PART IV AN ASSORTMENT OF CASE HISTORIES

To keep this volume as interesting as possible, case histories are presented in an anecdotal way:

A. A tough challenge ..... Branford Vibrator
B. Big parts ..... Danly Machine
C. High precision ..... Moore Special Tool
D. Wild rides ..... Rollercoaster reliability
E. Rapid application ..... Buick shift lever nuts
F. Ponderous parts ..... Missouri Pacific Railroad
G. High volume ..... Automotive applications
H. High flying fasteners ..... Kolbo Korp.
I. Aircraft engines ..... Continental Motors
J. Aluminum flat beds ..... McCullough Trailers
K. Outboard motors ..... Mercury Marine

A. BRANFORD VIBRATORS

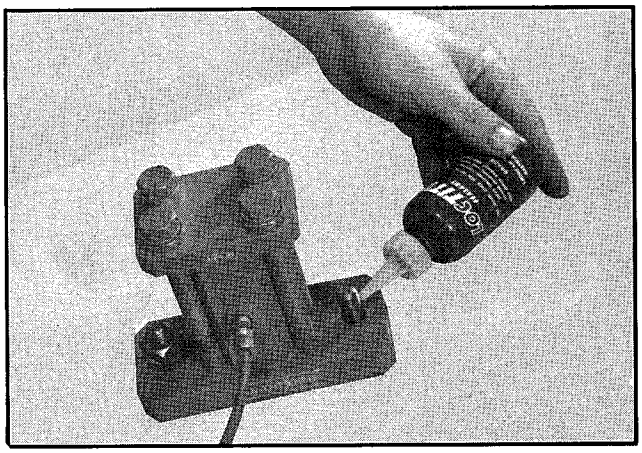
Securing vibrators

What has been called "the world's toughest vibration problem" was solved more than 25 years ago when the Branford Vibrator Company adopted some of the first Loctite threadlockers.

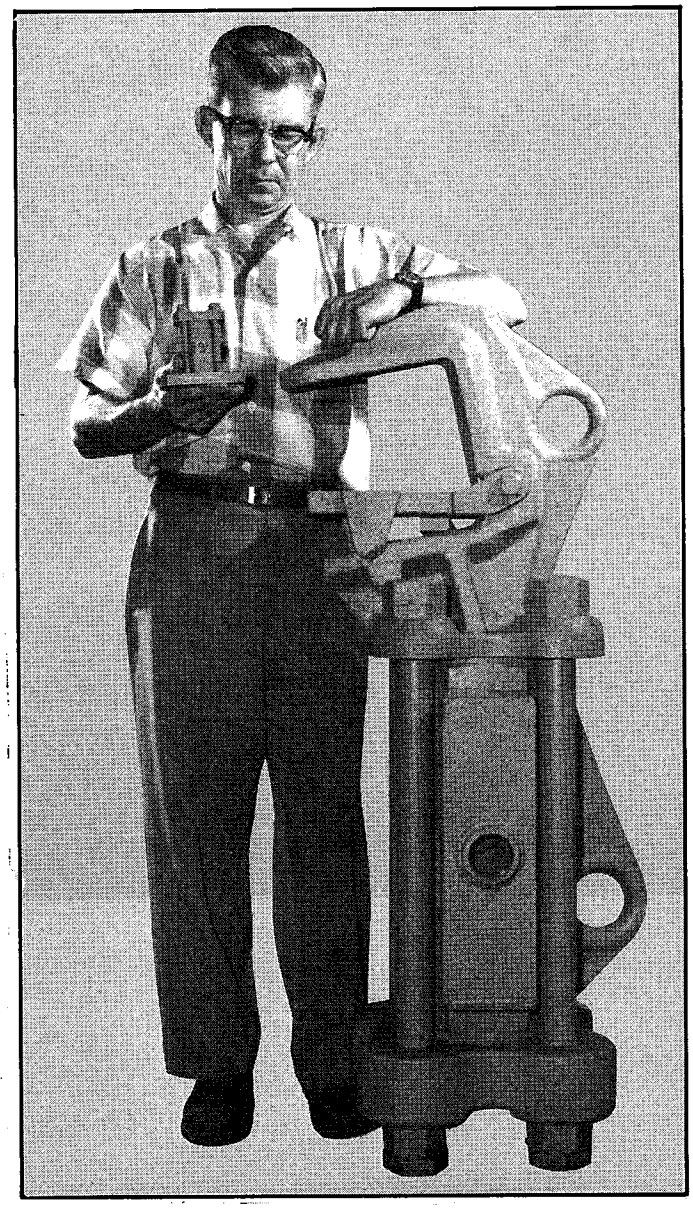
The vibrators shake out granular materials from rail cars, hoppers, and other large storage bins. They help newly laid concrete to settle and foundries to shake out sand molds. Previously, Branford vibrators shook loose from the equipment to which they were attached, or shook themselves apart.

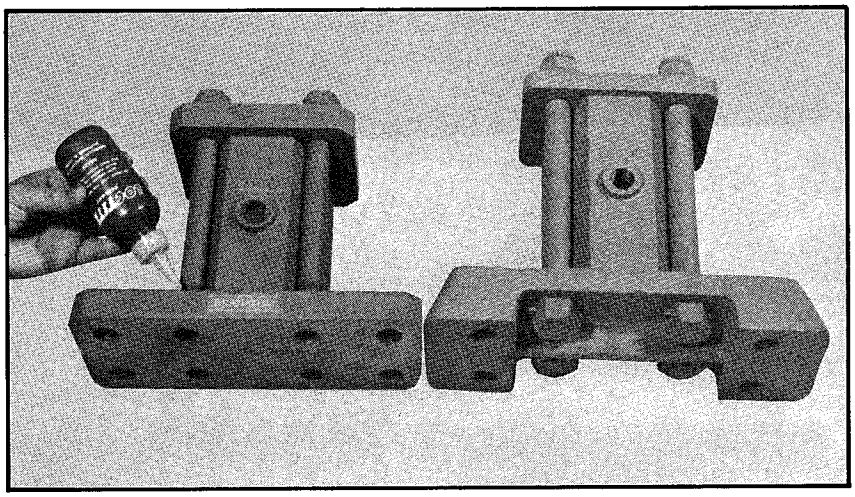
All types of mechanical methods had been tried, including double-nutting, welding, cotter pins, and triple lock nuts. All failed. The Loctite threadlockers brought a whole new standard to the industry — Branford could guarantee the units would stay in place and stay together.

Assurance against loosening brought new opportunities. Designs were simplified, accessories could be attached, and many fasteners were eliminated.



Above: Guarantee made possible. When threadlockers are used to attach vibrators, the company is able to guarantee its customers that the units will not shake loose.





Above right: Two Branford vibrators. Units are used to shake out containers but also tended to shake themselves apart prior to assembly with threadlocking adhesives.

