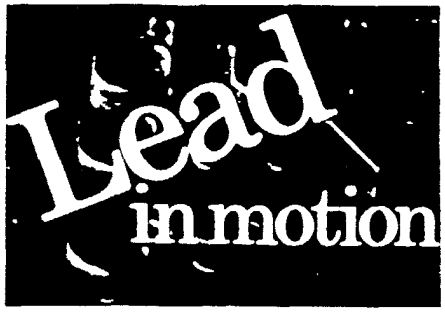


The voice of an industry

Any contemporary survey of the general populace as to the use of lead today is apt to reveal more ignorance than enlightenment. A major use of lead, one finds, is in lead pencils. For those who have leisure time by the sea, lead fishing line sinkers rank high on the list of application. Even for the informed, an awareness of the continuing range of lead utility and application in our society needs to be refreshed. This issue of LEAD Magazine typically represents this continuing change and range of application.

Energy conservation is a central preoccupation of our time as we come to accept the concept of limited natural resources. The use of the vast energy potential of the sun and wind challenges the engineering imagination. With this challenge goes the problem of storing the power of these fickle sources. Will lead-acid batteries play a role? We think it likely. See articles on Pages 4-5. Lead has been throwing its weight around for centuries. The principle of ballast gets a high flying application in the world's tallest tower. See story on Pages 8-9. Lead in architecture is as old as the Romans. Yet we think the lead shim application at the National Gallery in Washington will strike you as novel. The printed circuit board is an indispensable component of our age. What puts it all together? Solder, says our story on Page 14.

For a dramatic review of this moving target of application, LIA's new award-winning film, "Lead in Motion" is especially to be recommended. The film explores the multiple applications of this basic metal from the point of view of energy. The primary theme of the film is that lead is a universal product with many known, as well as potential, uses. The role lead batteries play in powering electric industrial materials handling equipment, as well as lightweight trucks used to pick up and deliver mail, packages and industrial products is shown. Other applications include lead's use in controlling noise and X-ray radiation, as well as the metal's use for architectural applications and for corrosion resistant paints.

The 16mm color film is 22 minutes long and is available free to qualified groups for viewing. "Lead in Motion" can play an educative role in your personal and community relations program. For your copy write Ray Assadi, Manager Association Services, Lead Industries Association, Inc., 292 Madison Ave., New York, N.Y. 10017.

Lead: key to safe X-Ray technology

Recent technological advances in the science of radiology have made it possible to accomplish a number of tasks that are not normally possible with conventional X-ray equipment. Perhaps the most significant of these developments are the highly sophisticated units, called whole-body scanners, that, within a matter of minutes, can examine thin cross-sections of tissue at various depths within the body or brain and deliver a computerized X-ray picture.

Coupled with these advances continuing efforts are being made to protect both patient and medical personnel from the effects of excessive exposure to radiation. This protection is still provided by various forms of lead, the traditional material used for radiation protection.

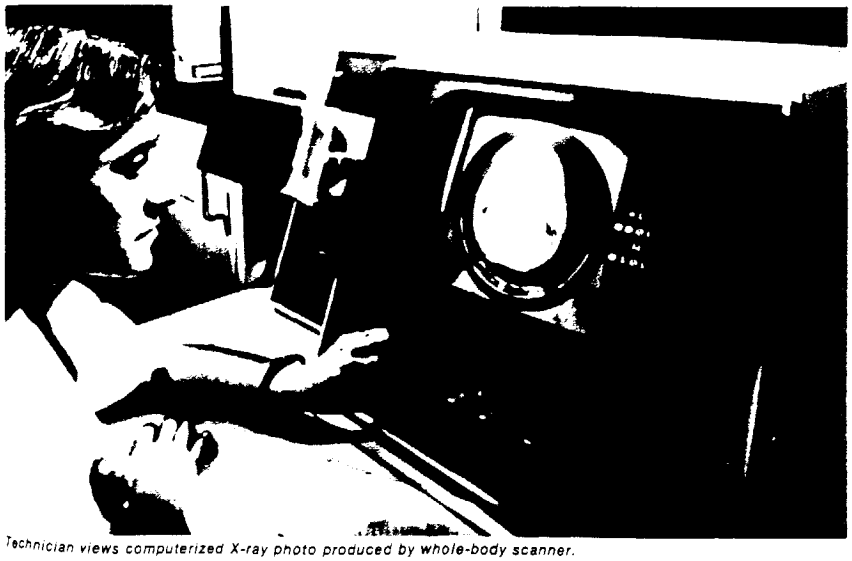
Lead is built into the equipment itself. For example, it is used to collimate or direct the X-ray beam to a specific part of the body during the X-ray procedure. Lead also is often used to line walls, floors and sometimes even the ceilings of rooms where both conventional and whole-body scan equipment are used. The metal can also be found in the glass windows that permit radiologists to observe the proceedings.

Typical of the new body scanners that employ lead is the unit manufactured by Pfizer Medical Systems, Inc., Silver Spring, Md. According to a Pfizer representative, the scanner's collimating assembly is completely lead lined. Part of this assembly includes cast lead collimator shields $\frac{1}{8}$-in. thick which rest on top of the X-ray tubes. Alignment of the X-ray beam is achieved through two pieces of $\frac{3}{8}$-in. cast lead. Each piece contains an aperture through which the X-ray beam passes and focuses on the specific part of the patient's body. Cast lead is also used as a counter balance in the scanner, which rotates around the patient to focus on a specific area of the anatomy.

As these examples illustrate, every effort is made to provide radiation protection through the use of lead when the scanners are in use. This precaution is extended to the rooms that house such equipment. Typical of such rooms is one at the Mayo Clinic at Rochester, Minn., which houses a scanner produced by EMI Medical, Inc., Northbrook, Ill. The room has walls containing 2 pounds per square foot (psf) lead, and $\frac{1}{4}$-in. thick glass windows that are the equivalent of 4 pounds psf lead. The room's radiation protection capability was tested by the clinic before the scanner was used. A report on the test stated that the amount of lead in the walls is "more than adequate for protection of personnel in the control area."

Lead's traditional use in X-ray and even nuclear shielding is based upon its density. Because the metal is the most dense of any commonly available material, it provides the greatest protection per unit of thickness. And because of its smooth surface, the metal does not become readily contaminated with dirt or other material which, in turn, might become radioactive.

Lead surrounds entire working area of new whole-body and brain scanners—lead impregnated clothing, lead-lined walls, leaded observation windows, and even collimators within the scanning devices.



Technician views computerized X-ray photo produced by whole-body scanner.

There could be a sun powered home in your future

The owners of all-electric homes are currently paying as much as $2,100 per year for utility charges in areas of the country such as metropolitan New York City. The result is not only a major financial problem for such homeowners, but utility costs are sure to rise even higher if the cost of oil and coal—two primary sources of electricity—continue to escalate.

Solar energy is showing promise of cost-saving potential in powering homes of the future. In fact, solar power is already being used for a number of homes. Most installations result from demonstration or research and development programs, and provide only partial electrical power. However, they illustrate that technology is available to produce electric power from the sun.

One of the major hurdles to be overcome before solar electric power is readily available is the cost of such installations. However, there is every evidence that, when mass-produced, solar electric power installations can in time become competitive with conventional electric power.

One tangible example of the viability of the solar energy concept is the new Decade 80 Solar House outside of Tucson, Ariz. Conceived and built by the Copper Development Association (CDA), it shows how the sun can be used as a heating, cooling, and electrical source in the face of continuously higher costs for conventional means of supplying such services. The elegant desert home is said to be the most self-sufficient in the country on an energy basis.

