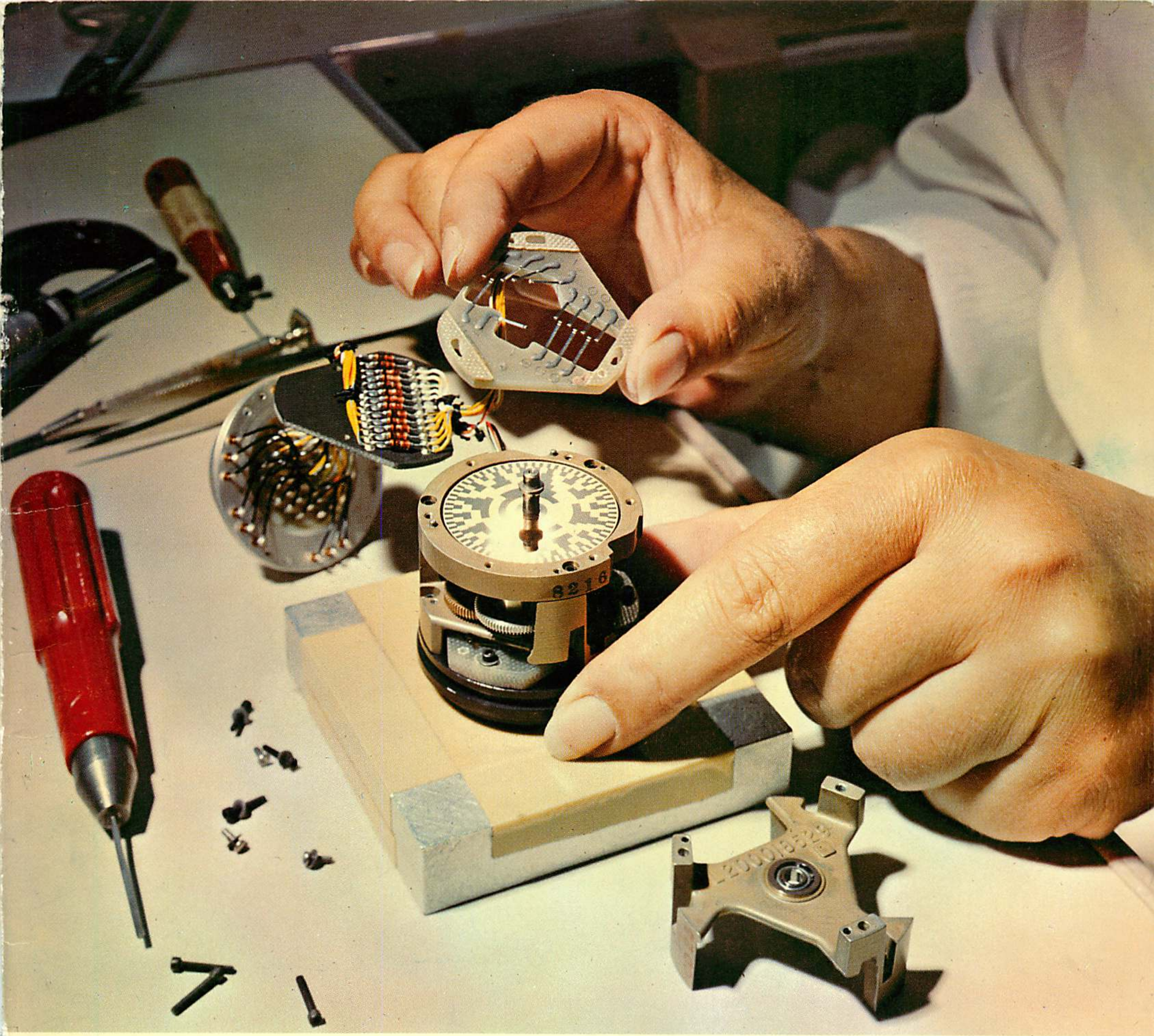
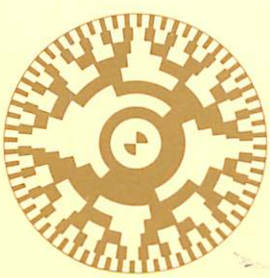


General Precision, Inc., Librascope Group



ENCODERS

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"AN ENCODER: A functional device more intricate and precise than a piece of jewelry. Its beauty lies beneath its surface."

A high-speed aircraft vectors in on its carrier and lands while the pilot watches, as a spectator with a front row seat. Immediately, the carrier's radar array concentrates on the next plane peeling off from the inbound squadron and at the same time carefully keeps watch on all other planes in the surrounding area. In each aircraft, tiny motors and shafts rotate small devices which translate shaft motion into numbers which are fed into compact digital computers.

A first cousin to these same devices turns with the carrier's radar while others feed shaft-related numbers, in an astronomical flood, into computing centers aboard the carrier, aboard the planes, and elsewhere in the task force.

Hundreds of tons of hot, newly formed, sheet steel spew from forming rollers at 30 miles per hour. The thickness and width of the sheet vary slightly within preset tolerances. Small shaft-operated devices turn slowly as width and thickness change—ever watchful, ever reporting to control centers the exact measurements of the steel being processed.

A giant radio telescope focuses on a minuscule radio signal emanating from the deep reaches of interplanetary space and numerically pinpoints the exact location and progress of an unseen man-made vehicle of almost unimaginable reliability and perfection. Simultaneously, devices on the space probe digitally report their positions and are digitally manipulated to maintain precise control of the vehicle along a curved path through the heavens to a degree of accuracy impossible but a few short years ago.

Two supersonic aircraft at the same altitude converge at a frightening rate of closure. An air-traffic-control radar beam sweeps across their transponders and an altitude signal is digitally transmitted from both to a ground receiver which processes the information to determine identification and exact locations. A computation is made. A message is flashed back and the planes pass safely without their pilots ever having achieved visual contact.

The wind-swept surface of the ocean shudders, then opens up with a mighty roar as an unannounced giant leaps from the depths, gathers speed, and with unprecedented accuracy streaks towards a target represented only by numerical coordinates on a map in a missile-control center sheltered safely beneath the waves.

A lathe spins quietly in the corner of a machine shop while its tools respond as though by magic and a precise metallic shape forms from a piece of raw metal, to be followed by another, over and over again without deviation. Another tool drills a pattern of holes in a block of metal while the operator takes a coffee break.

A theodolite follows and photographs a speck in the sky and numerically tells a computer its changing angular positions while at the same time the angular measurements are printed on each frame of the film.

A launcher turns slowly in response to a numerical command, lifts its cargo skyward, and a missile roars into space for a rendezvous.

A truck slips into position beneath a loading chute and a predetermined mixture of sand, gravel, and cement automatically fills the maw of its rotating mixer.

The cargo in a pipeline changes from fuel oil to liquid petroleum gas as sensors digitally communicate the occurrence to a control center 1500 miles away.

The college entrance exams from a new flood of applicants spew from the hopper of an automatic checking and grading machine. Some flunk, some matriculate.

An unknown sample of raw material passes before the business end of an X-ray diffractometer and suddenly its composition is known by a digital computer.

All of the foregoing occurrences are related in that their numerical functions originate in devices practically unknown a decade and a half ago. These devices are referred to as "encoders," or more precisely, as "shaft-position encoders," or simply, as "shaft encoders," to differentiate them from solid-state devices of more recent origin which perform a different encoding function.

What is a shaft encoder? It could be described as a most intricate and precise piece of jewelry, except that it is strictly functional in nature and its real beauty lies hidden beneath its surface. Here, glittering pure gold, platinum, rhodium, and other exotic metals abound while its outer surface is coated by a dull-looking member of the family of rubies and sapphires.

But, let us look at the shaft encoder in a more scientific and historical manner and depart from esthetic values and applications.

Some of the more than 250 encoder models manufactured by Librascope.

The Encoder Story at Librascope: From Scientific Pioneering to Mass Production

How an Encoder Functions

A shaft encoder is a device which translates shaft rotation (or linear motion) into digital form. Encoders are complex digital instruments, and are built with the highest degree of precision. An encoder consists basically of a shaft affixed to a disc upon which a unique arrangement of metallic and nonconductive areas exist. The metallic areas of the disc are electrically energized. The disc (commutator) rotates beneath a fixed array of many contact brushes. Each brush is connected to a wire which is brought out of the encoder. As the disc rotates, the brushes are energized when they touch the metallic surface and carry current out through their respective leads, or they carry no current when they rest on insulation. There exists a different pattern of energized and nonenergized brushes for each discrete position assumed by the disc. And, the pattern repeats itself each time the disc rotates. Thus, the position of the shaft is known at all times in terms of brushes which are carrying current and those which are not. The disc pattern geometry is so designed that binary codes are produced at the brush output leads.

Librascope Group of General Precision, Inc., one of the largest manufacturers of encoders, offers this brochure describing its encoder products and capabilities. We do this to promote better understanding of the techniques of manufacturing and the uses of encoders by those who apply them in digital systems.