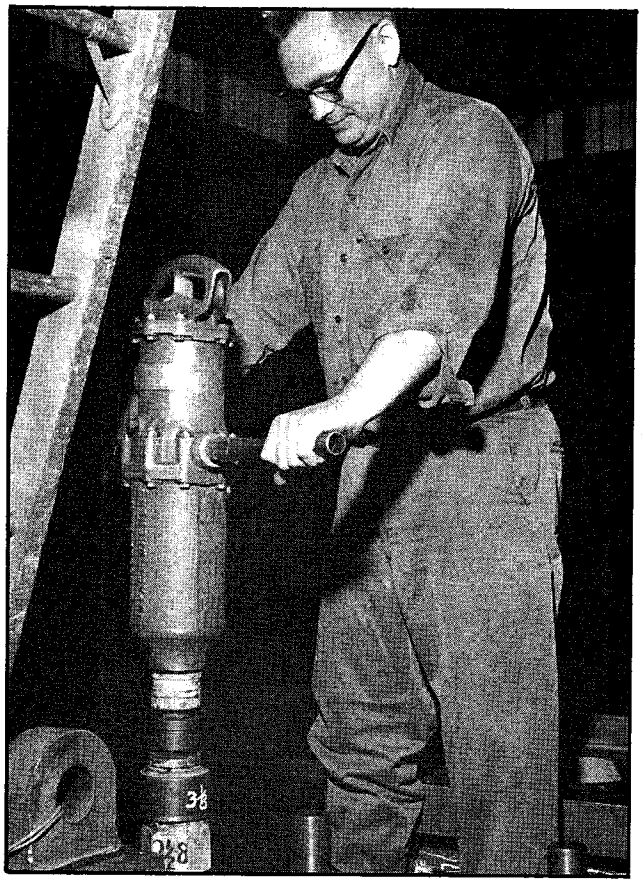
Below right: Threadlockers led to redesign. Unit at right was previous design. Nuts top and bottom, iron casting base plate. Unit at left is redesign: through-bolts into threaded steel base-plate. Fewer parts, stronger materials, less cost.

B. DANLY MACHINE CORPORATION

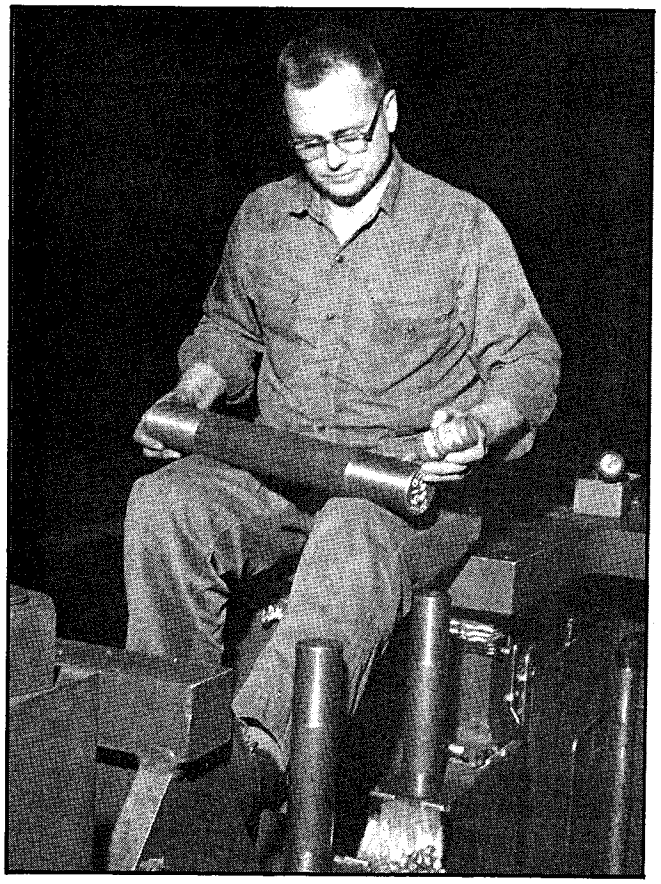
Anchoring giant studs

Danly stamping presses are among the world's largest, standing 30 to 40 feet high and weighing more than 1½ million pounds. The parts of these presses are held together with huge studs 2½ feet long and 3 inches in diameter. The old method of mounting such studs called for interference fits — the studs were driven into slightly smaller holes with jackhammers.

The problems of controlling thread size, interference, occasional broken studs or castings, and loosening of studs in the field convinced management more than 20 years ago to adopt Loctite threadlocking products. The Class 5 studs were reduced to hand-running Class 2 fits. Loctite 271 was applied to both the holes and the studs. The system continues in use today, credited with ending problems with broken studs and castings.



The old way of mounting giant studs. Jack hammers were used to force huge studs into castings. Some studs broke, some castings failed.



The new way of mounting studs: Class 5 fit is replaced by Class 2 fit, and studs are run in by hand. Liquid threadlocker secures them free of stress. Broken parts eliminated.

C. MOORE SPECIAL TOOL CO.

Maintaining millionths of an inch accuracy

The world's most precise machine tools are reputed to be built by Moore Special Tool Co, Inc. of Bridgeport, CT. The company pioneered machining to millionths of an inch accuracy, a dimension which can be altered by a machine operator's body heat. A number of anaerobic thread locking materials are used to prevent unwanted movement or shifting of parts on jig borers, grinders, and related equipment.

For example, all cap screws which hold the hardened ways to the machine bases are secured with anaerobic threadlocker. The slightest backing off would drastically affect machine accuracy.

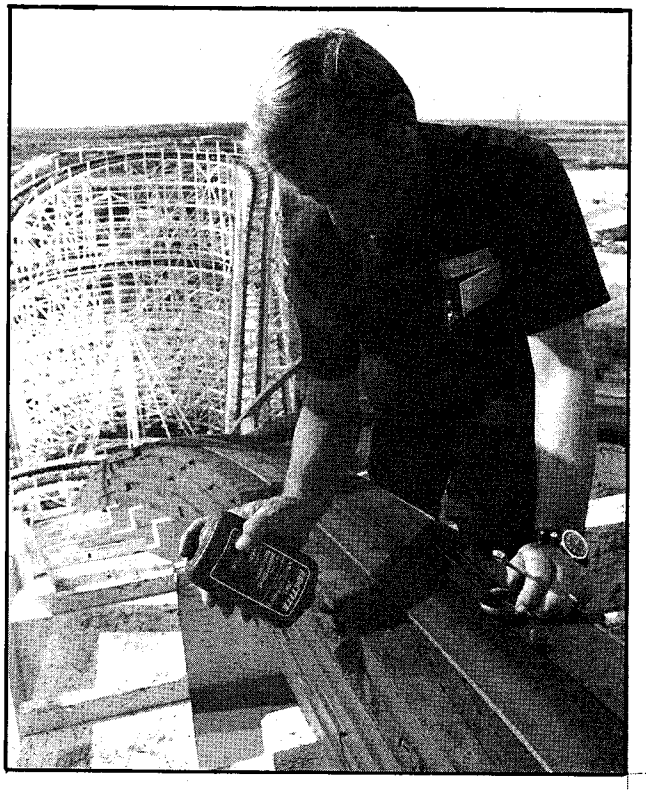
Another key application is on the end screws of precision vises. These are assembled with low torque to eliminate casting distortion and warpage. Throughout the Moore line, there are more than 80 applications of locking, retaining and sealing compounds.

Threaded fastener in high speed spindle is secured with anaerobic threadlocker. Assembly spins at 30,000 RPM.