One of the most interesting innovations of the CDA house is the silicon solar cell unit anchored to one of the roofs. A product of Solar Power Corp., Wakefield, Mass., it was incorporated in the overall design to demonstrate how future houses might be furnished with an alternate source of electrical energy. The solar array provides electrical power for the low voltage appliances such as TV, radio, stereo and clock, and for the front door's electronic latching device. It also supplies standby power for the overall security system in case of electrical failures.

The electrical power provided by the solar cells when they are exposed to light is stored in two lead-acid batteries in the basement. Since the solar cells themselves have no storage capability, these batteries supply the necessary power requirements at night. During the day the solar cells recharge the batteries in addition to handling the powerload. A built-in blocking diode in each solar array prevents discharge of the batteries back through the silicon cells in periods of darkness.

The solar array at the CDA house is mounted on the south facing roof at a 30 to 35 degree angle. It weighs 70-lbs., and measures 48-in. x 30-in. x 3-in. The mounting is fixed to give maximum exposure to light. Ideally, for maximum power output, the array should track the sun, but the energy used to operate the tracking device would offset any gain in array output power. According to Solar Power Corp., the best fixed position is usually facing the equator at an angle to the horizontal equal to the latitude plus five degrees.

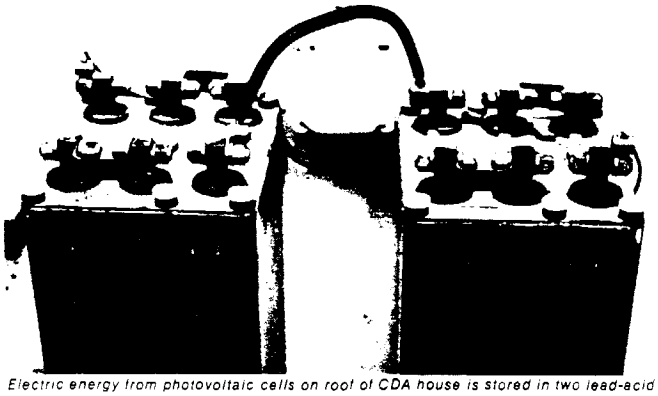
The array is composed of 34 solar modules mounted on a frame with series and parallel connections to meet design requirements. With no moving parts or deteriorating chemicals in the modules, maintenance requirements are low and life expectancy is 15 to 25 years. Twenty-eight of the modules provide 13½ ampere hours per day on a year 'round basis to power the appliances and electronic lock. An average residential home might use 300 ampere hours at 100v per day. The remaining six modules are designed to handle the security system.

The lead batteries provide about 250 ampere hours of storage. They are subject to a regular cycle of charging during the day and discharging at night. There also is an annual cycle of gradual discharge during the winter months when power requirements might exceed the amount available from the solar array, followed by a gradual return to the fully charged state in summer months. Battery life expectancy is 10 to 15 years.

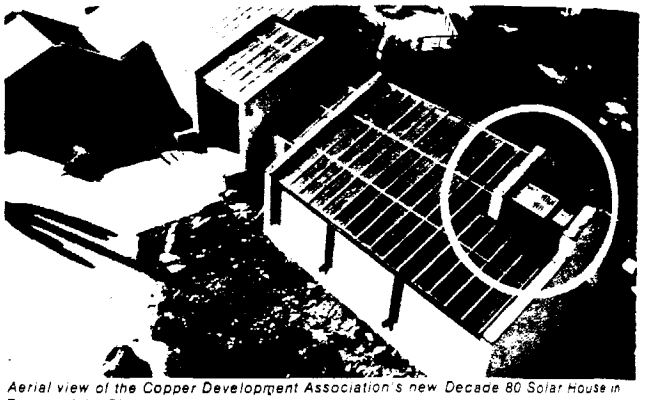
Captured solar energy also supplies up to 75 per cent of the cooling needs and 100 per cent of the heating requirements of the Tucson house. Although light and major appliances are powered in a conventional manner, overall energy savings are estimated at 90 per cent in the winter and 80 per cent in the summer. The totally integrated solar collector-roof system is said to be the first commercially available to the building industry.

The system consists of 2-ft. x 8-ft. copper sheets laminated to plywood, combined with rectangular copper tubing. The tubes carry the water used for energy transport and storage. A buried insulated storage tank furnishes standby energy when needed in the form of 3,000 gallons of solar-heated water. Air conditioning is provided by two standard lithium-bromide/water absorption units modified for hot water firing.

"Decade 80 shows that a solar home can be almost maintenance-free as far as its energy system is concerned," noted Paul A. Anderson CDA's building construction marketing development manager. He pointed out that the year 'round operating efficiencies of the house are not dependent on its being located in Tucson or other such high sun-yield locations. "Solar energy storage technology is at a sufficiently advanced stage to make solar assisted homes practical as far north as Canada," he said.



Electric energy from photovoltaic cells on roof of CDA house is stored in two lead-acid batteries located in basement. Batteries provide about 250 ampere hours of storage.



Aerial view of the Copper Development Association's new Decade 80 Solar House in Tucson, Ariz. Circled area pinpoints silicon solar cell array.

Scope for future energy sources

Wind: future source for electric energy?

Huge atomic powered or fossil-fueled power plants used today by utilities to generate electricity could someday be supplemented by a system of wind-driven turbine generators, each capable of providing power for as many as 25 homes.

A prototype of such a system is currently under test at the Plum Brook Station of the National Aeronautics and Space Administration's (NASA) Lewis Research Center in Sandusky, Ohio. Plum Brook is the site of a 100 kw experimental wind turbine generator designed to provide data to determine the feasibility of wind energy systems to generate commercial electric power.

The Sandusky turbine, the largest wind energy system of its kind currently in operation, is installed atop a 100-ft. high tapered tower. Its large propeller or rotor has a span of 125-ft. and weighs 4000-lbs.

According to NASA the giant turbine can provide enough electricity to power about 25 homes in the surrounding area. The gigantic turbine begins to generate power in a 9.5 mph wind, and reaches its maximum 100 kw output in 18 mph winds. When wind speeds exceed 40 mph, the turbine automatically shuts down by feathering the blades in much the same manner that the pitch angle of aircraft propeller blades is mechanically adjusted for decreased wind resistance.

NASA is managing the turbine tests for the Energy Research and Development Administration (ERDA) as part of a national five-year electric power wind generation program. ERDA's aim is to develop wind energy electric power systems that are both technologically and economically viable. The Sandusky unit is among the number of different types being investigated.

Specific areas of evaluation at Plum Brook Station include performance, operation and economic characteristics of wind energy as it applies to the electric utilities. Tests and experiments will also provide data for improved low-cost components and electric energy storage subsystems.

100 kw experimental wind turbine generator at NASA's Lewis Research Center in Sandusky, Ohio.

According to Rudy Duscha, storage project engineer, the first step in the evaluation of such storage systems was to determine how much storage would be required to satisfy a reasonable electrical base load. "Originally," Duscha says, "1000 kw hours were considered sufficient for a period of four days storage. For reasons of economy and space limitation we have since revised that figure to a little over 500 kw hours."

Among the electric energy storage systems that will be evaluated are lead-acid batteries, considered one of today's most viable means of storing electricity.