Librascope's Product Line

The Librascope family of encoders is produced and marketed by the Components Division. The encoder line is comprehensive and includes the following types in various classes, sizes, and ranges:

- BCD (Brush)
- U-Scan (Magnetic)
- Hybrid (Magnetic-Brush)
- Gray Code (Magnetic)
- Binary U-Scan (Brush)
- V-Scan (Magnetic)
- ICAO Altitude (Brush)
- M-Scan (Brush)
- Gray Code (Brush)
- Incremental (Magnetic)
- Sine/Cosine (Brush)
- V-Scan (Brush)
- Electromechanical Digital Shaft Comparators

Librascope Pioneers

Librascope began manufacturing encoders in 1952, and through the years has steadily advanced the state-of-the-encoder art by constant development work and perfection of manufacturing techniques. Much of the current capabilities of encoders used throughout the world rests on a basis of earlier inventions produced at Librascope.

Headquarters building of Components Division, Librascope Group, General Precision, Inc., in Glendale, California.

Mass Production Cuts Costs

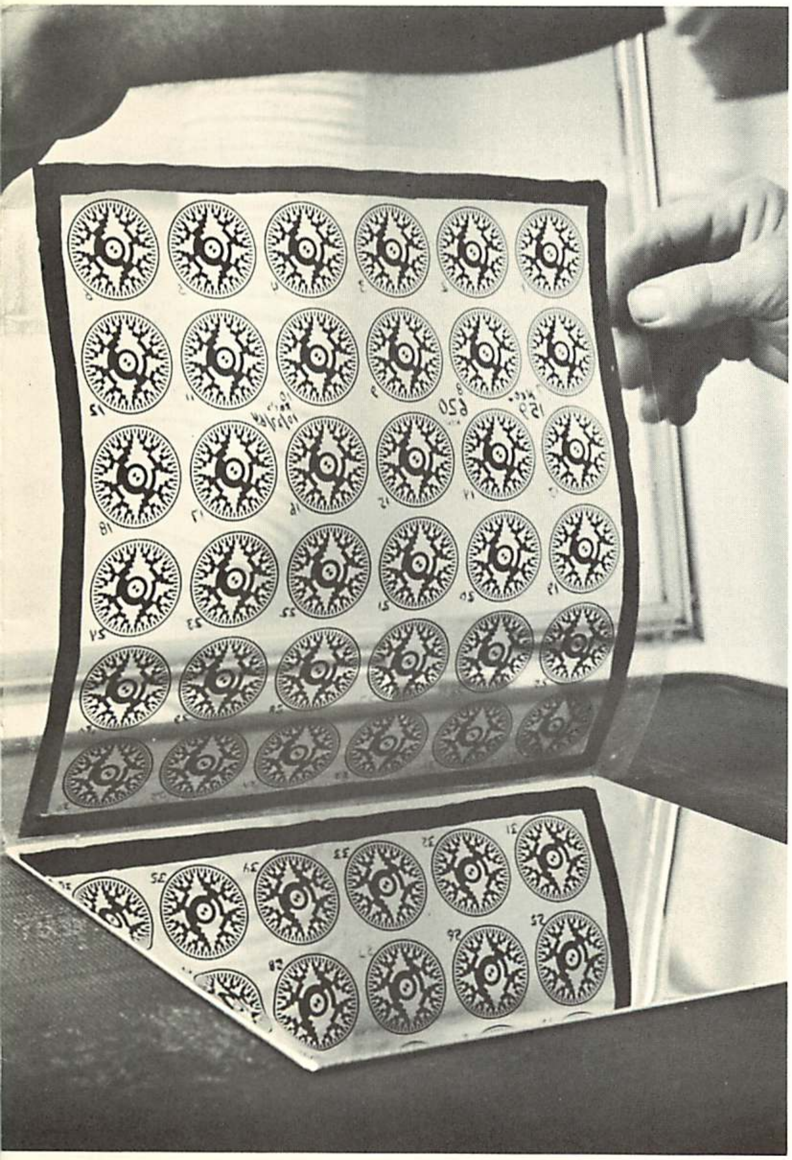
Manufacturing processes and techniques have been perfected to mass-produce encoders and to make possible significant price reductions. To simultaneously accomplish these substantial price reductions, while improving products, Librascope expanded and streamlined its manufacturing facilities.

Librascope's Components Division recently moved to new manufacturing facilities and is currently occupying one of the most complete and modern plants in the encoder industry. All manufacturing equipment is the latest design to assure efficient production of quality products. This equipment is installed in three modern, air-conditioned buildings with an area of approximately 70,000 square feet. In addition to these facilities, the Components Division has the direct support, and uses the capabilities, of other Librascope divisions. These capabilities include complete environmental laboratory facilities, a research-and-development center, a computer and electronic data processing center, and the numerous other services available within a large corporation.

Masters at Work

Librascope's Components Division employs more than 360 engineers, chemists, technicians, and support personnel who are responsible for Librascope's encoder production. This production is not only based on efficient facilities and techniques, but equally important, it includes the dedication of highly skilled personnel who have mastered the specialized manufacturing techniques for shaft-position encoders.

Fabricating Encoders at Librascope: A Study in Precision



In one of the first steps in fabricating an encoder commutator disc, technician positions negative on photosensitized plate before developing commutator image.

Creating the Commutator Disc: The Most Critical Task

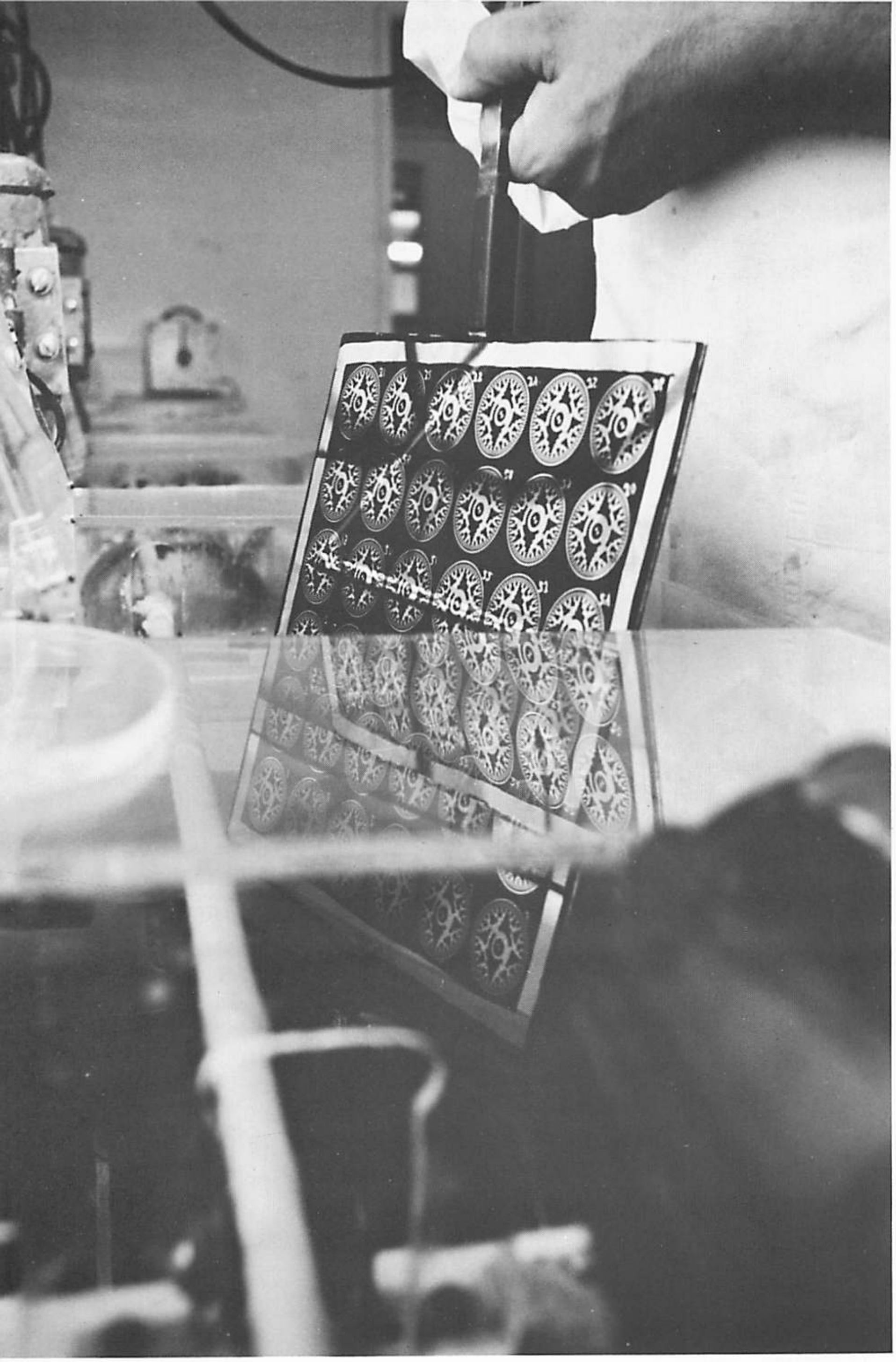
The most critical part of a brush encoder is the commutator disc. The commutator disc has a gold-plated geometric pattern on its surface. The pattern consists of electrically conductive and nonconductive segments that control the digital output of the encoder.

Designing the Disc

The commutator is conceived as a series of computations, calculated by an engineer, who accurately computes the angles and compensation offsets for all count transitions on all code tracks. He often programs a computer to perform this detailed task for him.