D. KINGS ISLAND AND ASTROWORLD

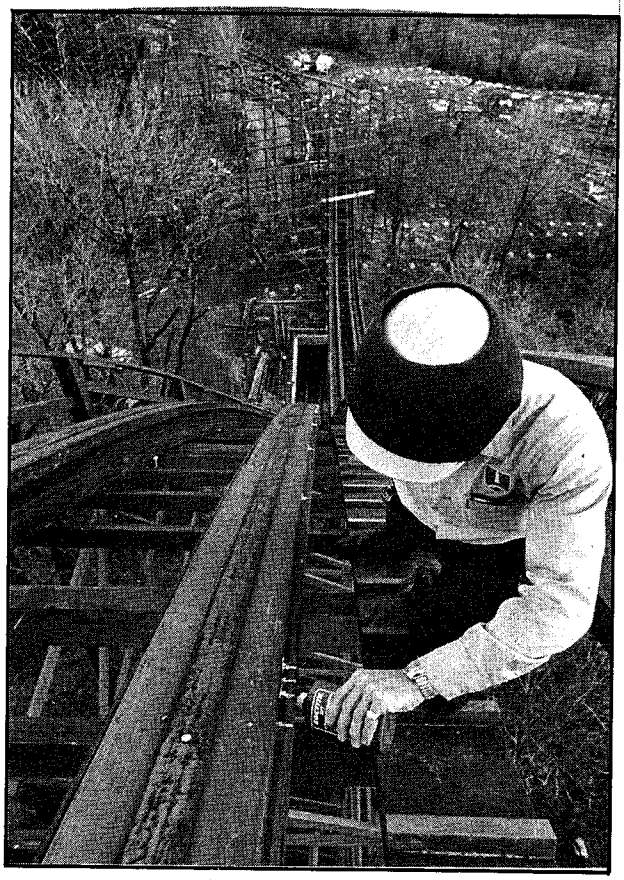
Securing roller coaster fasteners

"The Beast" is a $3.2 million rollercoaster, reputed to be the wildest, longest, and fastest in existence. Located in Kings Island, Ohio, the 7,400 foot track offers a 3½ minute ride at up to 70 miles per hour. The designers of The Beast sought ultimate safety and assembled the ride with 82,480 "Bowmalloy" bolts, a tough fastener which resists stretch, yield and 'necking out' common to other fasteners. To secure these special fasteners against the continuous intense bending and shock, the designers specified Loctite 277 threadlocking materials.



Texas Cyclone in Houston's Astroworld is secured with Loctite 290 which wicks into bolt threads. Shrinking wood allows fasteners to loosen.

Another rollercoaster which relies for safety on Loctite threadlocking reliability is the "Texas Cyclone" at Houston's Astroworld Park. A recent study rated it "the best rollercoaster in the world." Use of the threadlocker on the Cyclone was a retrofit situation. To avoid disassembly, the company chose Loctite 290, a thin grade, for application to the assembled fasteners.

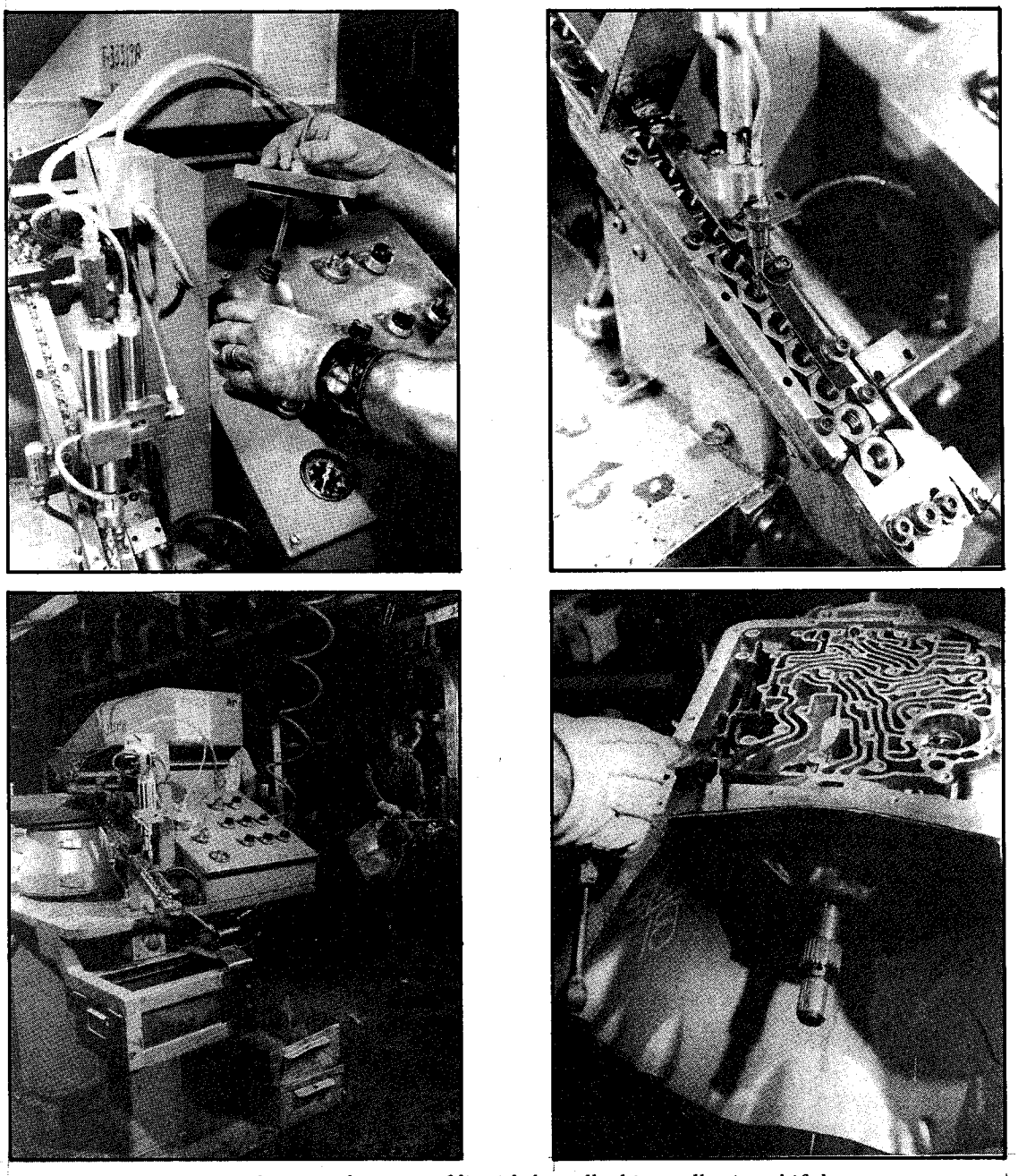


Locking threaded parts on The Beast at Kings Islands, Ohio. Thin Loctite 290 was applied after assembly and allowed to wick into threads.

E. BUICK SHIFT LEVER NUTS

Rapid fastener treatment

Back in 1973, nuts in Buick automatic transmissions were locked with anaerobic adhesive which was applied to the threads of each nut by a special machine, at a rate of 2,800 per hour. At that time, the operator took each fastener and assembled it by hand to the shift lever. The nuts had to be free-spinning for rapid assembly because of the fast-moving line. Although many nut treaters are still in use today, fasteners are being treated with pre-applied dry locking adhesive as a more efficient system.



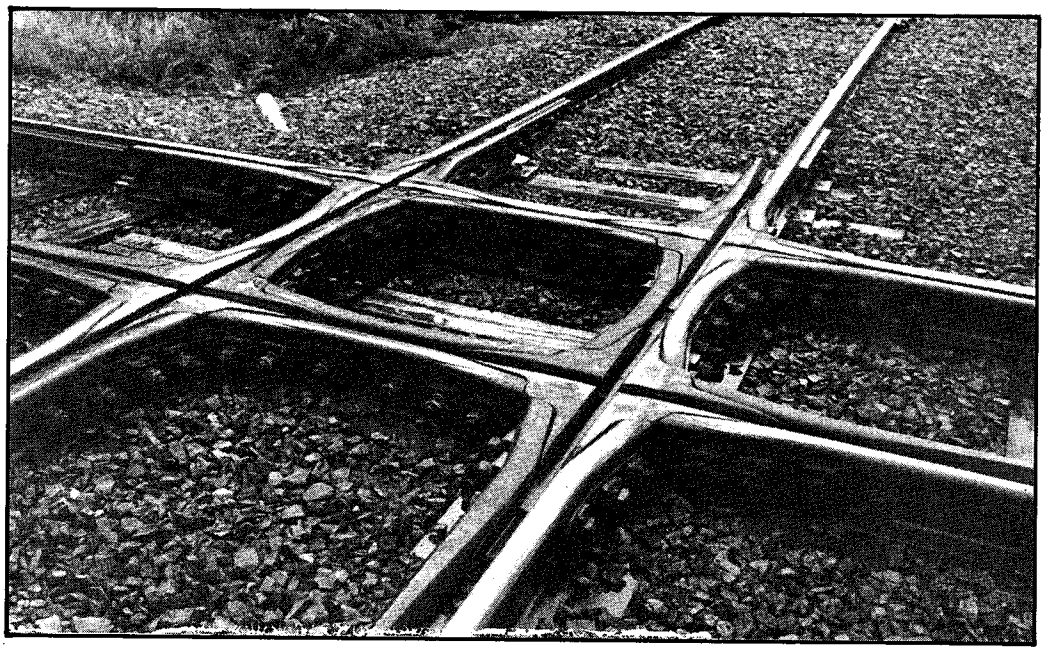
Old photos illustrate machine application of liquid threadlocking adhesive shift lever nuts on assembly line. Nuts are then mounted to secure transmission shift levers. Systems today use nuts which have been pre-treated with dry threadlocking material that is activated on assembly.