Duscha indicates that because specifications limited the size of the storage area, industrial-type lead-acid batteries with a capacity for relatively high ampere hours were considered. According to Duscha, "Since we want to keep the storage area small, we are considering 2-volt battery cells in the 1600 amp hour range. These cells could be packaged into 120-volt strings of 60 cells each. These 60 cells could be suitably trayed in smaller units for convenience of handling and locating. In turn, three separate 120-volt strings would provide the nearly 500 kw hours which would be sufficient for our needs."

The harnessing of wind to generate power dates back as far as 10th Century Persia where a windmill-type device was used to grind grain. Construction and operation of the 100 kw wind turbine marks a renewal of interest in wind energy conversion in this country. The largest known wind turbine to be built in the U.S. is a 1250 kw machine that was operated intermittently between 1941 and 1945 near Rutland, Vt.

More familiar, perhaps, are the wind devices found on the large ranches of the prairie states during the 19th and early part of the 20th Centuries. Wind generators are still used to pump water from artesian wells in many farming regions and can be used to provide power for low-wattage electrical equipment.

The fife and drum corps of the recreated 1st Maryland Regiment from Revolutionary War times forms a backdrop for a representative sampling of the lead uniform buttons and lead musket balls which are hand cast for Regimental use.

Lead buttons up modern Revolutionary War soldiers

Revolutionary War history reveals that a regiment of Maryland soldiers saved the entire Continental Army from defeat and capture in a valiant rear guard action at the Battle of Long Island in 1776. The troops prevented the British from completely overrunning Washington's army and helped rescue the Revolutionary cause from possible disaster. Now, 200 years later, a reincarnated 1st Maryland Regiment is playing an important role in this year's Bicentennial activities.

This recreated Continental Army unit is composed of men from all walks of life. Periodically they doff their 20th Century garb in favor of exact replicas of the 200-year-old 1st Maryland Regimental uniforms. In this attire they stage public displays of mock warfare and Revolutionary War camp life. The Regiment performs at ceremonies and festivals throughout the State, as well as at Fort Frederick, near Big Pool, where it is headquartered. The stone fort, built in 1765, is the only extant British fortification of the colonial period.

The 1st Maryland is distinguished by its authenticity of dress and manner. Each piece of uniform and various accoutrements are exactly reproduced versions of the originals. The fidelity of detail, which extends to spectacles and pipes, is marked by one exception—uniform buttons are made of lead instead of the original pewter.

Roger Zook, Senior Drum Sergeant of Regimental music, and a member of the 1st Maryland since its inception in 1966, hand casts all of the lead buttons used. He also supplies the .50, .69 and .75 caliber lead balls for the soldiers' muskets. During staged maneuvers, these muskets are loaded and fired exactly as outlined in the manual of arms used by General Washington's troops. A spokesman for the Regiment estimates that more musket balls will probably be fired during Bicentennial re-enactments than in the entire Revolutionary War!

The enterprising Zook performs his casting operations at campsite or over the gas kitchen stove in his Riverdale, Md. residence, using a casting pot and bullet ladle. One pound of lead yields about 100 buttons, depending on the size and type involved. With help, Zook turns out up to 1,000 buttons in four hours, and about 300 lead bullets an hour.

In 1967, when the bullet casting began, recycled telephone cable shielding served as the source for lead. Later a switch was made to linotype lead which retains its luster longer and pours easier. The linotype contains about 84 per cent lead, 4 per cent tin, and 12 per cent antimony. Re-melted cable shielding is still used as the chief material for musket ball casting.

Zook uses beeswax and candlewax to flux his casting pot, skimming the surface twice every half hour. While the molds and tools employed are not from the 18th Century, they are not too far removed in appearance. The molds are supplied by Robert Klinger of the Smithsonian Institution.

The 1st Maryland is the chief recipient of Zook's casting efforts, although he makes buttons for other Regiments as well. He charges a nominal fee for the products of his labor to cover the cost of lead and time involved. Each Regimental coat contains 46 large, and two small buttons. The waistcoat has 12 small buttons and the breeches 15 small and three large buttons. Hunting shirts have one to three small buttons, and the distinctive tri-cornered hat features one large button. Some of the buttons include a "I MR" imprint.

As the Continental Army private spent most of his time in camp and a relatively little amount of time in actual battle, members of the 1st Maryland go to great lengths to demonstrate the camp life of Revolutionary War soldiers. During the Regiment's monthly performances at Fort Frederick, the young soldiers set up a camp precisely as dictated by General Washington's manual. The 50 or more members of today's Regiment erect 20 small enlisted men's tents, two officers' marquees, tripods for cooking, gun racks and other pieces of eqiupment routinely used by the 18th Century soldier.

Called "Music and Musketry of the American Revolution," the Regiment's show is an increasingly popular affair with natives and tourists alike. Partially as a result of their success with this show, the 1st Maryland has been designated as the State's official Bicentennial troop.

Bicentennial salute: lead based flags

Of all the tributes offered to the United States during its Bicentennial year, perhaps none will be as patriotically meaningful and visibly dramatic as three symbolic American flags and Bicentennial numerals (1776-1976) painted on a 165-ft. high water tower in Cocoa, Fla.

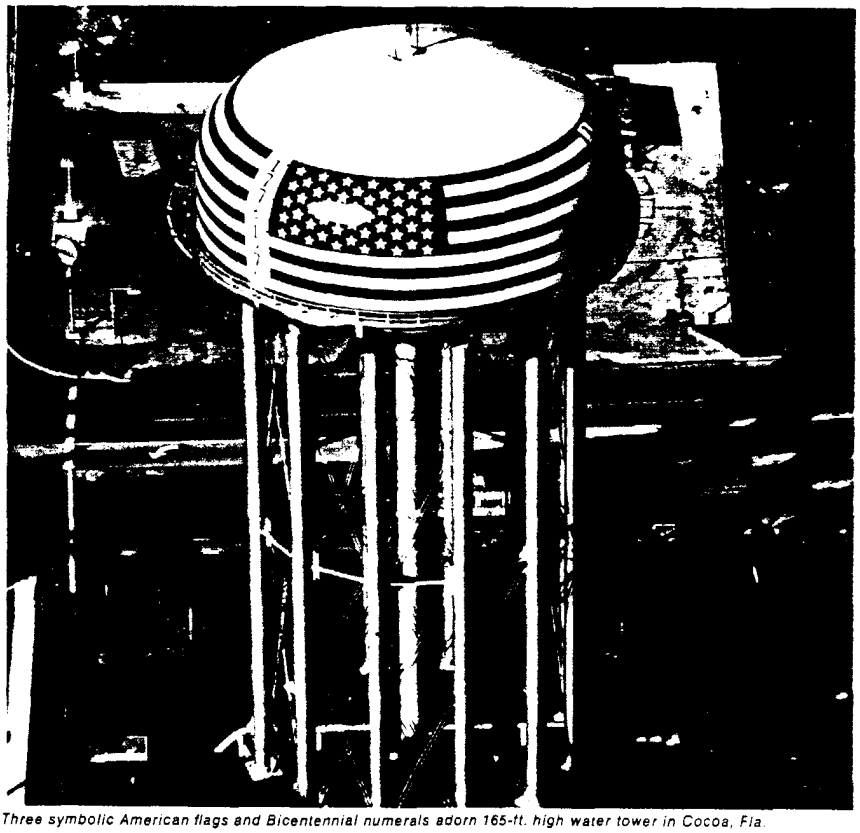
The flags and numerals are a personal gift to Cocoa and the nation itself from a naturalized American citizen and a resident of the U.S. for only 20 years. Demetrios Dourakos, president of the Royal Painting Company, Merritt Island, Fla., decided to express his appreciation to his community and to his adopted country on its 200th birthday. Approaching city officials, he volunteered to paint the symbolic Bicentennial flags on the city-owned water tower at no cost to Cocoa.

