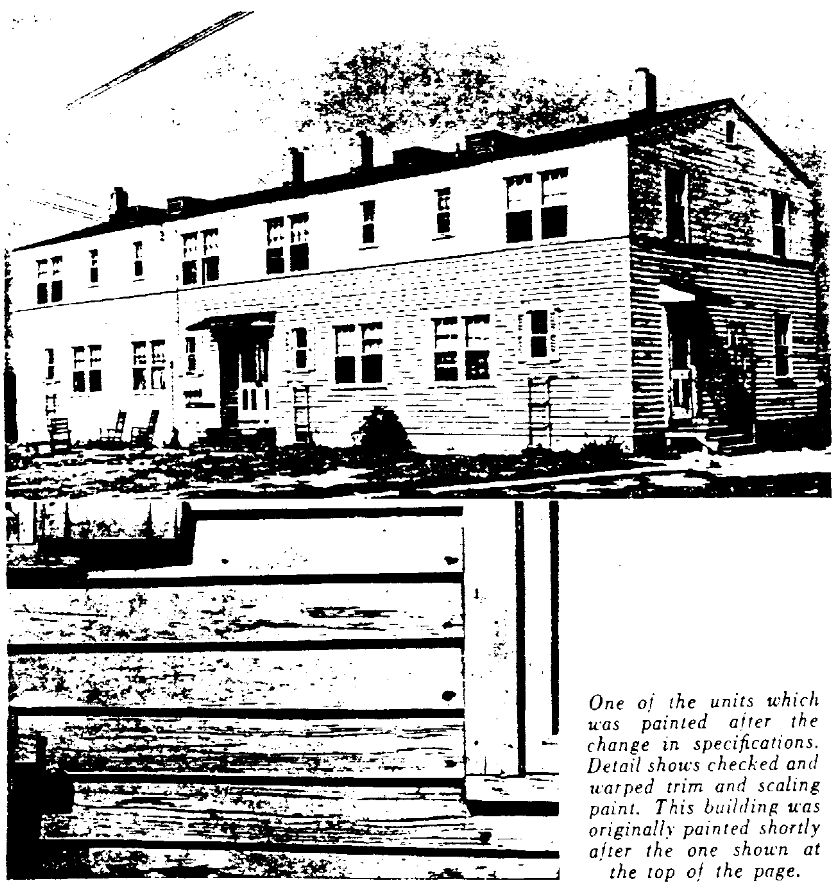
One of the houses in the group primed with pure white lead paint. Insert shows excellent condition of siding and trim.

THE importance and effectiveness of good paint as a protection for frame structures against weather can in no way be better demonstrated than by the failure of a poor paint application. A good paint will continue, for a long period of time, to seal the the wood against the penetration of moisture while it also maintains the good appearance of the building. A poor paint not only soon begins to look shabby but develops thin spots and cracks which will admit moisture to warp and check, and eventually to rot, both structural members and trim.

Only by prompt action in repainting can serious damage be averted when signs of paint failure are discovered. Such action has recently been taken by the Housing Authority of the City of Fayetteville, N. C., where the behavior of two different kinds of priming coats applied to different buildings of a housing project clearly showed the superiority of white lead paint.

The first buildings completed in this project which was built in 1941, were primed with white lead paint but certain changes in finish coat color requirements influenced the painting contractor to switch to a ready tinted mixed pigment paint for the rest of the job. The unfortunate results of this change are shown in the accompanying photographs which were taken in September, 1944, less than three years after the job was completed. The small single family house is one of the original group that was primed with white lead paint. The four family unit had only the mixed pigment paint. Both the shabby appearance and the beginnings of damage by moisture penetration as the result of paint failure are clearly shown in the pictures.

Too rapid weathering has thinned the paint film over the entire surface but what is worse, cracks in the paint film have admitted moisture which has forced the paint from the surface



One of the units which was painted after the change in specifications. Detail shows checked and warped trim and scaling paint. This building was originally painted shortly after the one shown at the top of the page.

in large flakes or scales. In addition water has entered at joints in both siding and trim causing some warping and checking.

Repainting of the entire project was begun shortly after these photographs were taken and the lesson on paint quality was not lost on the Housing Authority of the City of Fayetteville. The material used for the repainting was pure white lead exterior primer for the first coat and Federal Specification TT-P-40, Type II. a 95 percent white lead pigment ready mixed exterior paint for the finish coat.

Prompt action in repainting will arrest the progress of weather damage and the wise choice of pure white lead paint materials will insure long life of the vital protection which paint provides for the wood construction.

Electroplating With Lead Improves Airplane Engine Bearings

THE process of applying lead coatings to metallic objects by means of electroplating has been gaing rapidly in importance in recent years. While the process is not new it has not been extensively applied in the past although it was used to some extent during World War I for coating the inside of gas shells to protect them from the corrosive action of the gas forming chemicals. Recent examination of shells so coated more than twenty years ago has shown them to be in excellent condition. Also some storage battery manufacturers have made a practice of lead plating incidental hardware.