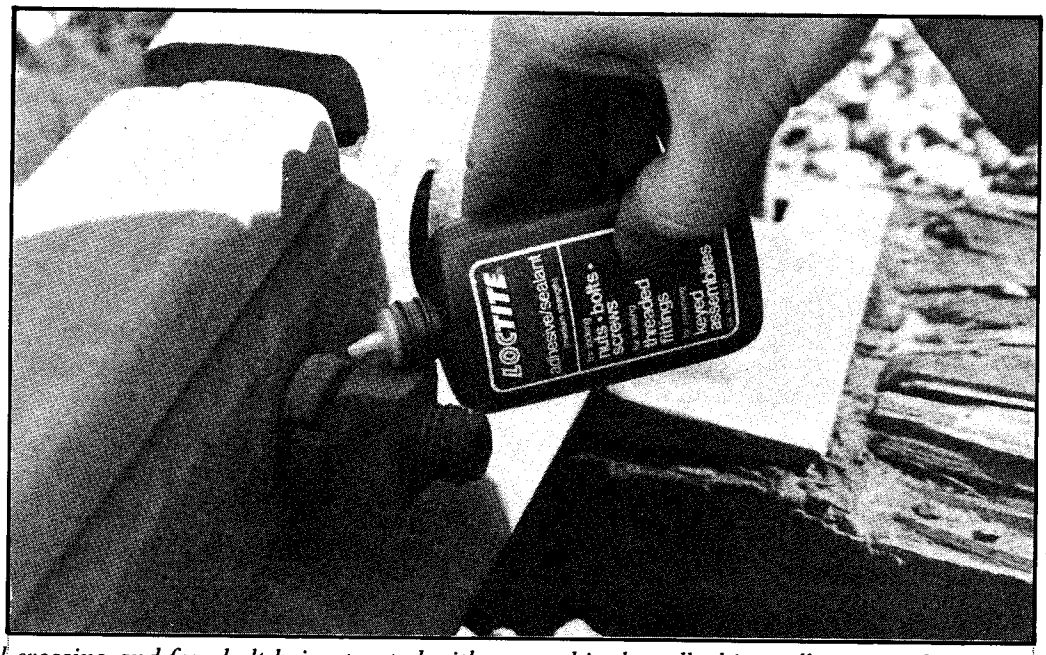
F. MISSOURI PACIFIC RAILROAD

Securing crossing track bolts

Keeping railroad crossing and switch frog bolts tight is a perennial task for roadmasters and track supervisors. Crews go out every year to re-tighten them. Traffic in Illinois is so extensive that the state's railroads cross each other in a spaghetti-like pattern all over the state. With so many crossings, maintenance crews were heavily involved in bolt retightening. To prevent such bolts from loosening, Loctite Corporation developed a material called "Rail Safe Track Bolt Lock" and supplied it to the Missouri Pacific Railroad.

The company had its crews back off bolts one inch, apply a layer of Rail Safe and then retighten. After a year of operation at a troublesome test crossing in Illinois, no bolts had to be retightened. The company now uses the procedure at all of its other crossings.





Rail crossing and frog bolt being treated with anaerobic threadlocking adhesive. Bolt is loosened, liquid applied and then bolt is retightened. Split ring washer has no locking function, contrary to popular belief.

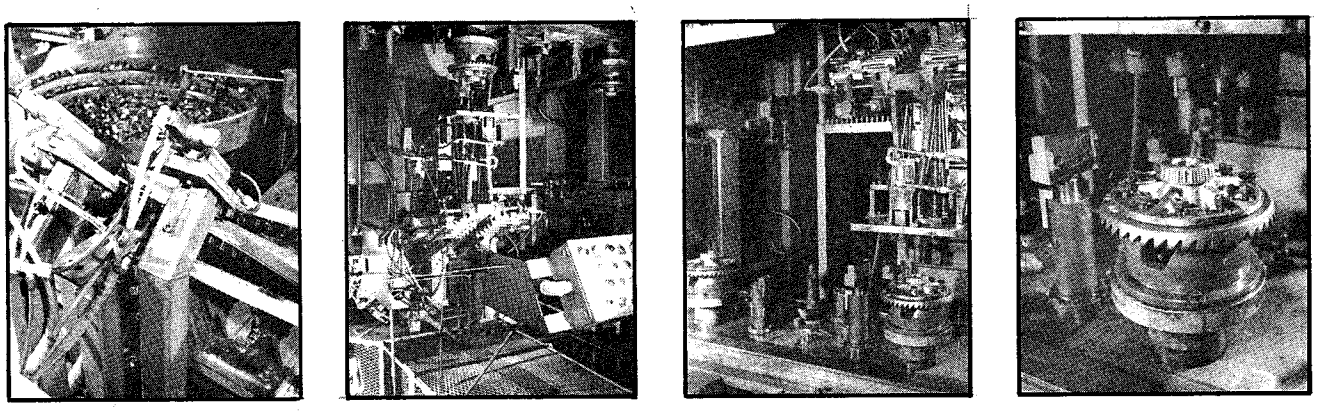
G. AUTOMOTIVE APPLICATIONS

Securing assorted fasteners

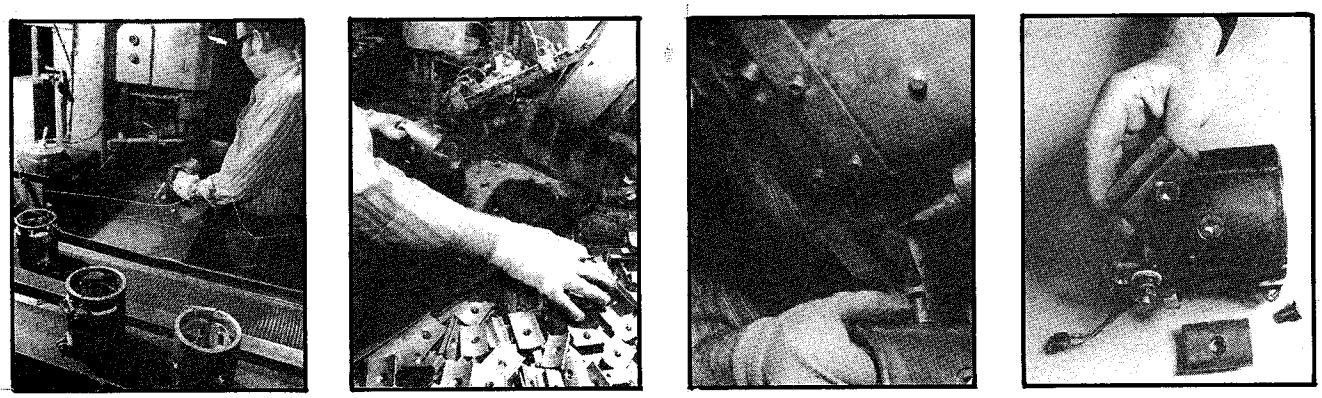
Threadlocking applications in the automotive industry have consumed the largest volume of chemical locking and sealing materials. There have been thousands of applications on such fasteners as studs, accessory bolts, flange nuts, linkage nuts, body bolts, main cap and rod bolts, pan cover bolts, wheel lugs, front-end bolts, electrical system screws and nuts, visor and mirror screws, turn levers, wrist pin bolts, rocker arm adjustment screws, shock absorber bolts, and many other.