Dourakos designed the flags, each of which is 31-ft. high and 84-ft. wide. With the assistance of four employees, the project was completed in about 10 days using 120 gals. of paint.

Paint and materials were donated by the Sterling Division of Reichhold Chemicals, Inc., Sewickley, Pa. Gary Wright, sales manager at Sterling, states that the paint system is specifically designed for exterior use on this type of water tank. It is an exterior alkyd coating system consisting of a medium and long oil alkyd resin. Silicone was added to the paint to provide the ultimate in gloss and gloss retention.

One of the key elements in the paint system is a rust inhibitive primer coat containing a 38 per cent red lead pigment. The lead pigment provides a superior protection against the corrosive salt-laden atmosphere that is a part of Florida's marine environment.

Using the Cocoa project as an example, Dourakos hopes to encourage other cities throughout the nation to adopt similar projects during the year. One city, Stuart, Fla., contracted Dourakos to paint two American flags on its own 140-ft. high water tower. The two flags measure 26-ft., 8-in. high and 56-ft. wide and were painted in nine days by four employees of the Royal Painting Co. The same paint system, including the rust inhibitive primer containing the lead pigment, was used to paint the Stuart water tower.



Three symbolic American flags and Bicentennial numerals adorn 165-ft. high water tower in Cocoa, Fla.

Sixteen-ton lead "hula-hoops" counter sway of world's tallest tower

Close-up of steel communications mast shows how 40,000 lb. lead counterweights, seen in circled areas, are installed.

How do you keep the world's tallest freestanding structure from swaying in the wind so much that it literally "whips" itself to destruction?

This was the problem faced by the designers of the CN Tower in Toronto, which has replaced Moscow's Ostankino Tower as the world's tallest structure. Both the 1,815-ft. high CN Tower and the 1,748-ft. high Ostankino Tower were primarily designed to house radio and television transmission facilities and, because of their height, they both are major tourist attractions.

One of the major problems engineers had to overcome in designing the CN Tower was to compensate for the effects of wind and other phenomena on the structure. It's a commonly known fact that tall buildings sway in the wind and the record high CN Tower is particularly susceptible to such stress.

To solve the wind vibration problem, CN Tower designers called on Vibron Limited, a Toronto engineering firm that specializes in noise and vibration control. After extensive tests and studies, Vibron developed a unique system for controlling the sway of the Tower and, in particular, the 335-ft. high steel communications mast atop the structure.

The system incorporates the use of two lead-filled counterweights to dampen the vibration and sway of the building. The counterweights weigh a total of about 40,000-lbs., and they are installed at the 1,850-ft. and 1,900-ft. levels.

A key component of each counterweight is a 14-in. wide, 12-in. deep circular steel ring. These are filled with about 800 pie-shaped lead sections that weigh 25-lbs. each. The ring installed at the 1,850-ft. level is 10-ft. dia., while the one installed at the 1,900-ft. level is 8-ft. dia.

The lead-weighted rings are not attached to the steel mast, but rather are hung from it through the use of three horizontally-mounted steel columns attached to the sides of the mast. Four-bearing universal joints that pivot in all directions attach the columns to the ring. Four separate hydraulically-activated fluid dampers mounted to the side of the mast and attached about midway in the center of each universal joint provide energy dissipation. As the lead weights move back and forth in much the same manner a hula-hoop operates around one's body, the hydraulic damper system absorbs the vibration and dissipates energy.

The steel mast, which weighs 290 tons, will accommodate antennas for five local television stations in the Toronto area as well as the city's five radio stations. Provisions also have been made for future television and radio station transmission facilities in addition to microwave transmission.

World's tallest structure, 1,815-ft. high CN Tower, soars above downtown Toronto skyline.

Interior sound control: key to quiet, secure offices

Interior designers who specialize in planning offices for both new and existing construction are becoming increasingly involved in seeking ways to overcome one of the most difficult problems encountered in insuring a comfortable environment: noise control.

There are three basic types of office noise. The first and most common noise is from typewriters and conversation stemming from routine office activity. The second is mechanical noise from fans, water systems, etc. The third is noise from outside sources—street traffic, airplane noise, sounds from adjacent industrial plants, etc. Noise from any of these sources can be annoying to the point where work concentration is impaired and conversation is difficult.

Adding to the problem is the need in many office situations for confidential work and conferences. In such cases, it is necessary to dampen sound to insure that conversation in conference rooms and offices cannot be heard outside these areas. Companies that specialize in industrial research and development are particularly security conscious and take every step to insure privacy.

To help overcome such noise control and sound dampening problems, architects and corporate office planners are turning to companies that specialize in soundproofing spaces inside offices, buildings and industrial plants. One such company is Wallboard Construction, a Boston-based company that specializes in soundproofing offices. The company cooperates with interior planning and design firms such as Rodgers Associates, Greenwich, Conn., to develop specifications for each project. In recent years, Wallboard has completed three major noise control projects in the Boston area and another major project, offices in a Federal government building, is being completed. The company is typical of those who work on regional area projects as opposed to those who undertake jobs anywhere in the country.

According to Gene Carlin, project manager for many of Wallboard's sound control installations, lead is particularly suitable for dampening sound in offices. "Lead is the most effective material for economically dampening sound at a reasonable cost. Lead can be used to eliminate thick enclosures that are not only more expensive to install, but take up more potential rental space as well. With today's cost-per-square-foot of office space at an all-time high, it's uneconomical to decrease the amount of usable space by installing thick walls."

Carlin reports that a law office in the New England Merchants Bank in downtown Boston is typical of installations that take advantage of the various properties of lead. Designed by Rodgers Associates, the offices occupy 2½ floors of the bank building. Because of the nature of work undertaken in the law firm, it was not necessary to dampen sound in all offices and areas. Most of the lead was installed above walls as plenum barriers between the various offices and in conference room areas in order to insure client privacy.

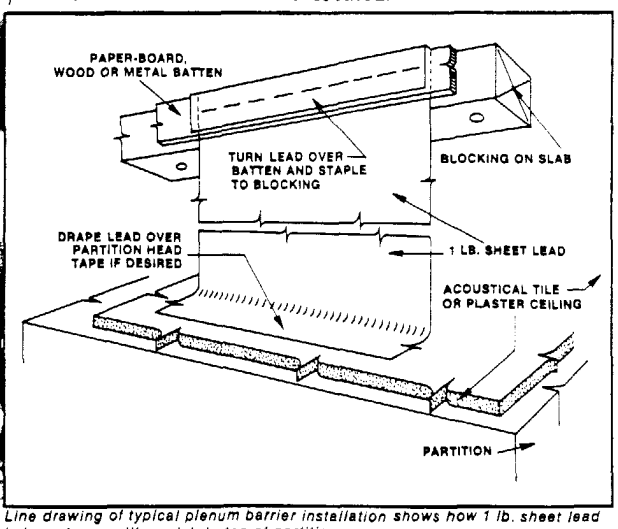
Nearly 15,000-sq. ft. of lead was used for the project. According to Sidney Rodgers of Rodgers Associates, the sheet lead was hung from ceiling slabs in 4-ft. lengths to allow space for duct-work, lighting, etc. above the dropped ceilings. Rodgers says the lead was installed in 3-ft. and 4-ft. widths in order to permit ease of handling.