These uses of lead electroplating were to make use of leads high corrosion resistance as a protection for the underlying metal. A number of recent applications are for similar purposes including the experimental production of lead plated sheet steel. However. one of the most important recent applications of this process is to lead coat the surfaces of airplane engine bearings. Here again the lead serves as a corrosion protection against the partly oxidized hot engine oil but it also improves the bearing.

Lead in itself is of a lubricating nature and the lead film on the surface of the bearing provides marginal lubrication under starting conditions while the flow of oil is being established by the operation of the engine. The lead film performs an additional function when the engine is first put into operation. It acts as a "run in" surface which because of its softness forms quickly to the running shape of the bearing. This softness also allows extraneous material which might be in the oil to become imbedded in the lead without damaging the harder surface running against the lead plate.

Lead can be plated out of several different solutions. the most common now in use being the lead fluoborate and the lead sulfamate. The plating baths are easily prepared from concentrated solutions or salts which are readily available on the market. Deposition rates are high and smooth dense coatings can be built up to any reasonable thickness. The accompanying table shows the time required to deposit various thicknesses of lead plating at different current densities.

Lead plating is sometimes applied over a copper flash but it can be satisfactorily applied directly to iron or steel. Anodes of pure chemical lead are used and the baths are not difficult to maintain in operating condition.

Oz. lead per sq. ft.	Thickness in inches	Cathode Current Density in Amp. per Sq. Ft. at 100% Cathode Efficiency				
		10	15	25	50	60
		Time in hours and minutes (2:45 = 2 hours 45 minutes)				
0.094	.0001	4.14	2.76	1.66	.83	0.69
0.188	.0002	8.28	5.52	3.31	1.66	1.38
0.376	.0004	16.56	11.04	6.62	3.31	2.76
0.564	.0006	24.84	16.56	9.94	4.99	4.14
0.752	.0008	33.12	22.08	13.24	6.62	5.52
0.94	.001	41.40	27.60	16.56	8.28	6.90
1.88	.002	1:23	55.20	33.12	16.56	13.80
5.64	.006	4:08	2:46	1:39	49.68	41.40
9.4	.01	6:54	4:36	2:46	1:23	1:09
47.0	.05	34:30	23:00	13:48	6:54	5:45

Lead plated airplane engine parts. Two at left and one lower right, plated all over. Others plated only on inside diameter.

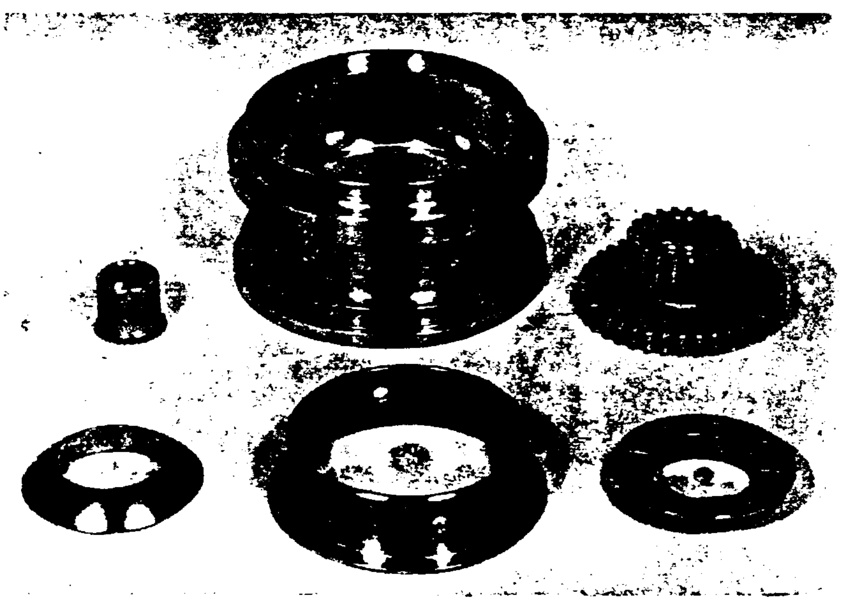


PHOTO COURTESY WRIGHT AERONAUTICAL CORP.

Actual Aerial Combat Practice Made Possible by Lead and Plastic Bullet

By engaging in actual aerial combat in flying airplanes the gunners of the United States air forces are now being brought through the critical stage of their training where real guns and actual bullets take the place of the truly marvelous devices used to teach the principles of aerial gunnery. This has been made possible by the doing of another of those things that couldn't be done, the development and perfection of a type of bullet that can be fired from real machine guns into a specially armored airplane which assumes the part of an attacking enemy flyer.