Preparing a Master Layout

These complex computations are then transferred to a precise master layout, a disc master, many times the size of the commutator disc which will ultimately result from his work. The master is photographically reduced with precision optics to its actual encoder size. A ganged photographic negative with multiple reproductions of the master is prepared, and is sent to the plating laboratory for processing. The negative is photographically exposed on a mirror-like plate of photosensitized material. The plate is then developed much like a snapshot.

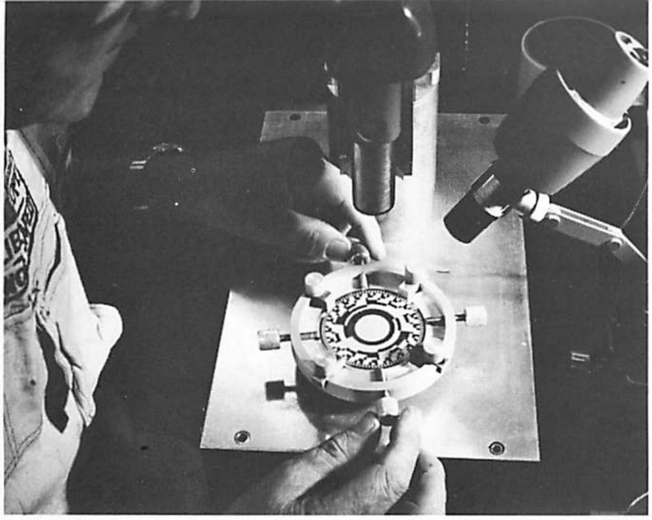


Goldsmith places plate with developed commutator images into a 24-carat gold-plating tank. Gold plating is transferred onto the commutator images.

After gold plating, technician then strips plated images from plate, in preparation for curing process.

Curing completed, inspector examines each disc image for imperfections. Discs that pass inspection go to next operation.

Discs are inspected again after cutting apart. Imperfect discs are discarded.



Technician precisely locates center of each disc. Hole is then drilled for future shaft placement.

Technician tests each disc for short circuits after center holes have been drilled.

Gold Plating

After development, the panel is gold plated. The gold used has a purity in excess of 99%; as such it qualifies as 24 carat. A minute amount of non-gold material, precisely controlled, is added for functional reasons. The resultant plated image becomes the first portion of what will eventually be a group of high quality commutators.

Curing

The gold image is removed from the plate and is fastened to an aluminum panel with a space-age epoxy. Then the entire assembly is placed in a high temperature multi-ton hydraulic press for curing.

Inspecting

After curing, the panel is removed from the press and a minute examination is made of the panel to assure that only microperfect disc images will continue to be processed. Imperfect images are marked for rejection. The panel of encoder discs is then delivered to the main plant for further processing and inspection.

Sawing the Disc

After passing the stringent scrutiny of incoming inspection, the panel of discs is transferred to the machine shop. Each disc segment is sawed from the parent sheet and returned for further inspection at which time all rejected discs are discarded.

Drilling the Center Hole

The remaining discs are precisely measured to determine their exact centers, placed in a precision lathe, and their shaft holes are drilled. The center hole drilling for the shaft placement is a critical operation. A slight departure from the true center can cause erroneous encoder operation, count eccentricities, or out-of-tolerance count transitions.

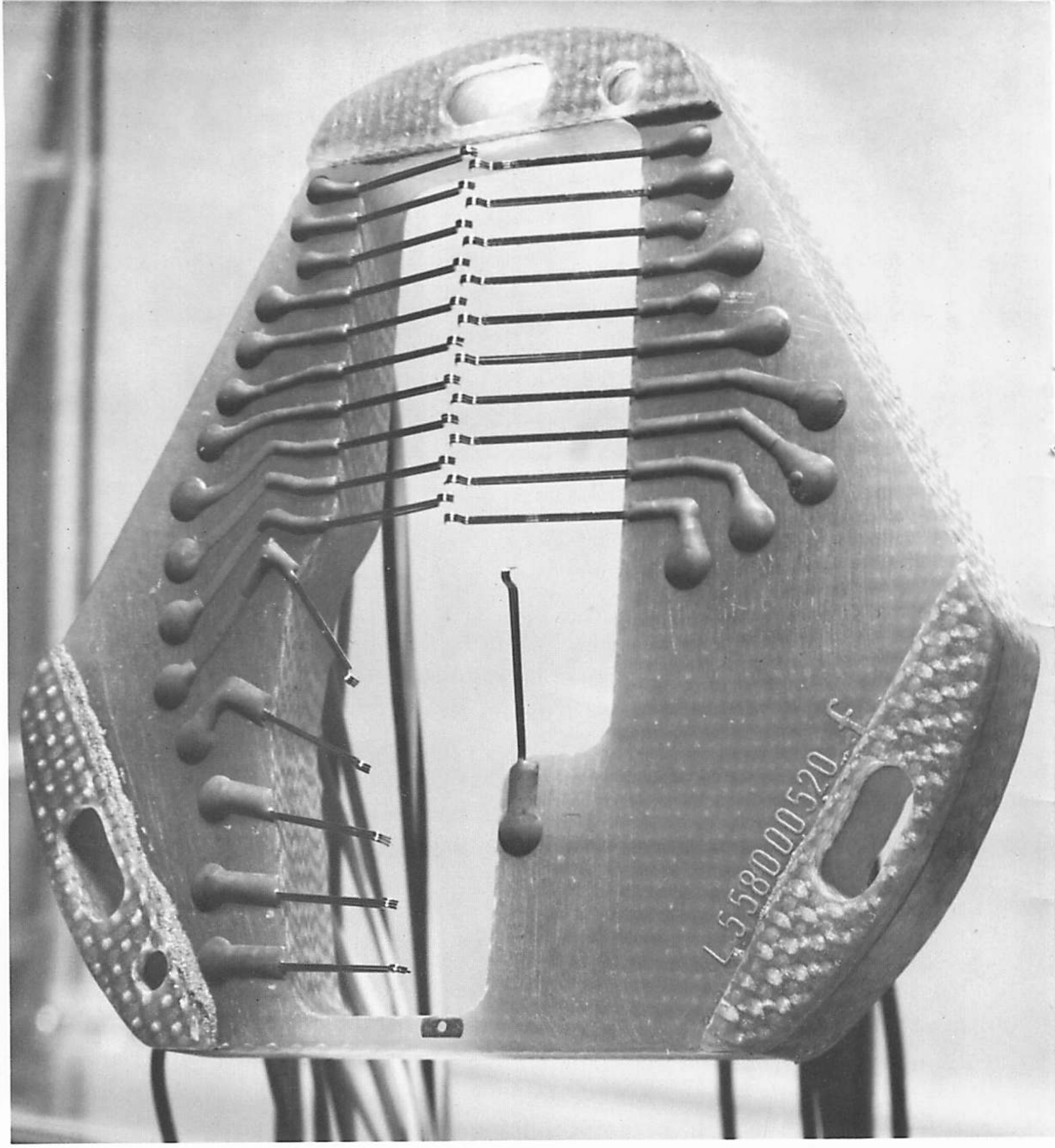
Electrical Testing

The discs are then electrically tested to verify that no short circuits have occurred. After passing the electrical test, the disc goes to a series of mechanical operations.

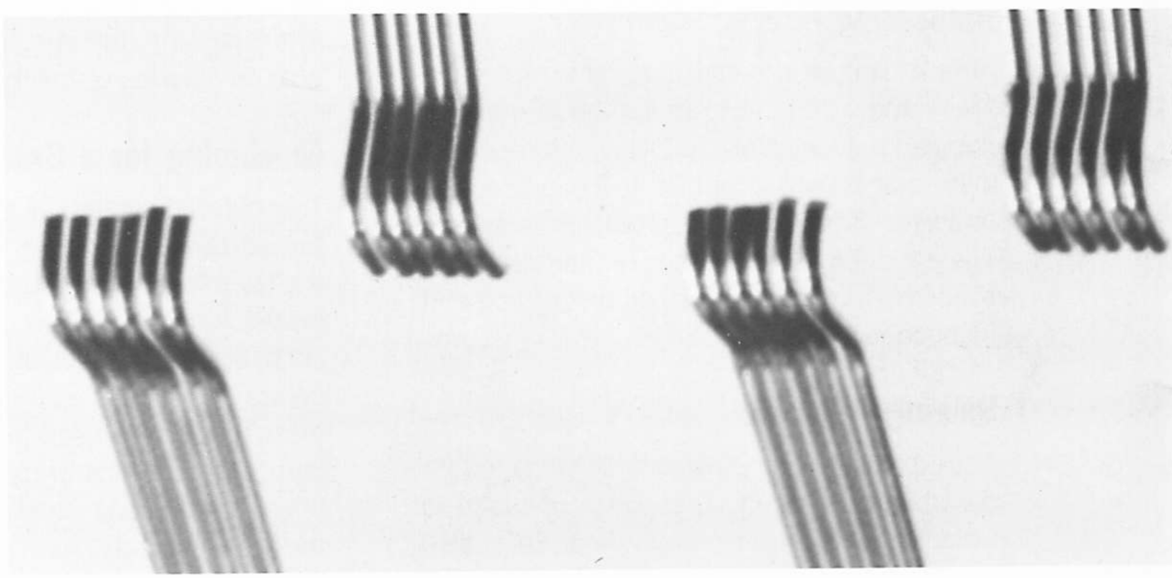
Machining for a Snug Fit

The outer diameter of the disc is carefully turned down in a lathe, a hub is turned on the reverse side, and its shaft is inserted and locked into place. The completed disc-and-shaft assembly must again pass inspection before it is scheduled into the assembly complex. While the discs are being processed, parallel operations prepare other subassemblies, so all parts meet at the correct time for final assembly.