Though smaller, a sound control project Wallboard completed for the accounting firm of Arthur Young & Co., required a similar installation of lead. About 4,200-ft. of 1 lb. lead was used to soundproof the firm's executive offices as well as the conference room and library in the middle of the office area. Here, too, the lead was used to keep sound from being transmitted between offices and other work spaces such as the library. Wallboard worked with the Interior Design Group on the accounting office project.

Wallboard cooperated with the Boston office of New York-based Griswold, Heckel & Kelly to install 11,500-sq. ft. of sheet lead in the Peat, Marwick, Mitchell offices located in the Boston Company Bldg. in Boston. Consisting primarily of ceiling-hung sheet lead plenum barriers, the installation had to match a 36dB Vaughn wall system. Because of the private nature of conversations with the accounting firm's clients, sheet lead was used to dampen the sound in all the firm's offices.

Wallboard is now completing the installation of about 7,000-sq. ft. of sheet lead in a General Services Administration (GSA) office at 100 Summer Street in Boston. The company is working with GSA staff architects and the general contractor, Aberthaw Construction Co. of Boston, to install 1 lb. sheet lead above selected walls for three floors of the building where conference rooms, executive offices, and security and audit offices are located.

Lead plenum barriers installed out of sight above ceilings help control noise in interior spaces such as this executive area in a Boston office.



Line drawing of typical plenum barrier installation shows how 1 lb. sheet lead is hung from ceiling slab to top of partition.

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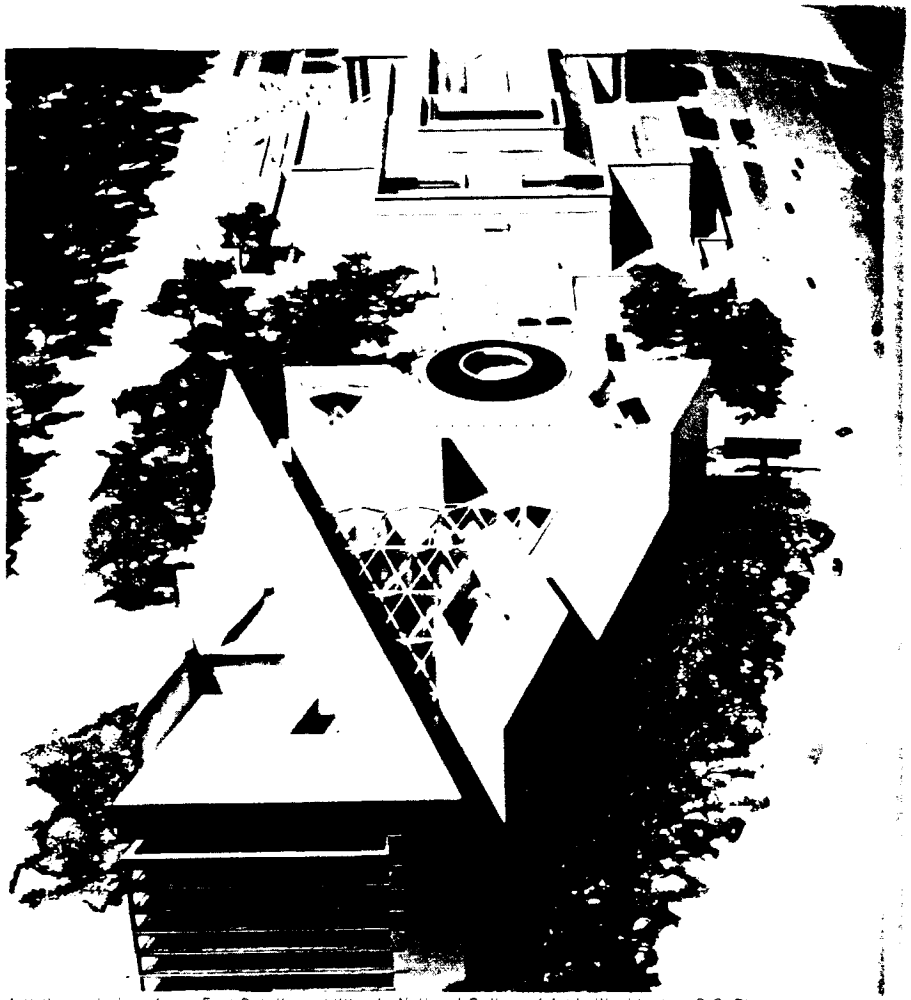
Lead: Part of the picture in National Gallery addition



Artist's rendering of new East Building addition to National Gallery of Art in Washington, D.C. The ultra-modern new wing (foreground) will be connected to the existing Gallery (rear) by an underground pedestrian concourse.

The National Gallery of Art in Washington, D.C., is an elegant, marble-faced building constructed 35 years ago to house a number of the nation's art treasures. The Gallery's collection of paintings and sculpture has grown through the generosity of over 200 prominent donors and it is now one of the prime tourist attractions in the nation's capitol.

With the number of visitors increasing, a burgeoning art collection, and a growing number of programs and services, expansion became necessary. It was decided to add a new wing to the Gallery's facilities to provide nearly 600,000-sq. ft. of additional space. Plans called for the wing's exterior wall to be compatible with the existing structure, which boasts a facing of rose-white Tennessee marble. Obtaining the marble for the job was no problem. Duplicating the original Gallery's wall system was another matter.

When the National Gallery was built in 1941, the practice was to use $\frac{1}{8}$-in. finish joints between the sections of marble used to face the building. Reportedly, it is difficult to attain mortar joints of such thinness in stone with today's techniques. So, thin, square pieces of lead were used to solve the problem.

In order to adhere to the original design concept, I.M. Pei & Partners, New York City, designers of the addition, specified lead shim "spacers" to achieve the $\frac{1}{8}$-in. joint in the marble wall system. "In addition, we wanted to accommodate temperature induced movement without the periodic necessity of large expansion joints," reported Project Architect Robert Bates of the Pei firm.

Bates explained that the shims, which are 1-in. square and $\frac{1}{8}$-in. thick, are placed on top of the base course of marble. A horizontal, factory-extruded neoprene gasket is placed into the stone to seal the wall from the elements. Mortar is placed on the stainless steel anchors which hold stone in place against the masonry backup wall. The next course of stone is then set down on this support.

Since the mortar is soft, the stone is set down until it bears on the lead spacers. This tightly compresses the neoprene gasket and establishes the finish joint [illegible] at $\frac{1}{8}$-in. width.