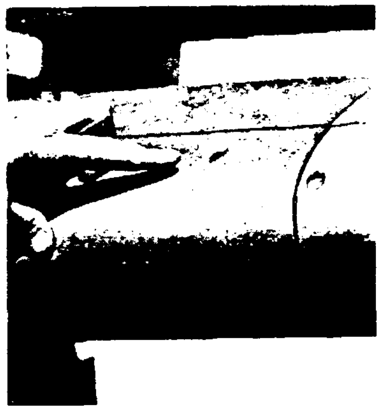
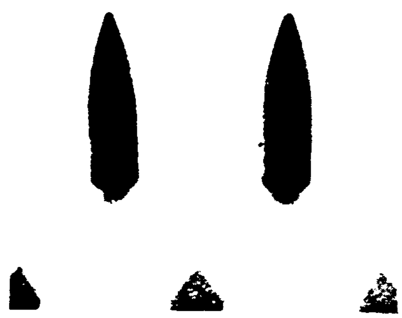


PHOTO BY U. S. ARMY AIR FORCES

Armored wing of target plane showing marks of hits by lead plastic bullets.

This bullet is molded of a mixture of plastic material and powdered lead and it is heavy enough to have flight characteristics closely approximating those of the real metal jacketed bullet used in actual warfare. It is known as a frangible bullet and upon impact against a sufficiently resisting surface it shatters into a puff of black dust. Special duralumin armor and laminated glass had to be developed for use on the attacking plane because these bullets will penetrate ordinary dural sheet and they would kill an unprotected man as easily as would an ordinary bullet.



New type of lead and plastic bullet which may be fired at actual plane in flight.

The frangible bullets were developed by the Bakelite Corporation working in cooperation with researchers at Duke University. The experimental molding was done by the Bakelite Corp. but production is now in the hands of a number of plastics molding concerns, some of which have aided the program by contributing manufacturing improvements which increased the number of bullets per pound of material used.

Lead is used in these training bullets for the same reason that it is used in the regular bullets, to give them weight and carrying power. The combination of lead with a plastic material to produce a heavy yet frangible substance is one of the many completely new developments resulting from war needs which are stimulating to the minds of designers in industry. Investigation of the various properties of the mixture may well disclose other uses to which this sort of material is adapted.

The following articles and reprints contain information, drawings and specifications on the use of lead products helpful to architects, engineers and others in the construction industry. They are available, free of charge, upon request to the Lead Industries Association, 420 Lexington Avenue, New York 17, N. Y.

PROPERTY PROTECTION WITH WHITE LEAD PAINT
A 28 page booklet on the protective value, durability and beauty of pure white lead paint with quantity estimating tables, formulas and mixing and tinting instructions for exterior and interior use.

LEAD CARRIES ITS WEIGHT
By Fred P. Peters
An interesting resume of many of the long established uses of lead plus information on a number of recently developed adaptations of the properties of lead to special purposes. Reprinted from *Scientific American*, June, 1944.

SOME PAINTING PROBLEMS AND THE ANSWERS
By Dr. F. L. Browne, Senior Chemist, Forests Products Laboratory, Madison, Wis.
Reprinted from the *National Real Estate Journal*, Sept., 1939.

LEAD EQUIPMENT USED IN INDUSTRY
By F. E. Wormser, Secretary of Lead Industries Association
A summary of the uses of lead in the production and handling of corrosive chemicals. Reprinted from "Metal Progress" to be included in the next edition of *American Society of Metals Handbook*.

FEDERAL SPECIFICATION WW-P-325
For Pipe, Bends and Traps, LEAD.
Part 5 of Section IV of the Federal Standards Stock Catalog, official publication by the Government Printing Office.

LEAD X-RAY SHIELDING
Graphic chart based on recommendations of the International Commission on X-Ray and Radium Protection giving thicknesses of lead for respective voltages in millimetres, inches and pounds per square foot.

RED LEAD FOR STRUCTURAL WORK
By Dr. L. L. Carrick, Director, Red Lead Research, Lead Industries Association
A discussion of the rust inhibitive qualities of red lead paint and the best means of making use of those qualities for the protection of structural metal. Reprinted from *Engineering News Record*, April 6, 1943

STAMFORD'S DOUBLE LIFETIME HOME
A complete analysis of hard lead flashing, white lead paint, lead plumbing, plywood and red cedar Certigrade shingle details and installation methods. Reprinted from the *American Builder*, July, 1939.

STOP DEMON RUST
Leaflet giving concise, simple instructions in the use of the rust preventing qualities of Red Lead Paint in protecting farm machinery.

COMMERCIAL STANDARDS:
Calking Lead, CS94-41
Lead Pipe, CS95-41
Lead Traps and Bends, CS96-41
Official publications by the Government Printing Office of the above Commercial Standards as promulgated by the U. S. Department of Commerce through the National Bureau of Standards, effective June 25, 1941.

LEAD COATINGS ON STEEL
By Harold A. Knight, News Editor, Metals and Alloys
A thorough discussion of hot dip and electroplated coatings on steel sheet, wire and fabricated products including the technique of application, thickness of coatings, uses and advantages. Reprinted from the November, 1944 issue of *Metals and Alloys*.

SUMMARY OF NOTES ON LEAD ROOFING
A brief description of the uses of lead for roofing and flashing purposes and the proper practices of its application. Reprinted from *Sheet Metal Worker*.

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