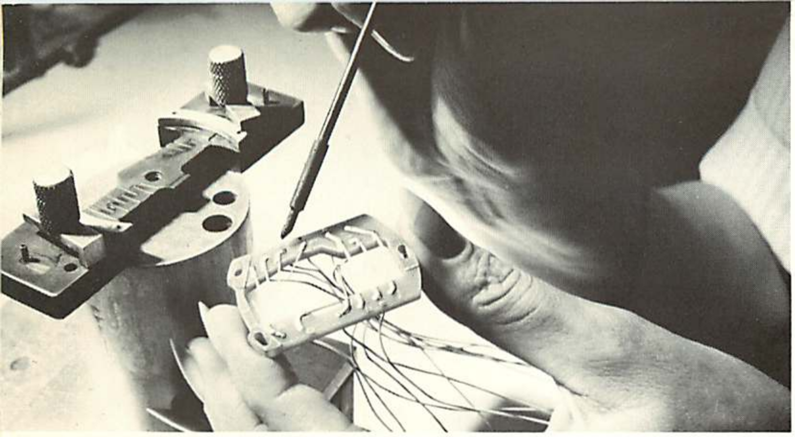
Technicians assemble encoder components in fabrication and wiring room.



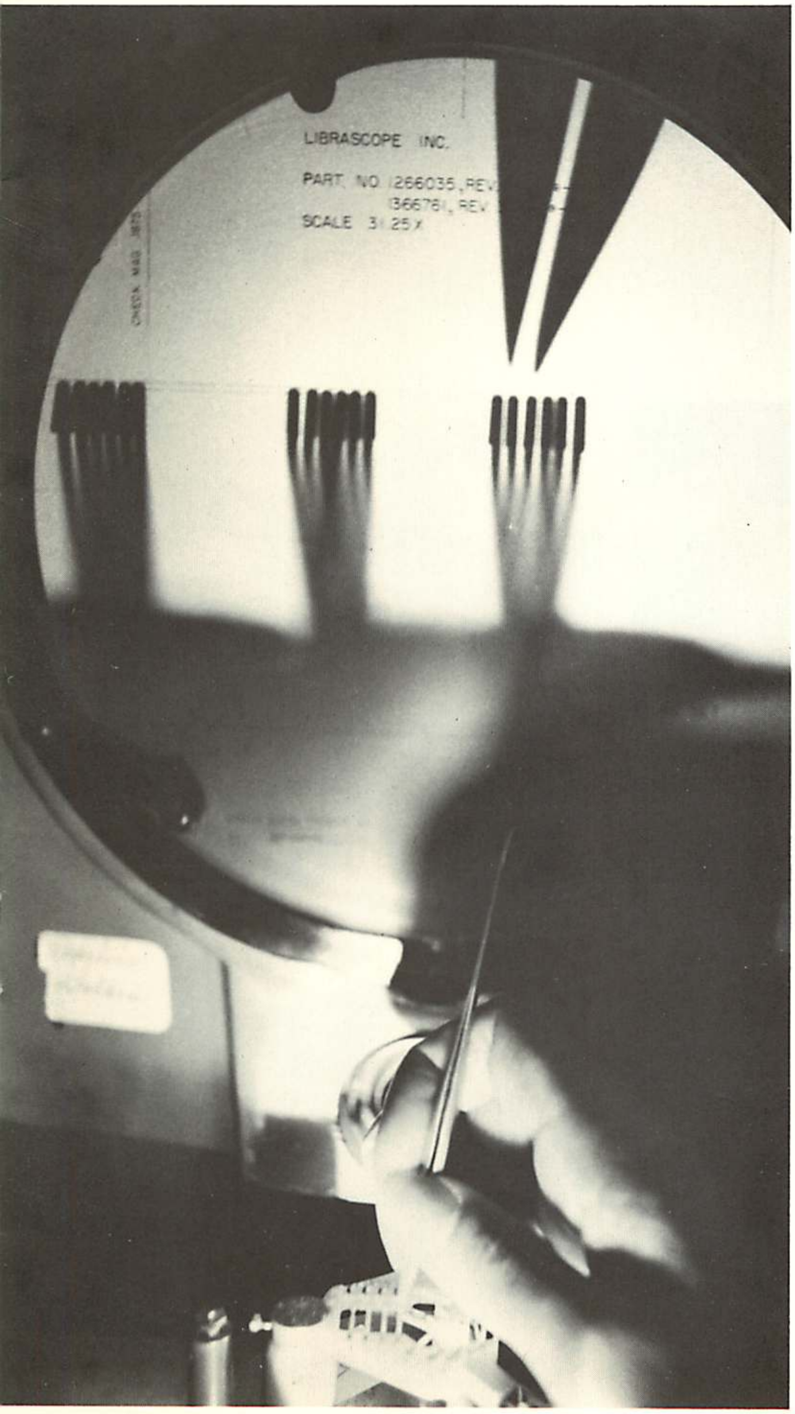
Magnified brush block assembly, showing how brushes are positioned and mounted.



Greatly enlarged closeup of six-strand redundant brushes after crimping.



Craftsman using magnifying lenses hand-solders precious metal brushes to brush block prior to crimping operation.



Technician patiently removes "memory" characteristics from crimped brushes working with an optical comparator.

Fabricating Brushes: Painstaking and Precise

An encoder consists of one or more commutator discs and a set of commutator brushes for each disc. These precision brushes, painstakingly formed with special tools, are fabricated, assembled, and processed on a production line basis. These, combined with their commutators, form the heart of an encoder and constitute the most critical components.

Changing Precious Metals Into Brushes

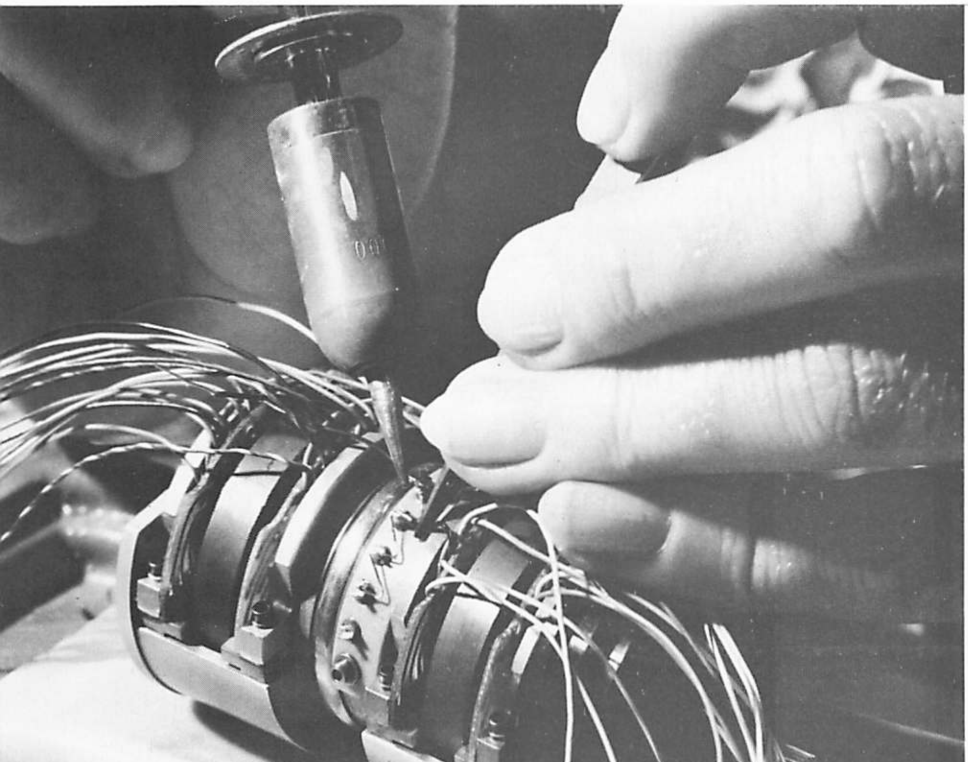
Multi-strand (redundant) brushes are produced from precious metal wires in the "wire room." Brush blocks are assembled, diodes are put in place, and rough subassembly is completed. Brushes are soldered to their brush blocks. Most of this work is done under large magnifying lenses, or 60-power binocular microscopes.

Positioning the Brushes, Accurately

After soldering, the brushes are crimped to form a precise contact area for each strand. When wire has been worked, or disturbed from a previous configuration, it has a tendency to return to its former state. This "memory" is "broken" during the deflection procedure which also brings the contact areas into precise alignment. This critical operation is performed with the aid of an optical comparator. The completed brush block is then placed in a protective carrier, and is scheduled into the next assembly operation.