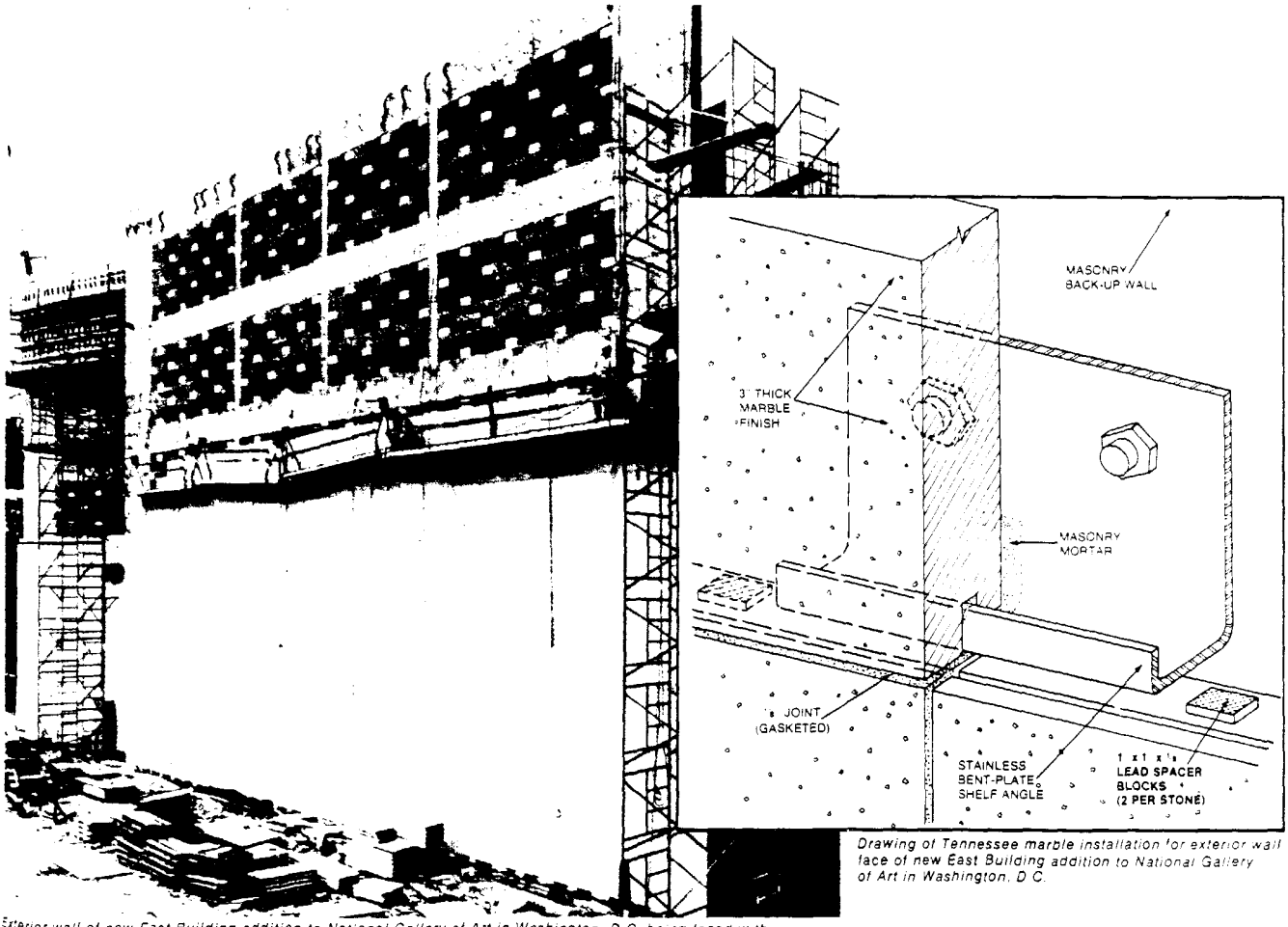
The weight is temporarily transferred through the lead spacers to the steel supports of the stone below. The supports are designed to hold two courses while the mortar is curing. As each course of mortar on the steel angles cures, the steel permanent support becomes functional for that particular course. There is no accumulation of weight transmitted through the spacers.

When completed, the exterior of the addition, known as the East Building, will contain 186,000-sq. ft. of marble. Each stone is 3-in. thick and measures 2-ft. by 5-ft. In addition, the interior wall will contain 73,000-sq. ft. of marble. Although these stones also measure 2-ft. by 5-ft., they are only $1\frac{1}{4}$-in. thick. A total of 25,900 marble slabs will be used in the completed addition. About 50,000 lead spacers, weighing almost a ton and a half, will be used to construct the facade of the new wing.

The East Building is located directly across Fourth Street from the existing Gallery, and faces the U.S. Capitol. It also will respect and complement its neighbors. These include the white stone Government buildings that line Constitution Avenue and form the Federal Triangle, and such important edifices along Pennsylvania Avenue as the National Archives and the Post Office Building.

General contractor for the East building construction project is Charles H. Tompkins Co. An underground link between the addition and the Gallery itself is expected to be completed this summer. The entire project is slated to be finished in the 1977-78 season. The 591,000-sq. ft. of new space it will create will free the ground floor of the Gallery, now substantially devoted to administrative offices and storage, for public use.

The East Building will house a Center of Advanced Study in the Visual Arts which will include a major library and photographic archive. It also will incorporate exhibition galleries. The complex structure might best be described as a trapezoid divided diagonally into two complimentary triangles. The larger of these faces the existing museum. The other triangular portion is the Advanced Study Center.

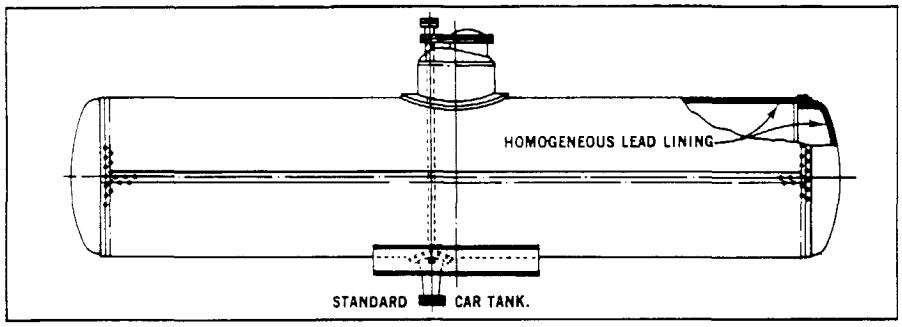


Exterior wall of new East Building addition to National Gallery of Art in Washington, D.C. being faced with 3-in.-thick Tennessee marble. The spacing of the finish joints between the marble is accomplished with the aid of lead shim "spacers" which temporarily set the ¼-in. height of the joint. The marble compresses a factory-extruded neoprene gasket to this thickness.

Drawing of Tennessee marble installation for exterior wall face of new East Building addition to National Gallery of Art in Washington, D.C.

Lead-lined rail and truck tankers ward off chemical corrosion

Rail tank car with metallurgically-bonded lead lining is used to transport highly corrosive liquid bromine for this chemical company. Cars are supplied by General American Transportation Corp.



The corrosive nature of many chemicals make them difficult to transport. One way to overcome this problem is to line tanks of the two principal carriers for these chemicals, rail cars and trucks, with lead.

For example, one highly corrosive chemical is liquid bromine. This material contains unique properties which make it a useful additive in many process industries. They include the production of gasoline, dyes, photographic chemicals, medicinals, fire extinguishing fluids, hydraulic fluids, and water disinfectants.

Liquid bromine for such applications is usually shipped in rail tank cars in capacities from 2,300 to 4,400 gallons, or tank trucks of 600 and 1200-gallon capacity. The difficulty of shipping this highly corrosive chemical is compounded by the fact that it also is very heavy—about three and one-half times the weight of water. Therefore, shipping containers must be exceptionally strong as well as corrosion resistant. Lead not only supplies the necessary corrosion barrier, but helps to strengthen the containers.

Due to unusual transportation requirements involving liquid bromine shipping, lead linings must be metallurgically bonded to the steel used to fabricate the tanks. The lead/steel composite provides the best possible combination of strength and corrosion resistance. It allows the tanks to cope with the heavy bromine's reaction to the vibration, swaying and bumping involved in rail and truck movement, and also provides a corrosion resistant barrier between the chemical and the steel.

The metallurgical, or homogeneous, bonding technique can be compared to using soldering techniques to bond one material to another. In the case of lead-lining a chemical tank, the technique insures a total metal-to-metal bond for the inside diameter of the cylinder tank car as well as the dished ends.