In today's world of high reliability, precise torque tension and clamping force are critical needs. These new requirements are being met with fasteners that have lubricant under the bolt heads and locking compound on the threads. The growing sophistication in securing fasteners has made the lubricity of thread locking materials as important as their ability to properly secure parts, such as head bolts.

Starter pole pieces are a typical case in point. Each motor has four, held in place by a tapered head bolt that penetrates the case. These are short bolts with no inherent ability to retain clamp load without a liquid threadlocker. The bolts are torqued to 300 inch pounds. If they loosen they can cause starter failures and warranty returns. As engines became smaller they were subject to more vibration, which increased the incidence of loosening. At a Ford plant in the early '70's an automatic dispensing system was installed to apply a single drop of anaerobic compound to each pole piece screw. The procedure reduced failures of these assemblies to zero and warranty costs were greatly reduced.



Assembly station of differential bolts, secured with anaerobic threadlocker. Auto industry now prefers dry locking materials preapplied to fasteners.



Four photos illustrate treatment of starter pole piece screws with threadlocking adhesive to prevent loosening.

H. KOLBO KORP.

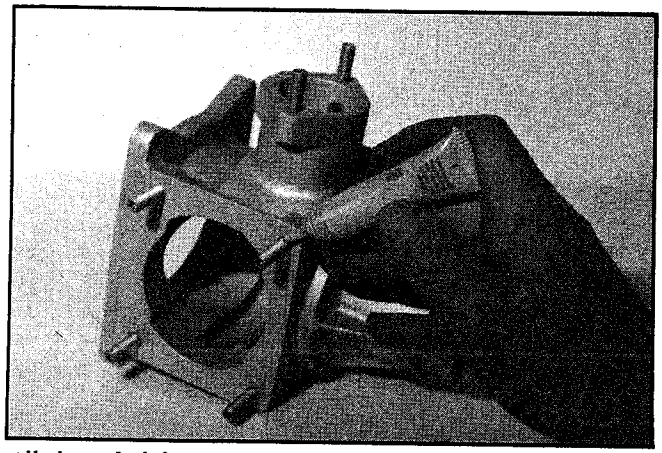
Securing small engine fasteners

Remotely Piloted Vehicles (RPV's) look like oversized model airplanes, but they do some important jobs. In the Middle East they are used for homing in on and destroying radar units, for surveillance and mapping. They can also take air samples from above smokestacks, check on radiation levels over nuclear plants, dust crops, and many other tasks.

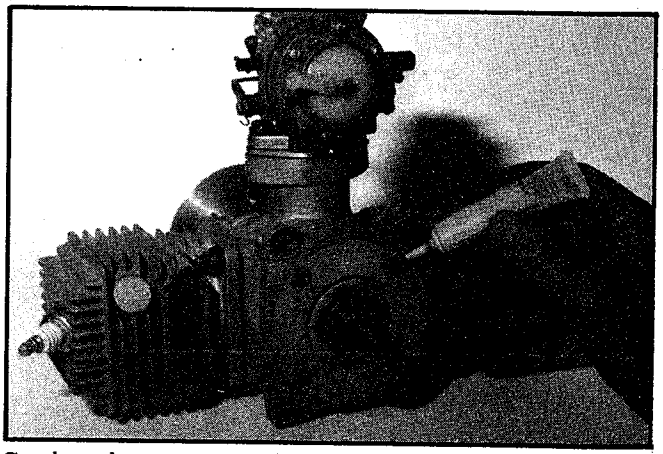
With no pilot on board they must be extra reliable, particularly the engines. A major producer of the 14 horsepower two-cylinder engines, Kolbo Korp of Anaheim, CA attributes much of the reliability of their engines to the use of anaerobic threadlocking materials on every threaded fastener in the aluminum and steel engines. Kolbo specifies either Threadlocker 271 or 272. This more reliable process eliminates costly locking devices, interference studs or titanium bolts and nylon inserts.

One key application is to secure two 160,000 psi cap screws that hold the piston connecting rod ends. In order to hold the precise torque required to prevent damage to the needle bearings between rod and crank, the fasteners are lightly coated with the compound before tightening. They are tightened with enough torque to prevent loose needles, while not distorting the bearing case. Other applications include head and carburetor studs, carburetor bolts, propeller hub nuts and stainless steel backplate bolts.

Size of RPV engine and prop is illustrated with Fred Kolbo holding assembly.



All threaded fasteners in Kolbo engine assembly are treated because smaller engines have higher vibration.



Steel studs are mounted into aluminum castings without stress damage when inserted with Class 2 running hand fit, and secured with anaerobic material.