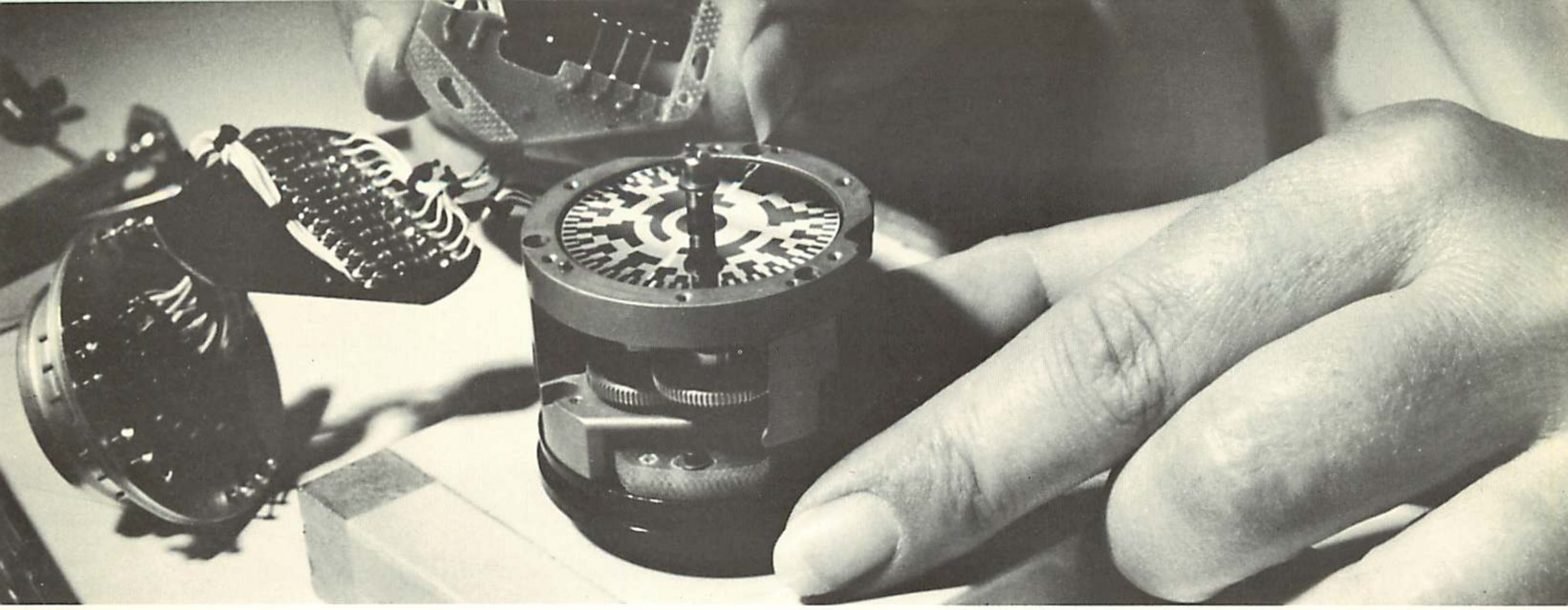
Frame fabrication; Technician using precise measuring equipment verifies diameter of encoder front frames.

Another manufacturing step; Assembler checks and verifies dimensions of encoder covers with dial gauge.



Precision hand-soldering of toroid leads is shown in enlarged view.

Technicians working at assembly operations in dust-free temperature-controlled assembly room.



Encoder begins to assume final form as it nears end of assembly operation.

Fabricating Magnetic Encoders: Similarity Breeds Perfection

Difference in Construction:

The same basic precision techniques used in manufacturing brush encoders are used to make noncontact magnetic encoders, though magnetic encoders do follow separate production line procedures due to the differences in their manufacturing requirements.

Noncontact magnetic encoders have no brushes. They use small doughnut-shaped sensors and ferrite discs in place of commutator discs. One technique used in manufacturing ferrite discs is to etch a raised pattern on the surface of the disc, very similar in appearance to that of a brush-encoder disc pattern, except that this raised pattern serves as the base for the magnetic-code pattern. Precise positioning of components must also be maintained in magnetic encoders, just as in brush encoders.

Packaging Brush and Magnetic Encoders: A Tight Squeeze

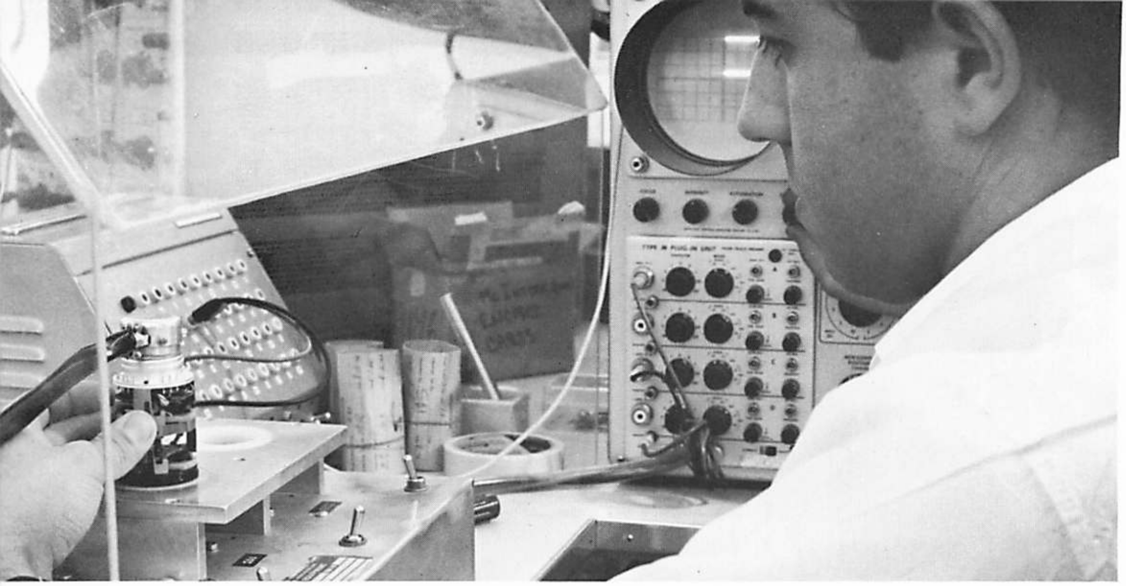
Fabricating Front Frames

Subassemblies in the machine shop, and other departments, are carefully inspected for conformance to exacting standards. Encoder front frames must be built with a precision equaling that of the disc and brush blocks.

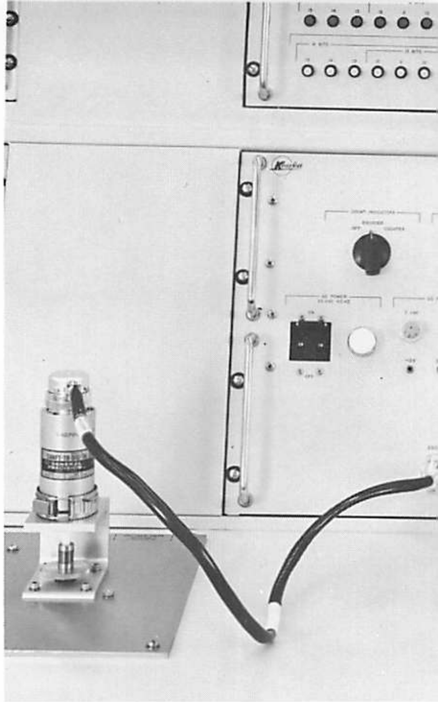
Although encoder covers have greater tolerances than other parts, they must fit snugly to prevent impurities from entering the finished unit.