The homogeneous bonding process involves three steps. Initially, the interior face and ends of the tank are sand-blasted to bare metal. The surface is then pickled with a caustic chemical such as muriatic acid to remove impurities. After the surfaces have been prepared, they are fluxed with a chloride and a 60/40 tin lead powder is applied by hand with a brush. The lead lining is then built up by melting filler metal with a torch.

In applying the lining with a torch, the precoat and then the filler material are alternately melted and joined. The soldering temperature is approximately 300°F. Several passes are required to build up the $^{3}/_{16}$-in. to $^{1}/_{4}$-in. thickness required for adequate corrosion protection against bromine. After each pass, the built-up lining is inspected for pinholes and other flaws, and additional passes are made as required to insure quality control. About three to four weeks are required to lead-line a single tank, depending on its dimensions.

Rail tank cars range from 5 to 6-ft. in diameter, and are 25 to 40-ft. in length. Approximately 800-sq. ft. of lead is required for a $^{1}/_{4}$-in. lining on the inside of a tank that is 6-ft. in diameter, and 40-ft. long. The estimated service life of such cars when hauling bromine would be about 7 years.

While it is possible to apply the lead lining by "strapping on" the lining, this technique is not preferred because its use shortens the service life of cars used to transport liquid bromine. Because the lining is not metallurgically bonded to the steel, the heavy volume of the liquid bromine causes it to shift and rub against the steel shell. The resulting abrasion reduces the thickness of the lining and shortens its service life. Liquid bromine attacks lead at the rate of about 20 mils per year and abrasion adds to this wear rate.

Because of the economic advantages of strapped-on lead linings, this technique is used for many chemical transport applications other than liquid bromine. A third technique, adhesive bonding, is also used for a wide variety of chemical tanker linings. Both techniques are used to construct in-ground and above-ground storage facilities for caustic chemicals.

Lead used to line both portable and stationary tanks for transporting and storage of caustic materials is called chemical lead. It is 99.9 per cent pure lead, and contains small amounts of copper and silver which add to its corrosion resistance and mechanical strength.

ıttery-powered ınk and boutique ·rvice airline ıssengers

TWA's electric courtesy cart transports elderly and handicapped passengers between the airline's terminal and gates at Kennedy.

pair of battery-powered banks on wheels are making it possible for ıe passengers at New York's Ken- International Airport to change money into foreign currency at the ·ture gate before flying overseas. in another unusual application of ry power at the airport, an electric boutique on wheels provided pas- rs with a miniature mobile shop- center during a six-month test pe- last year.

e battery-powered banks are op- d by Citibank. In service at Pan ·ican (PAN AM) and Trans World ıes (TWA) terminals, the mobile s can each accommodate two bank s who exchange money in $20, $50 $100 denominations. The electric lled, battery-powered banks sup- nt Citibank's stationary branches d at PAN AM and TWA.

e first vehicle began operation in the middle of 1974 at the PAN AM terminal while the second was introduced this past January in TWA's terminal. Both vehicles operate seven days a week and are powered by six, six-volt lead-acid batteries that are charged daily for approximately 3-4 hours.

Clayton Mead, Citibank manager—foreign currency exchanges at Kennedy, reports that the vehicles are a big success. "The vehicle in the PAN AM terminal services about 12 gates. During the summer months the cart operates about 8 to 10 hours a day and averages 10 to 12 miles. In the winter months it is in service perhaps 5 to 6 hours a day covering about 3 to 4 miles. Our second vehicle has been in service only a few months but it too will probably work the same hours as the other vehicle."

TWA introduced a new concept in airline passenger shopping when it tested a battery-powered mini-boutique in its departure lounge at Kennedy Airport for a six-month period during 1975. The boutique, a one-fourth-scale replica of one of London's famous double-decker buses, was powered by six, six-volt lead-acid batteries. Operating in the departure lounge for about 10 hours per day, the "mini-bus" carried a wide variety of international food and gift items including gourmet foods, French perfumes and colognes; Swiss chocolates, designer ties and scarves, and even fresh loaves of French bread flown in from Paris.

Battery-powered vehicles are not a new concept with TWA. In fact, for about the past 10 years the airline has been operating an electric courtesy vehicle to transport handicapped and elderly passengers between TWA's lounge and gates. The vehicle, which is also powered by six, six-volt batteries, has been designed to look like one of San Francisco's cable cars.

of the two Citibank lead battery-powered foreign exchange banks that serve passengers at Kennedy International Airport in

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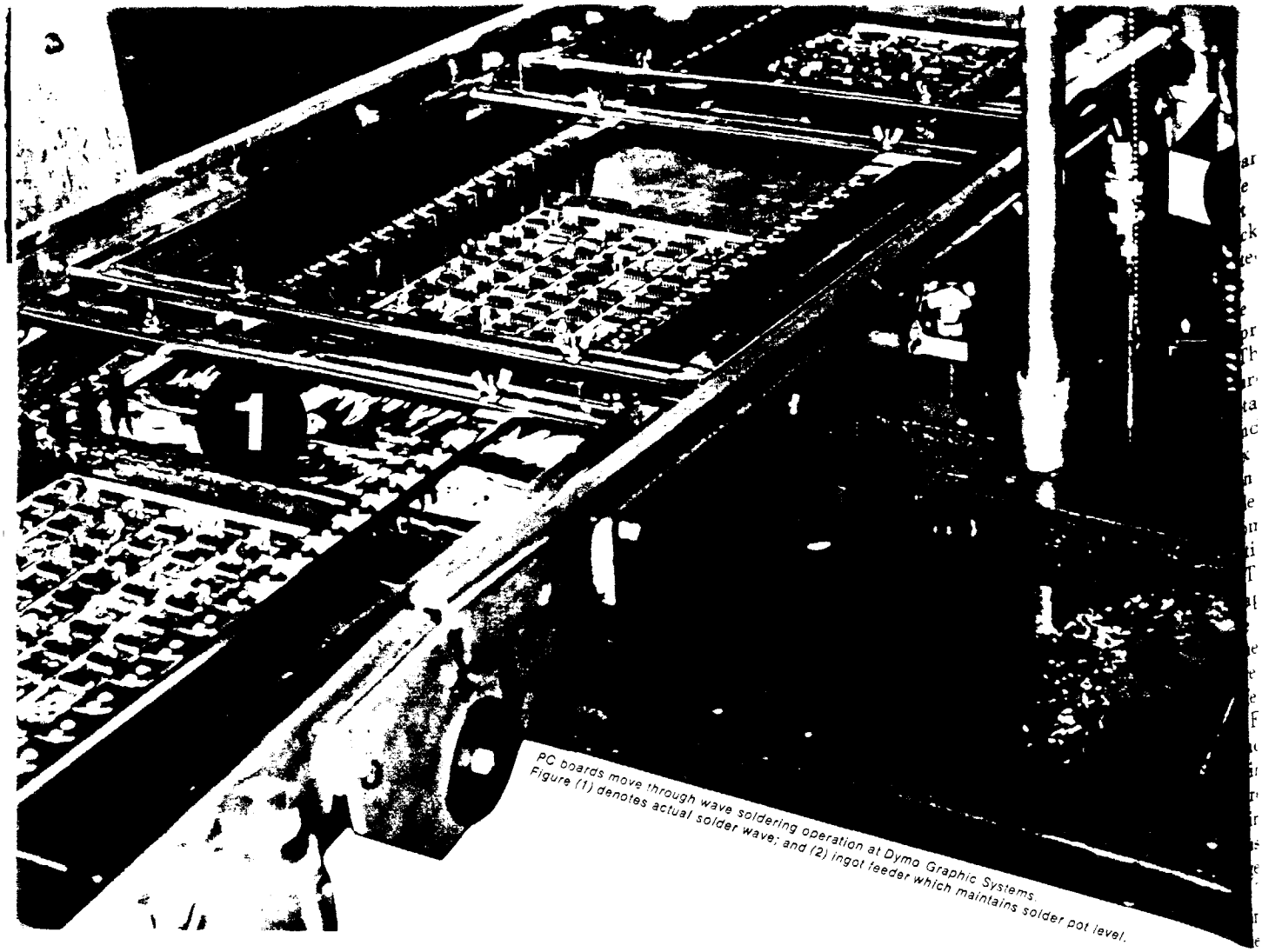

PC boards move through wave soldering operation at Dymo Graphic Systems. Figure (1) denotes actual solder wave; and (2) ingot feeder which maintains solder pot level.