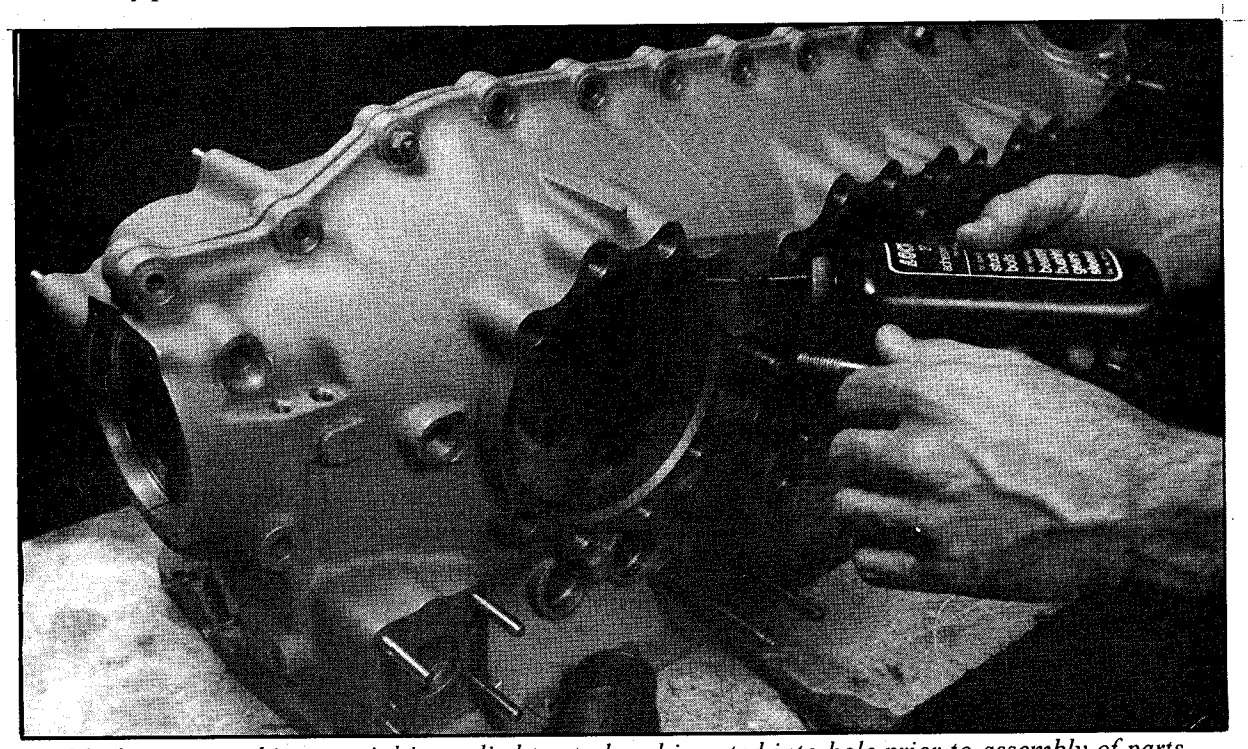
I. TELEDYNE CONTINENTAL MOTORS

Securing aircraft engine fasteners

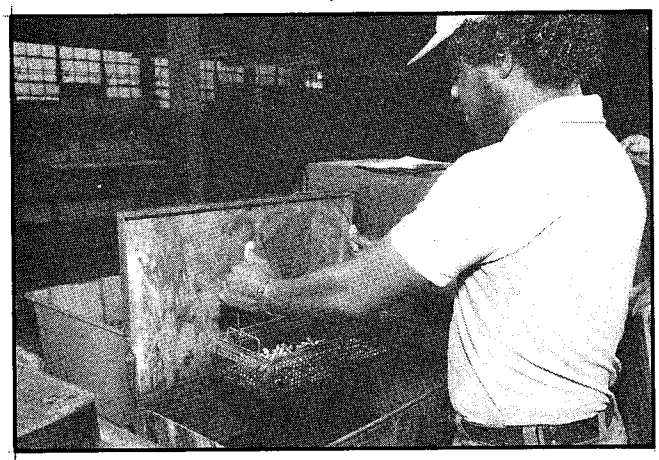
There are 92,000 Continental aircraft engines in active use, or 41% of the available business/recreational piston engine market. Over its 80-year history of building engines, the company has acquired a reputation for the highest possible reliability. It assembles the engines with anaerobic threadlockers on virtually all fasteners. For example, 48 steel cylinder and accessory mounting studs are inserted into the alodized aluminum crankcase castings. The threaded holes are through-bored to the crankcase chamber.

The assembly procedure calls for studs to be primed in a dip tank. The casting holes are also primed with a spray can. Loctite Threadlocker 271 is squirted into both the hole and the stud threads. A tool then runs the studs to a precise depth.

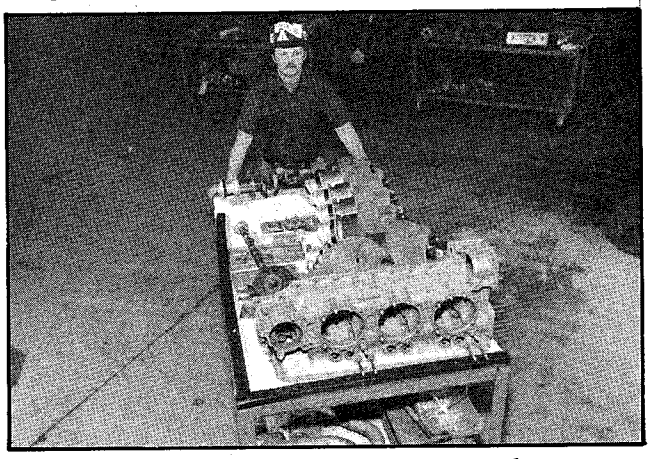
Prior to this method, Class 3 fits were used. These stressed the crankcase casting, and studs broke during assembly at great expense. For the longer, thinner accessory studs, Loctite 222 is used. This milder strength, slower curing material adds assurance that studs will not be broken if cure starts while running the studs into place.



Stud locking anaerobic material is applied to stud and inserted into hole prior to assembly of parts. These studs will hold cylinder to block casting. Alodized parts require priming.



Class 3 studs are dipped into Locquic primer prior to use on assembly line.



All engine parts for Continental engine are kept together throughout their life cycle. Rolling stand contains a complete engine.

J. McCULLOUGH ALUMINUM TRAILERS

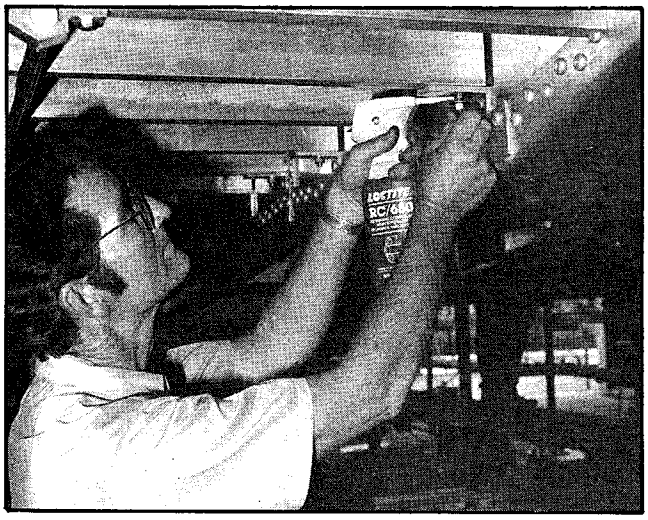
Bolting and bonding replace welding

Flat bed truckers have long desired lighter weight aluminum trailers to realize higher payload profits in areas that restrict gross loads. However, builders who have assembled aluminum flat beds with welding torches (the common method for steel) have not achieved the ultimate reductions. McCullough Aluminum Trailer Company of Dunn, NC, has developed a new method which is proving highly successful: adhesive bonds combined with bolts for all parts. The adhesive contributes 4,000 psi of bonding shear strength and the stainless steel Huck bolts contribute another 4,000 psi with high peel resistance.

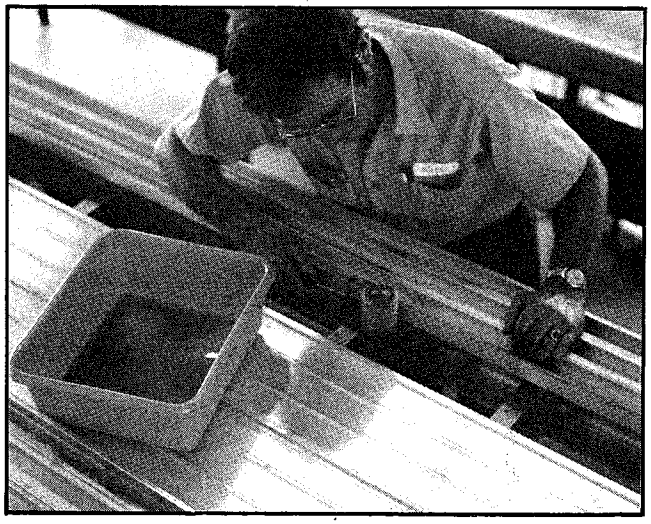
All fasteners are stainless steel, including the nuts and washers. These are assembled with Loctite 680 adhesive which performs a dual function: it prevents galling during assembly, then cures to prevent loosening. Some Grade 5 high tensile steel bolts are required in the suspension area, and these are isolated from the aluminum in stainless steel sleeves to prevent electrolytic corrosion.

The adhesive is Loctite 324, used without primer to extend the curing time as long as possible. This allows the bolted assembly to settle into its natural position prior to the adhesive cure.

The result of the assembly process is a 7,000 pound flat bad trailer which has a 4,200 pound greater payload than its steel counterpart. The added payload pays for the trailers in less than a year.



Extra strong anaerobic material is applied to stainless steel fastener under aluminum trailer.



Flat bed parts are bonded together with Loctite structural adhesive.

Loaded aluminum trailer ready to make delivery run with 4200 extra pounds of payload.