The Encoder Takes Its Final Shape

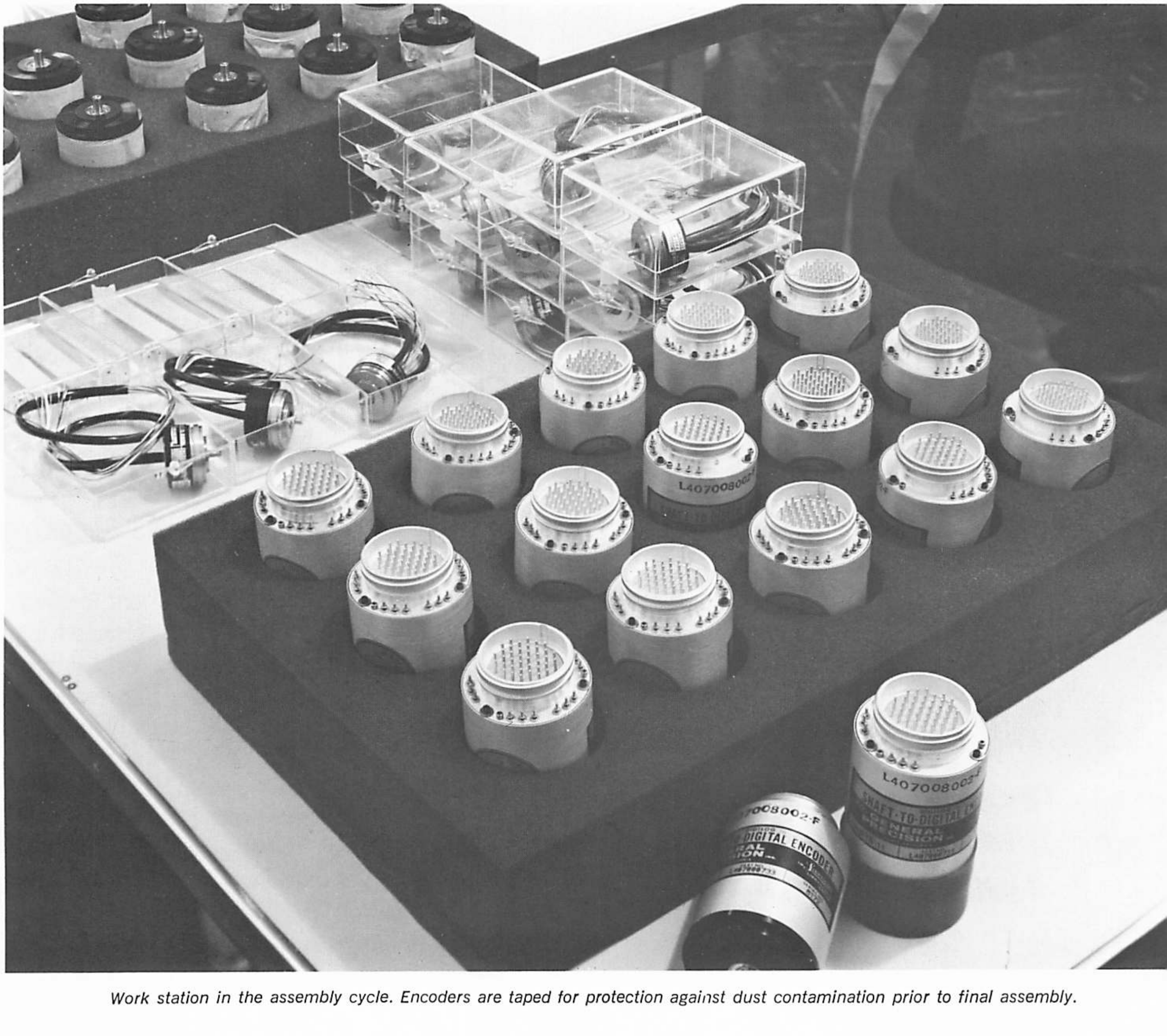
All subassemblies are scheduled to arrive at the same time in a dust free room for final assembly. Skilled technicians assemble each encoder into its completed form and submit it for final inspection. Positive air pressure is maintained in the dust free assembly area to prevent airborne dust particles from entering. Air, forced into the room, is filtered and dehumidified. "Clean benches" are always available for emergency use, in the event of a temporary shutdown of the forced-air filtering system. A "clean bench" is an enclosed work station with its own forced and filtered air system.



Technician, at a "clean bench," aligns subsections and runs functional tests on encoder before cover is installed.



Computerized testing duplicates operational conditions an encoder will encounter. Special test equipment designed by Librascope is used.



Work station in the assembly cycle. Encoders are taped for protection against dust contamination prior to final assembly.

Each encoder continues to be carefully protected against damage and contamination as it nears completion. Prior to the assembly of the encoder covers, units are protected by a layer of special tape. The tape captures stray dust particles and keeps the interior of the encoder spotless.

Computer Testing

Completed encoders proceed to a series of quality control stations where all parameters are inspected and tested. This includes mechanical, electrical, and functional testing, which, in many cases, actually duplicates the encoder operation in the specific system with which it will operate. Special testing equipment is provided for this purpose. After all quality control requirements have been satisfied, the encoders are sealed in plastic bags, and are placed in individual, padded containers for shipment.

Customizing Encoders in Assembly-Line Style

Although assembly-line techniques are used for production efficiency, each encoder is earmarked for a specific customer from the time of reception of its purchase order. The elapsed time, from start to finish, can take from 4 to 14 weeks, depending upon the availability of parts. Librascope has consistently manufactured and delivered well in excess of 1,000 mixed production models of these precision devices per month. This production ability, coupled with Librascope's long experience in the encoder manufacturing industry, is the user's assurance that large production orders can be delivered on schedule, and to the highest quality standards.

Engineer calibrates tools and gauges against "high-precision" reference blocks. This is but one of many procedures to assure precision fabrication of Librascope encoders.

Quality Control: Insurance of Perfection

To maintain and safeguard Librascope's excellent reputation for quality, approximately one out of every nine persons producing encoders is assigned the task of assuring the quality of the product. Because the quality of the end product is no better than the quality of its parts, Librascope's mandatory procedures subject each encoder subcomponent to the most detailed quality control scrutiny. If a part passes these very strict inspection standards, it is used in an encoder assembly, along with as many as 400 or more other precision parts.

To maintain this exceptionally high standard for quality of product, measurement devices are periodically calibrated to standards directly traceable to those of the National Bureau of Standards.

Librascope Encoders: Where the Action is

Librascope encoder applications are many and varied, and are constantly expanding. Various models are used in many control applications. For example: Analog-to-Digital Conversion and Digital-to-Analog Conversion in Aircraft Systems — Fire Control Systems — Gyro Systems — Inertial Guidance Systems — Numerical Machine Tool Controls — Missile Guidance Systems — Navigation Computers — Industrial Process Control — Radar Antenna Position Indication — Wind Tunnel Instrumentation — Steel Mill Processing.

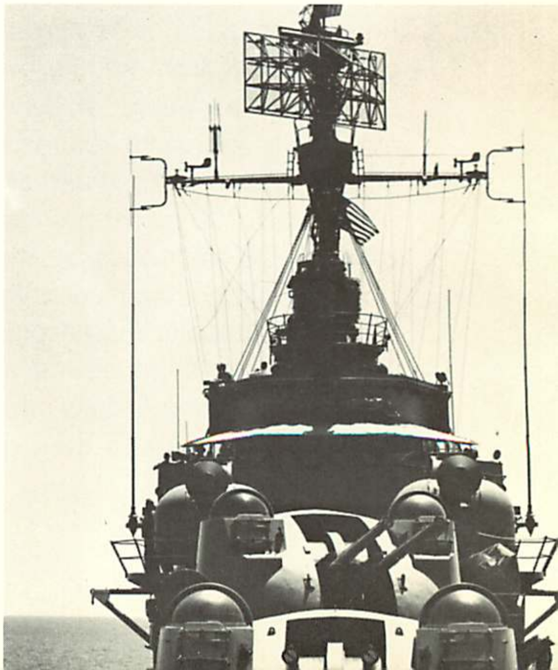
Application List

The following application list shows the basic model numbers of many encoders used, and how they are applied.

Typical Applications of Librascope Encoders

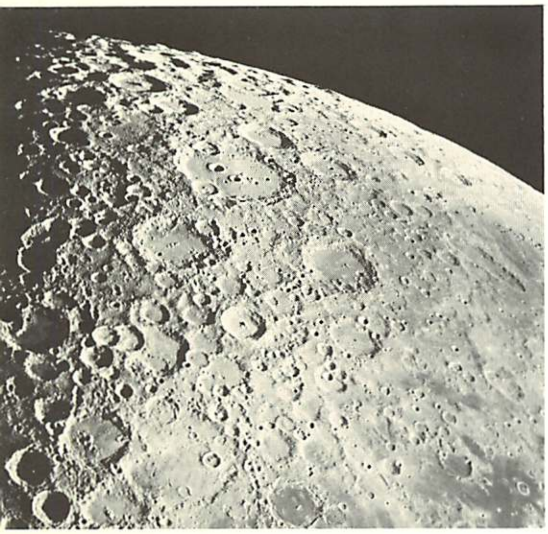
On Land

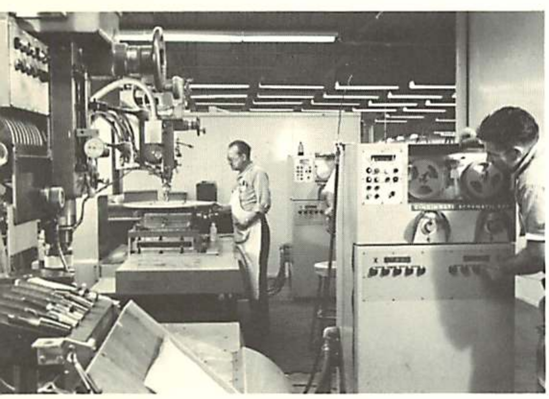
Basic Models	Applications
738-18	Air-ground data link.
778-31	Geared to optical devices on tracking radar used on the Atlantic Missile Range.
813-18	Military tactical display systems.
857-23	Cathode ray tube track-ball control.
857-15	
790-35	
708-18	



At Sea

Basic Models	Applications
707-11 709-11	Conversion of Loran C data in an airborne navigation system. (LORAN C)
713-18 719-18 and others	Ship's inertial navigation systems and airborne missile systems.
743-18	Underwater missile launching.
758-42	Antenna position for airborne radar.
770-31	Underwater weapons control.
770-31 778-18	Horizontal and vertical remote control for unmanned helicopters.
857-15	Cathode ray tube track-ball control.