Wave soldering brings economy, reliability to printed circuit board production

With a big assist from wave soldering, Dymo Graphic Systems has carved out a $14 million share of the electronic newspaper typesetting market. A key element in the New Jersey-based company's success is its ability to quickly, economically and reliably join and connect the scores of electronic components used to produce printed circuit (PC) boards.

These boards are the heart of Dymo Graphic's computer-directed printing system that increases the typesetting rate over 450 per cent. The equipment permits type to be set at an average rate of 150 lines per minute. This compares with an average rate of 27 lines per minute achieved manually.

Joining hundreds of components to the PC boards by hand represents a monumental soldering job. The boards range in size from 2-in. x 3-in. to 16-in. x 22-in. The largest board alone contains some 300 integrated circuit packages, each with 14 leads. Another 300 feed-through holes connect the circuits from one side of the board to the other.

Wave soldering is more than equal to the task. This system automatically conveys PC boards over the top of one or more mechanically generated waves of tin lead solder. As they pass over the crest of the wave with electronic components facing downward, the boards are simultaneously soldered at the desired point in seconds.

Wave soldering was adopted by Dymo Graphic at its Clifton, N.J. facility when it was no longer economically feasible to hand solder PC boards from a time and quality control standpoint. The original wave soldering system by Electrovert, Inc., Mt. Vernon, N.Y., featured a 10-in. wide solder wave. About two years ago, a switch was made to a newer Electrovert model with an 18-in. wide wave to accommodate larger boards.

A 12-foot long conveyor transports about 100 boards daily through fluxing, preheating and actual soldering of the components to the circuit. The conveyor moves on an incline to achieve best adherence of the solder to the circuitry, provide smaller fillets around the joints and insure a thinner, more uniform solder deposit over all the circuitry.

The boards move along the conveyor on pallets at about 4-ft. per minute, although the actual soldering is almost instantaneous. According to Dymo Graphic production engineer Robert Mack, as many as five boards are soldered at a time. "We vary the speed slightly from board to board, depending on the type of circuitry involved," he reported.

Special pallets enable smaller boards to be soldered side-by-side to take full

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jvantage of the 18-in. wave width. We also have pallets designed to sup-rt the bigger boards on a flat plane," ack explained. "The conveyor is ad-sted so the entire board makes con-ct when it hits the top of the wave. e pallets also keep the boards rigid prevent heat warpage."

The initial "foam" fluxing of the ards removes oxidation from the tallic surfaces to facilitate solder nding. Mack reports that rosin-based x is employed for good capillary ac-n of the solder in the plated-through les. The flux also protects the circuit m reoxidation and contamination til the solder joint is safely made.

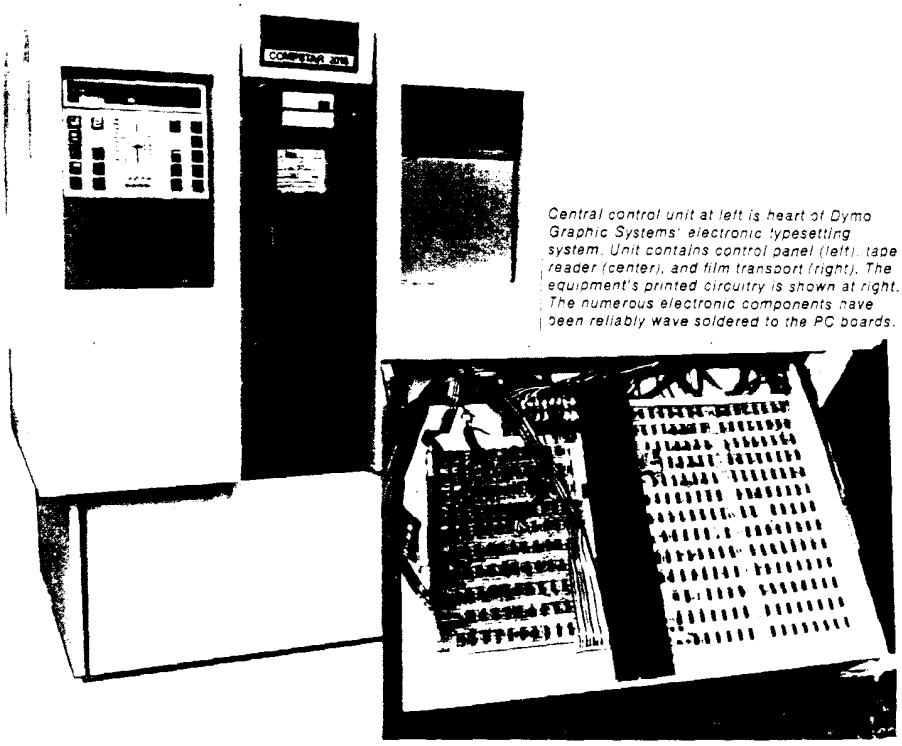
The preheating step which follows porates excess solvent and conditions assembly against thermal shock en the board touches the solder wave. heating also overcomes the heat sink cts of large components.

For the actual soldering, a 63/37 tin d solder is employed to permit rapid ning at the lowest possible tempera-e. This is important because delicate ing and materials used for the vari-electronic components can be dam-d by exposure to excessive heat.

The PC boards pass through the bi-ctional solder wave where there is most solder movement, or the high-velocity point. This permits the sol-to wet the boards more effectively. scrubbing action of the solder's v, which is counter to the direction the PC boards traveling on the con-or, also helps the wetting action. boards exit at the wave's lowest city point to reduce icicle formation excess solder deposits.

Post-soldering operations consist of cleaning of the boards with an organic solvent, inspection for defects, and hand soldering touchup, if needed. The fact that touchup at the plant reportedly runs only about 2 per cent attests to the reliability of wave soldering.

Mack noted that wave soldering is playing an important role in the upgrading of newspaper printing, just as it did for radio and TV. "This metal joining technique permits the mass production of high quality PC boards which are helping to bring this third form of communication into the world of modern electronics," he said.



Central control unit at left is heart of Dymo Graphic Systems' electronic typesetting system. Unit contains control panel (left), tape reader (center), and film transport (right). The equipment's printed circuitry is shown at right. The numerous electronic components have been reliably wave soldered to the PC boards.

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Leaded Grades: Answer to Free-Machining Needs.

Reprint reports on benefits derived from using leaded steels for free machining. Case histories are employed to demonstrate that these grades can enable partsmakers to raise production of quality components with efficiency and economy. M-32

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