K. MERCURY MARINE

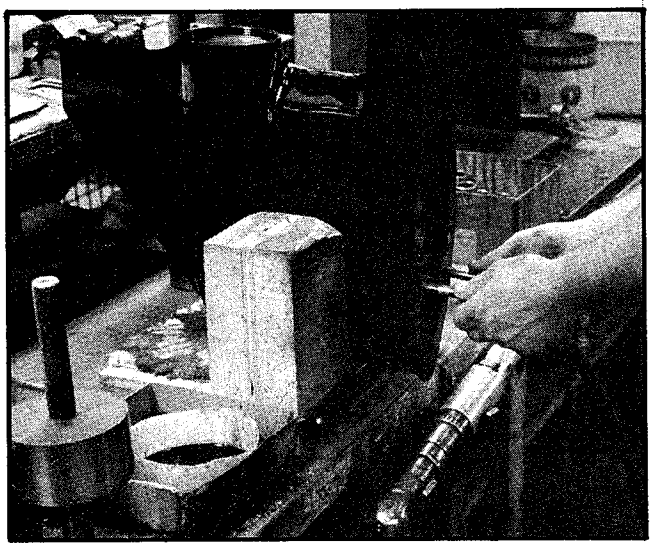
Securing outboard motor fasteners

Mercury Marine outboard motors are famed throughout the world for their reliability. Numerous threaded fasteners are secured with threadlockers and sealants. Applications include:

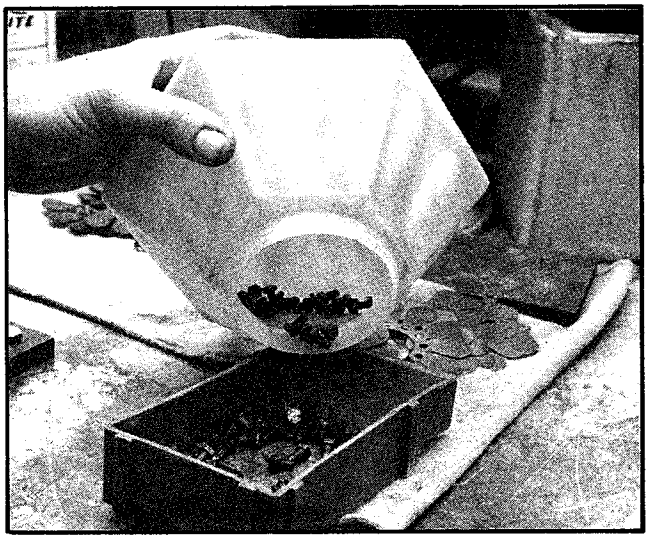
- Lock and seal nylon and brass fittings which admit oil and fuel mixture into the power head.
- Retain studs in aluminum castings in lower gearcase housing.
- Seal threads at each end of the hydraulic cylinder of the power trim.
- Retain block studs which hold the crankcase housing.
- Lock threads of stern drive shift actuator cam retaining screw
- Lock steel studs in aluminum lower drive unit gimble housing.

Prior to these methods, specifications called for Class 5 steel stud threads with .005" interference. These resulted in cracked castings during assembly, and even worse, some failures after engines were in service. The studs have since been switched to Class 2.

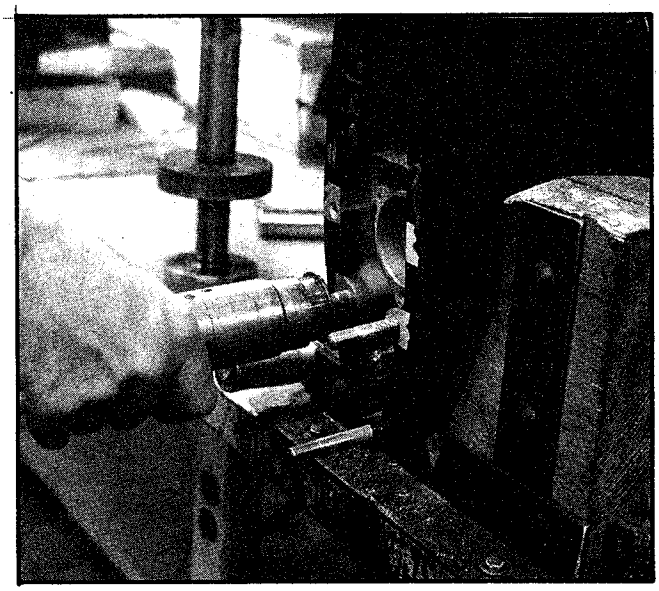
Steel studs are retained in aluminum lower end unit. Liquid is being inserted into blind hole.



Studs are started by hand.



Air intake vane fasteners are coated with threadlocker by tumbling in small rotating drum.



Air tool runs stud into pre-treated hole in lower end unit. Air tool is used for speed, not to apply force. Press fit has been eliminated.

BIBLIOGRAPHY

"What's New In Fasteners," *Metal Progress,* (May, 1968), p.60

"Designing With Threaded Fasteners," *Mechanical Engineering,* (October 1983), p.17-31

"Myths That Must Be Shattered," *Automotive Industries,* (April, 1982), p.43

"Keeping Fasteners Tight," *Machine Design,* (September 18, 1975), p.86

"Fastening Directory," *Design News,* (1985), 170 pages

"Assembly Technology Buyers Guide," *Assembly,* (1986), 400 pages

"Fastening & Joining Reference Issue," *Machine Design,* (November 14, 1985) 156 pages

The Heritage Of Mechanical Fasteners, Industrial Fasteners Institute, (1974) 32 pages

"What Is A Screw? What Is A Bolt?," *Assembly Engineering,* (November, 1965)

Fasteners, Industrial Fastener Institute, (undated), 16 pages

Effects Of Marine And Industrial Atmosphere Corrosion On The Strength Of Ferrous And Nickel-Alloy Bolted Joints, Battelle Memorial Institute, (April 27, 1971) 36 pages

Corrosion Of Ferrous Fasteners And Their Coatings, The American Society Of Mechanical Engineers, (March, 1968) 12 pages

A Logical Approach To Secure Bolting, Loctite Corporation, (1981), 26 pages (112481)

The Technology Of Preapplied Adhesives And Sealants, Loctite Corporation, (1984), 8 pages (LT-953)

A New Look At Locking & Sealing Studs, Loctite Corporation, (1971) 8 pages

Design Handbook, Loctite Corporation, (1968) 160 pages

Mechanical Engineering Design, Joseph E. Shigley, *McGraw-Hill,* 695 pages

Product Specifications

Loctite® Threadlockers used on a standard fastener can eliminate expensive locking devices while you increase the reliability and quality of your assembly. One drop prevents loosening. Two removable strengths for large and small applications and a permanent strength for locking parts you never want to take apart.

PRODUCT BENEFITS

Loctite threadlockers:

- Prevent fastener loosening.
- Work where mechanical methods fail.
- Provide extra insurance on critical assemblies.
- Assure that parts can be removed.
- Act as a thread lubricant.

TYPICAL APPLICATIONS

- Lock bolts in heavy equipment, such as bulldozers, plows, tractors, etc.
- Secure bolts in machine tools and presses.
- Permanently mount studs, even under the most severe conditions.
- Secure bolts in pumps and compressors, prevents leakage past threads.
- Secure small screws in lathes, meters, gauges and allow easy removal.