In the Air

Basic Models	Applications
707-18	These provide digital inputs for the C-141 military cargo aircraft navigation computer: air speed, bearing, yaw, pitch, roll, altitude, etc.
713-18	
716-18	
707-20	Navigation system for the B-70 bomber and missile control.
713-20	
717-20	
713-11	Pilot's moving map display. Avionics instrumentation systems.
713-18	A6A airborne inertial navigation system, and others.
737-18	
739-18	
743-18	Digital air navigation computer inputs.
749-18	
750-27	Frequency selector switch for radio communications.
757-23	Digital inputs for the F105 airborne Doppler navigation system.
758-42	
754-servoed	
757-servoed	
758-servoed	
786-servoed	
791-servoed	
761-11	Beacon program. Automatic altitude reporting. Many classes of military and commercial aircraft.
738-18	Common air to ground data link.
	Altitude— flight data for computers.
778-31	Ballistic missile early warning radar system.
803-11	F-111 flight simulator computer inputs.
818-11	
723-11	Airborne data annotation systems for photographic surveillance.
724-11	
733-11	

In Space

Basic Models	Applications
719-8	Apollo moon vehicle simulator computer inputs.
819-15	
770-31	Gemini approach radar for space rendezvous.

In Industry

Basic Models	Applications
722-31	Data retrieval and process control.
723-31	
724-31	
733-31	
734-31	
790-35	
789-35	
813-18	Industrial process control.

In Missiles

Basic Models	Applications
719-18	Seaborne missile launch control system.
778-18	
857-15	
758-18	Missile arming control.
778-11	Missile instrumentation.

Encoder Models

BINARY V-SCAN BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
700-18-1	1	18	0-1,048,575	2^8	4096	BNRY	V	Pos	CW	Solder pins
707-11-1	2	11	0-127	2^7	1	BNRY	V	None	CW	Leads
708-11-1	1	11	0-255	2^8	1	BNRY	V	None	CW	Leads
708-11-2	3	11	0-255	2^8	1	BNRY	V	Pos	CW	Leads
708-18-1	1	18	0-255	2^8	1	BNRY	V	Pos	CW	Solder pins
713-11-1	1	11	0-8191	2^7	64	BNRY	V	None	CW	Leads
713-11-8	1	11	0-8191	2^8	32	BNRY	V	Pos	CW	Leads
719-11-3	1	11	0-524,287	2^7	4096	BNRY	V	Pos	CW	Leads, w/connector
719-11-5	1	11	0-524,287	2^7	4096	BNRY	V	None	CW	Leads, w/connector
707-18-1	1	18	0-127	2^7	1	BNRY	V	None	CW	Solder pins
707-18-2	1	18	0-127	2^7	1	BNRY	V	Pos	CW	Solder pins
708-18-1	3	18	0-127	2^8	1	BNRY	V	Pos	CW	Solder pins
713-18-1	1	18	0-8191	2^7	64	BNRY	V	None	CW	Connector
713-18-3	1	18	0-8191	2^7	64	BNRY	V	Pos	CW	Connector
714-18-1	3	18	0-16382	2^8	64	BNRY	V	Pos	CW	Solder pins
719-18-1	1	18	0-524,287	2^7	4096	BNRY	V	None	CW	Connector
719-18-6	2	18	0-524,287	2^7	4096	BNRY	V	Pos	CW	Solder pins
719-18-9	2	18	0-524,287	2^7	4096	BNRY	V	None	CW	Leads, w/connector

M-SCAN BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
707-11-12	2	11	0-127	2^7	1	BNRY	M	Pos	CW	Leads
707-11-13	3	11	0-127	2^7	1	BNRY	M	None	CCW	Leads
707-11-14	2	11	0-127	2^7	1	BNRY	M	Pos	CCW	Leads
709-11-14	2	11	0-511	2^8	2	BNRY	M	Pos	CCW	Leads
713-11-11	2	11	0-8191	2^8	2	BNRY	M	Pos	CCW	Leads
716-11-10	2	11	0-65,535	2^7	512	BNRY	M	None	CCW	Leads
707-18-11	2	18	0-127	2^7	1	BNRY	M	Pos	CW	Connector
716-18-11	2	18	0-65,535	2^7	512	BNRY	M	Pos	CW	Connector

8421 BCD BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
722-11-1	2	11	0-199	200	1	8421	Block-V	None	CW	Leads
723-11-1	1	11	0-1999	200	10	8421	Block-V	None	CW	Leads
724-11-1	1	11	0-19999	200	100	8421	Block-V	None	CW	Leads
725-11-1	2	11	0-199999	200	1000	8421	Block-V	None	CW	Leads
733-11-1	1	11	0-3599	200	18	8421	Block-V	None	CW	Leads
734-11-1	2	11	0-35999	200	180	8421	Block-V	None	CW	Leads
735-11-1	2	11	0-359999	200	1800	8421	Block-V	None	CW	Leads
722-31-2	1	31	0-199	200	1	8421	Block-V	None	CW	Connector & Logic
723-31-1	1	31	0-1999	200	10	8421	Block-V	None	CW	Connector & Logic
723-31-2	2	31	0-1999	200	10	8421	Block-V	Pos	CW	Connector & Logic
723-31-3	2	31	0-1999	200	10	8421	Block-V	None	CCW	Connector & Logic
724-31-1	1	31	0-19999	200	100	8421	Block-V	None	CW	Connector & Logic
724-31-2	2	31	0-19999	200	100	8421	Block-V	Pos	CW	Connector & Logic
733-31-1	1	31	0-3599	200	18	8421	Block-V	None	CW	Connector & Logic
733-31-2	2	31	0-3599	200	18	8421	Block-V	Pos	CW	Connector & Logic
734-31-1	1	31	0-35999	200	180	8421	Block-V	None	CW	Connector & Logic
735-31-1	1	31	0-399999	200	1800	8421	Block-V	None	CW	Connector & Logic
734-31-2	2	31	0-35999	200	180	8421	Block-V	Pos	CW	Connector & Logic
720-35-1	1	35	0-999	1000	1	8421	U	None	CCW	Leads
720-35-2	3	35	0-999	1000	1	8421	U	Pos	CCW	Leads
720-35-3	3	35	0-999	1000	1	8421	U	Neg	CCW	Leads
720-35-4	3	35	0-999	1000	1	8421	U	None	CW	Leads
720-35-5	3	35	0-999	1000	1	8421	U	Pos	CW	Leads
720-35-6	3	35	0-999	1000	1	8421	U	Neg	CW	Leads

SINE-COSINE BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
758-35-1	1	35	2^8+ Sign	4 quad-rants	1	BNRY	U	Neg	Both	Leads

CYCLIC DECIMAL BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
760-35-1	3	35	0-999	1000	1	Unit distance	None	None	Both	Leads

ICAO ALTITUDE ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
761-11-1	2	11	−10 to 1269	80	16	Alt	None	Neg	CW	Leads
761-11-3	2	11	−10 to 1269	80	16	Alt	None	Neg	CW	Leads (RFI Filter, internal)
761-11-4	2	11	−12 to 1267	80	16	Alt	None	Neg	CW	Leads (RFI Filter attached piggy back)
761-11-5	2	11	−12 to 1267	80	16	Alt	None	Neg	CCW	Leads (RFI Filter internal)
761-11-6	2	11	−10 to 1269	80	16	Alt	None	Neg	CCW	Leads
761-11-8	2	11	−12 to 707	80	9	Alt	None	Neg	CW	Leads (RFI Filter internal)
761-11-10	2	11	−10 to 389	80	5	Alt	None	Neg	CW	Leads (RFI Filter internal)

GRAY CODE BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
778-11-7	1	11	0-255	2^8	1	Gray	None	None	CCW	Leads
778-11-8	2	11	0-255	2^8	1	Gray	None	None	CW	Leads
778-18-1	1	18	0-255	2^8	1	Gray	None	None	CW	Solder pins
778-18-2	2	18	0-255	2^8	1	Gray	None	None	CW	Leads ($\frac{1}{4}$ bit accuracy)
770-18-1	2	18	0-1023	2^8	4	Gray	None	Pos	CW	Special connector
770-31-2	1	31	0-1023	2^{10}	1	Gray	None	None	CW	Solder pins
770-31-8	2	31	0-1023	2^{10}	1	Gray	None	None	CCW	Leads
771-35-1	3	35	0-2047	2^{11}	1	Gray	None	None	Both	Leads

BINARY U-SCAN BRUSH ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
787-18-3	1	18	0-127	2^7	1	BNRY	U	Neg	CW	Solder pins
787-18-4	2	18	0-127	2^7	1	BNRY	U	None	CW	Solder pins
789-35-3	1	35	0-511	2^9	1	BNRY	U	Neg	CCW	Leads
790-35-1	3	35	0-1023	2^{10}	1	BNRY	U	None	CCW	Leads
790-35-2	3	35	0-1023	2^{10}	1	BNRY	U	Pos	CCW	Leads
790-35-3	1	35	0-1023	2^{10}	1	BNRY	U	Neg	CCW	Leads
790-35-4	3	35	0-1023	2^{10}	1	BNRY	U	None	CW	Leads
790-35-5	3	35	0-1023	2^{10}	1	BNRY	U	Pos	CW	Leads
790-35-6	3	35	0-1023	2^{10}	1	BNRY	U	Neg	CW	Leads
793-18-1	2	18	0-8191	2^7	64	BNRY	U	Pos	CW	Connector
793-18-2	1	18	0-8191	2^7	64	BNRY	U	Neg	CW	Solder pins
799-18-1	3	18	2^{19}	2^7	2^{12}	BNRY	U	—	CW	Leads

ENCODERS WITH MATING BRUSH SELECTION MODULES — BINARY

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
707-20-1	2	20	2^7	2^7	1	BNRY	V	+ or −	Both	Connector
713-20-1	2	20	2^{13}	2^7	2^6	BNRY	V	+ or −	Both	Connector
717-20-1	2	20	2^{17}	2^7	2^{10}	BNRY	V	+ or −	Both	Connector
719-20-1	2	20	2^{19}	2^7	2^{12}	BNRY	V	+ or −	Both	Connector

MAGNETIC BINARY ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
813-11-1	1	11	0-8191	2^7	64	BNRY	V	None	CW	Leads
807-18-1	2	18	0-127	2^7	1	BNRY	Block-V	None	CW	Solder pins
807-18-2	2	18	0-127	2^7	1	BNRY	Block-V	None	CW	Connector
813-18-1	1	18	0-8191	2^7	64	BNRY	V	None	CW	Solder pins
887-18-3	1	18	0-127	2^7	1	BNRY	Block-V	None	CW	Solder pins
893-18-1	1	18	0-8191	2^7	64	BNRY	Block-V	None	CW	Connector

INCREMENTAL MAGNETIC ENCODERS

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
857-15-1	2	15	Infin	2^8	1	Pulse	None	None	Either	Leads
857-15-2	2	15	Infin	2^8	1	trains	None	None	Either	Leads—splined shaft
857-23-1	1	23	Infin	2^8	1	are generated	None	None	Either	Leads
857-23-5	2	23	Infin	72	1	in quadrature	None	None	Either	Leads (internal circuits)
857-23-6	2	23	Infin	28	1	for direction sensing	None	None	Either	Leads (internal circuits)

HYBRID MAGNETIC-BRUSH ENCODERS (HIGH SPEED LONG LIFE)

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
818-11-1	2	11	2^{18}	2^8	2^{10}	BNRY	V	None	CW	Leads
803-11-1	2	11	2^{23}	2^8	2^{15}	BNRY	V	None	CW	Leads
819-15-1	2	15	2^{19}	2^7	2^{12}	BNRY	V	None	CCW	Leads

SHAFT COMPARATORS—DIRECT SHAFT COUPLED (TAILORED TO THE APPLICATION) (PATENT PENDING)

Model No.	Class	Size	Range	Counts Per Turn	Turns	Code	Scan	Diodes	Ascending Count	Output—Input
730-18-	3	18	(Open)	100	(Open)	8421 BCD	R	None	(Open)	Leads
730-35-	3	35	(Open)	≤ 1000	(Open)	8421 BCD	R	None	(Open)	Leads
740-18-	3	18	(Open)	2^6	1	BNRY	R	None	(Open)	Leads
740-35-	3	35	(Open)	$\leq 2^{10}$	1	BNRY	R	None	(Open)	Leads

Significance of Class Ratings:

Class 1 — Full class "A" drawing status. Standard production model.

Class 2 — Class "C" drawing status. Alternate standard model.

Class 3 — Limited production or prototype status.

Note: All Size 8, Size 27, Size 32, Size 42, and Size 73 encoders, and obsolete models have been omitted from this list due to limited use.

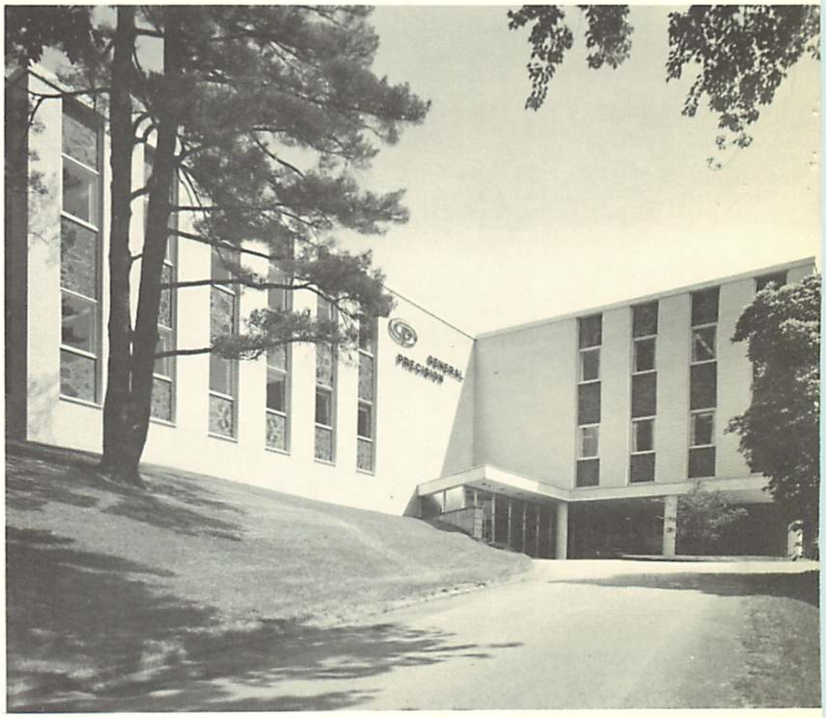
Strong Corporate Background

Encoders constitute one of the principal product lines of General Precision, Inc., Librascope Group. Librascope also designs and manufactures □ computing and data processing systems for Navy antisubmarine warfare applications □ computer memories, components, and special-purpose computers for government and industrial use, □ optical systems and instrumentation for spacecraft, submarines, helicopters, and other highly mobile systems.

The research, development, and production facilities of each member of Librascope Group are available to all members. Thus the Components Division has ready access, if needed, to the broad technical capabilities and extensive facilities of the entire Librascope Group.

In addition to Librascope's resources, the Components Division can also draw upon the capabilities of the other members of General Precision, Inc. These organizations include Aerospace Group, Little Falls, N.J.; Link Group, Binghamton, N.Y.; and Tele-Signal Corp., Hicksville, N.Y.

General Precision, Inc., is a subsidiary of General Precision Equipment Corp., Tarrytown, N.Y. GPE is a diversified electronics company whose subsidiaries produce a wide range of precision products for government, controls, and education markets. It has annual sales of $440 million.



Headquarters building of General Precision Equipment Corp. and General Precision, Inc., Tarrytown, New York.

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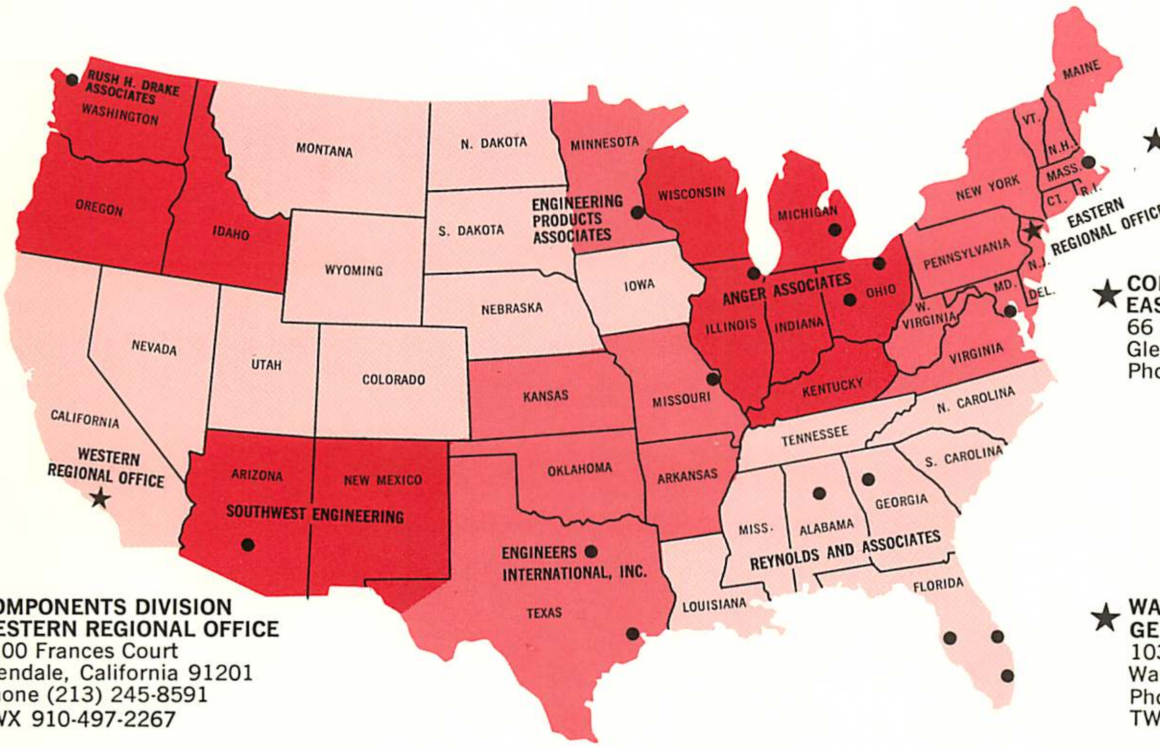
Technical Support

Librascope's manufacturing knowledge and capability is supported by over 55 field sales representatives. These engineers are available throughout the United States, Free Europe, and the Free Far East, to offer engineering services based on broad experiences to encoder users.

You are invited to request technical assistance when you have a requirement or design problem involving encoders. We can often assist in avoiding design pitfalls, save you substantial amounts of design dollars, and at the same time, supply you with reliable encoders incorporating the latest advances in this specialized technology.



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