PRODUCT PROPERTIES

Uncured Properties

	222	242	262
Resin (Anaerobic)	Dimethacrylate	Dimethacrylate	Dimethacrylate
Viscosity (Brookfield at 20 RPM)	700-1300 cp (mpa's)	900-1300 cp (mpa's)	1300-1700 cp (mpa's)
Specific Gravity	1.05	1.05	1.1
Flashpoint (Cleveland Open Cup)	Above 200° F (93° C)	Above 200° F (93° C)	Above 200° F (93° C)
Shelf-Life (Liquid At R.T.)	1 year minimum	1 year minimum	1 year minimum
Toxicity	Low	Low	Low
Corrosivity (Per MIL-S-22473-D)	None	None	None
Color (Fluorescent)	Purple	Blue	Red
Cure Speed (Time to 20% on steel)	10-30 minutes	10-30 minutes	3-10 minutes

Cured Properties

Shear Strength (2)	600 psi (4.1 mpa) (low)	800 psi (4.4 mpa) (medium)	2000 psi (14 mpa) (high)
Operating Temp. Range	–65 to +300° F (–54 to 149° C)	–65 to +300° F (–54 to 149° C)	–65 to +300° F (–54 to 149° C)
Resin	Solid Polyacrylate	Solid Polyacrylate	Solid Polyacrylate
Color	Purple	Blue	Red

Cure Speed

	STEEL		PHOS/OIL	
	Fixture	**Full Cure**	**Fixture**	**Full Cure**
222	10-30 min.	24 hrs.	10-30 min.	24 hrs.
242	10-30 min.	24 hrs.	10-30 min.	24 hrs.
262	10-30 min.	24 hrs.	30-min.-1 hr.	24 hrs.
	ZINC		**CAD.**	
	Fixture	**Full Cure**	**Fixture**	**Full Cure**
222	2-4 hrs.	24 hrs.	2-4 hrs..	24 hrs.
242	30 min.-1 hr.	24 hrs.	2-4 hrs.	24 hrs.
262	1-2 hrs.	24 hrs.	30-min.-1 hr.	24 hrs.

Assembled parts may be put in service immediately. On slow surfaces, Primer T or Primer N may be used to accelerate cure.

Environmental Resistance

Solvent Resistance (Tested per Mil-S-22473-D)
Percent retained strength after 30 days at 188° F (87° C)

Solvent (% reference)	222	242	262
Air Reference @ 180° F	100%	100%	100%
Motor Oil	67%	100%	100%
Water	35%	27%	100%
Glycol/Water	27%	30%	98%
Transmission or Fluid	88%	100%	100%
Gasoline	67%	95%	86%
Skydrol	82%	95%	78%
Gasohol	—	87%	—

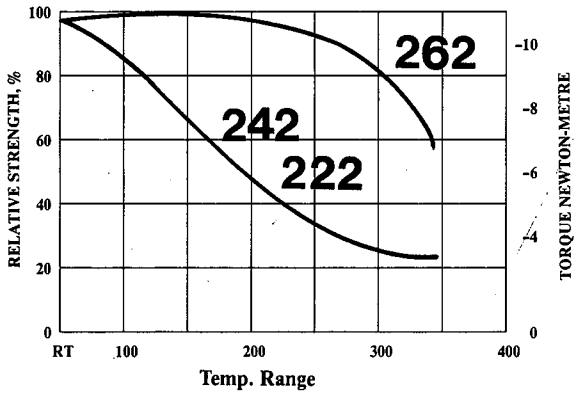
Cold Strength

Air + 72° F	100%	100%	100%
Air – 100° F	170%	130%	64%

Hot Strength

The chart below shows the hot strengths of these adhesive/sealants. Testing was performed on ⅜"-16 steel nuts and bolts cured at room temperature for 24 hours. Values were recorded when samples reached test temperataure.

Hot Strength of Loctite 222, 242, & 262 on steel surfaces.



One Of These Five Dri-Loc Adhesive Types Is Right For You . . .

(Pre-Applied Thread Locking Products)

PRODUCTS FOR LOW AND HIGH SPEEDS

A. Dri-Loc Adhesive 203 (Silver) Mild locking/sealing strength.

B. Dri-Loc Adhesive 202 (Green) Medium locking/sealing strength.

C. Dri-Loc Adhesive 200 (Yellow) High locking/sealing strength.

D. Dri-Loc Adhesive 204 (Red) High locking/sealing strength for plated fasteners.

E. Dri-Loc Adhesive 201 (Yellow) — High strength — High temperature to 400° F.

Controlled Torque Tension falls within narrow predictable limits.

Low on Torque — coating lubricity requires ¼ of the maximum allowable torque specified by Industrial Fastener Institute IFI-124.

Speeds Production — nothing to add, ready to use — just screw them in; no special handling, machining or unusual preparation necessary.

Instant Sealing — Through holes are immediately and positively sealed at temperatures ranging from -65° F to 300° F. Dri-Loc 201 performs to 400° F.

Inhibits Corrosion between mated threads. Adhesive/sealant assures easy disassembly — even after years of service.

DRI-LOC® PROPERTIES SUMMARY

UNCURED STATE					
Formula	200	201	202	203	204
Color	Yellow	Yellow	Green	Silver	Red
Fixture Time	10 minutes	10 minutes	10 minutes	10 minutes	10 minutes
Base	Methacrylate Ester	Methacrylate Ester	Methacrylate Ester	Methacrylate Ester	Methacrylate Ester
Flashpoint	Above 200° F (93° C)	Above 200° F (93° C)	Above 200° F (93° C)	Above 200° F (93° C)	Above 200° F (93° C)
Toxicity	Low	Low	Low	Low	Low
CURED PROPERTIES					
Strength Range	High	High	Medium	Mild	High
Breakaway Torque (Note 3)	220 lb.-in.	245 lb.-in.	200 lb.-in.	160 lb.-in.	280 lb.-in.
Shear Strength lb./in.²	2400 psi shear	2700 psi shear	2200 psi shear	1800 psi shear	3100 psi shear
Temperature Range	-65° F to +300° F (-54° C to +150° C)	-65° F to +400° F** (-54° C to +204° C)	-65° F to +300° F (-54° C to +150° C)	-65° F to +300° F (-54° C to +150° C)	-65° F to +300° F (-54° C to +150° C)
On Part Life	4 years	4 years	4 years	4 years	4 years
Cure Time @ R.T.	72 hours	72 hours	72 hours	72 hours	72 hours

Dri-Loc Adhesive/Sealant Application Method

Dri-Loc® Adhesives are applied to threaded fasteners by authorized converters throughout the United States. Bolts with diameters of 1/16″ through 3/4″ and with shank lengths of 3/8″ to 6″ can be coated with specially developed equipment. Quantities can be handled promptly with minimum turnaround time. Production parts can be coated by user or franchised coating processor.

To request additional information please call (203) 246-1223 for the name of your nearest Loctite Marketing Representative. In Canada, call (416) 625-6511.

ABOUT THE AUTHORS

GIRARD S. HAVILAND

Girard S. Haviland is manager of the Loctite Engineering Center. This group provides technical services and information to Loctite Corporation's Divisions, distributors and customers around the world.

Author of 16 technical publications, Haviland holds 50 U.S. and foreign patents and is a recognized authority on machinery adhesives. His book *Machinery Adhesives For Locking, Retaining and Sealing* is available from Marcel Dekker, Inc., 270 Madison Ave., N.Y., N.Y. 10016.

Haviland has a BME from Cornell University, a BSME from Vanderbilt University and has been named a Certified Manufacturing Engineer for life by the Society of Manufacturing Engineers. His professional memberships include the SME, ASME, ASTM, SAMPE, ASM and EXI.

DALE BARSNESS

Dale Barsness is a Senior Product Manager for Loctite Corporation. He is responsible for thread locking and flange-sealing products. He holds a BS in chemistry from the University of North Dakota and an M.B.A. from the University of Hartford. He was previously with the GE Silicone Products Division and the Research and Development Center at Wright-Patterson Air Force Base. He has authored ten major technical publications.

WILL BARBEAU

Will Barbeau, president of Barbeau Associates, Inc., has served as public relations consultant to Loctite Corporation since 1961. He has written hundreds of technical articles on all aspects of anaerobic technology.

In the course of his 30-year professional career Barbeau has executed public relations programs in support of marketing efforts for many large firms in the industrial northeast.

He is an accredited member of the Public Relations Society of America and a charter member of the Society's Counselors Section.

Barbeau holds a BS degree from Bates College and completed graduate work in public relations at Boston University.

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Loctite Corporation
Industrial Group

For the name of your nearest Loctite distributor, call 800-562-0560. In Canada, call 800-263-5043.

Loctite products are available from your authorized Loctite products distributor. Many are members of trade associations as indicated by logos as shown.

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