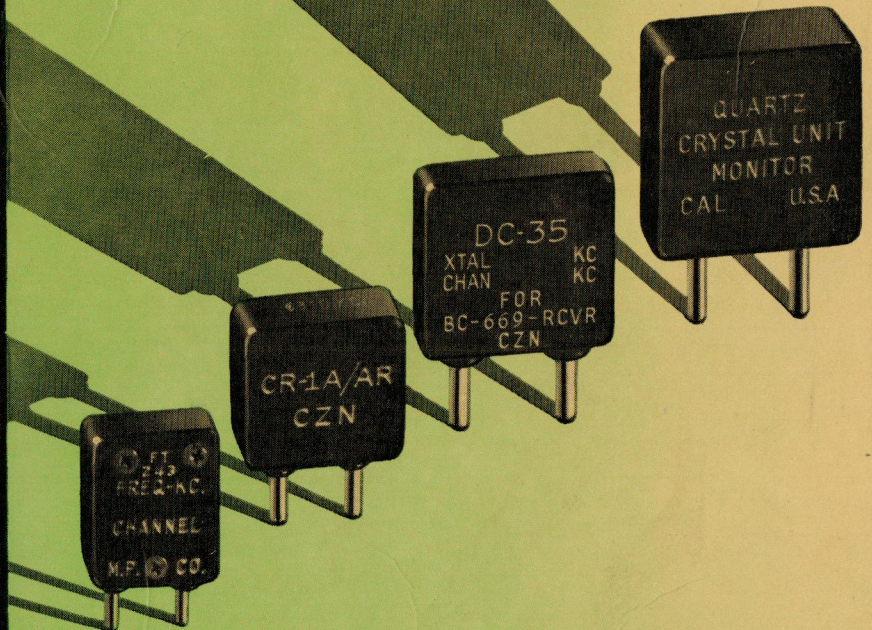


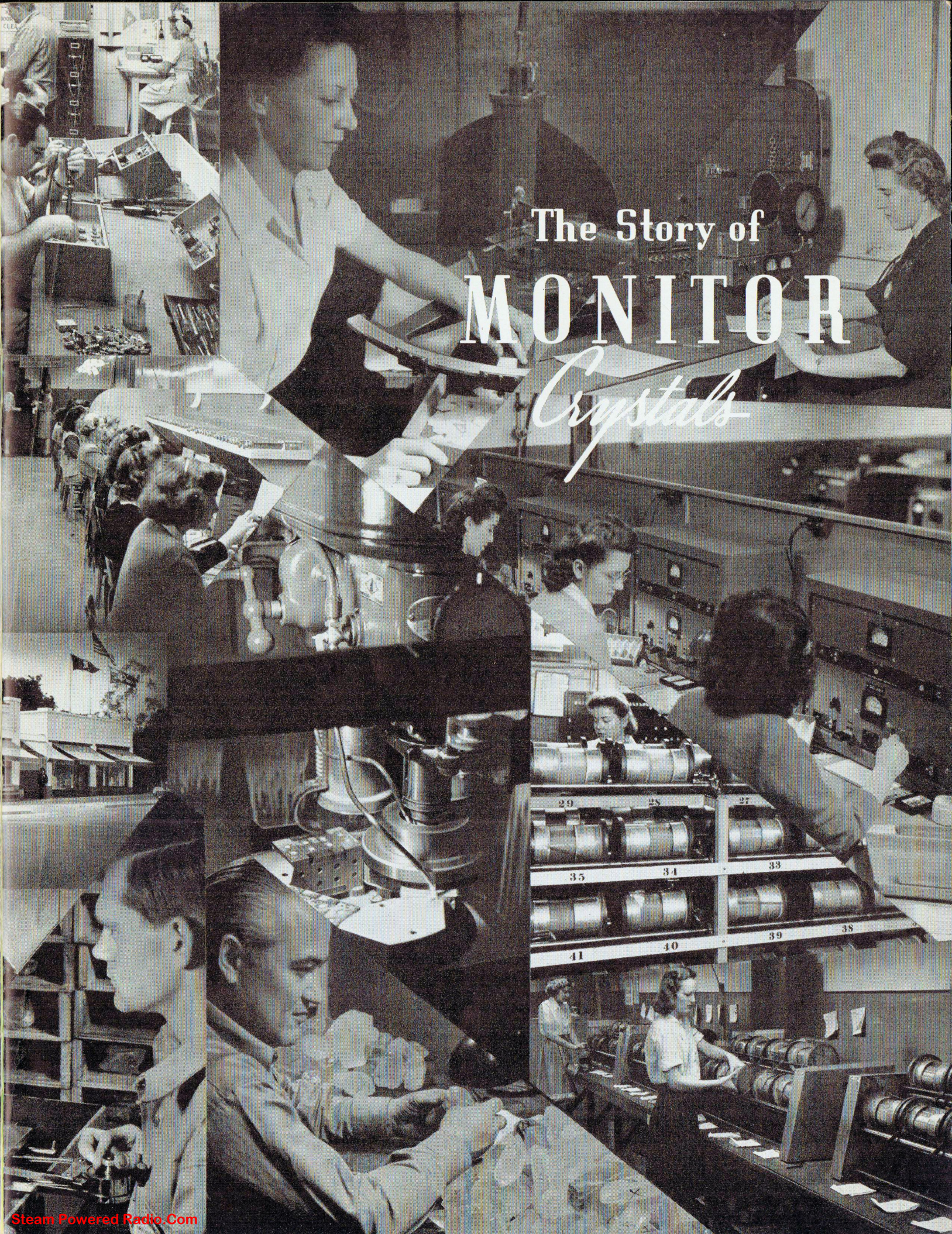
The Story of  
**MONITOR**  
*Crystals*





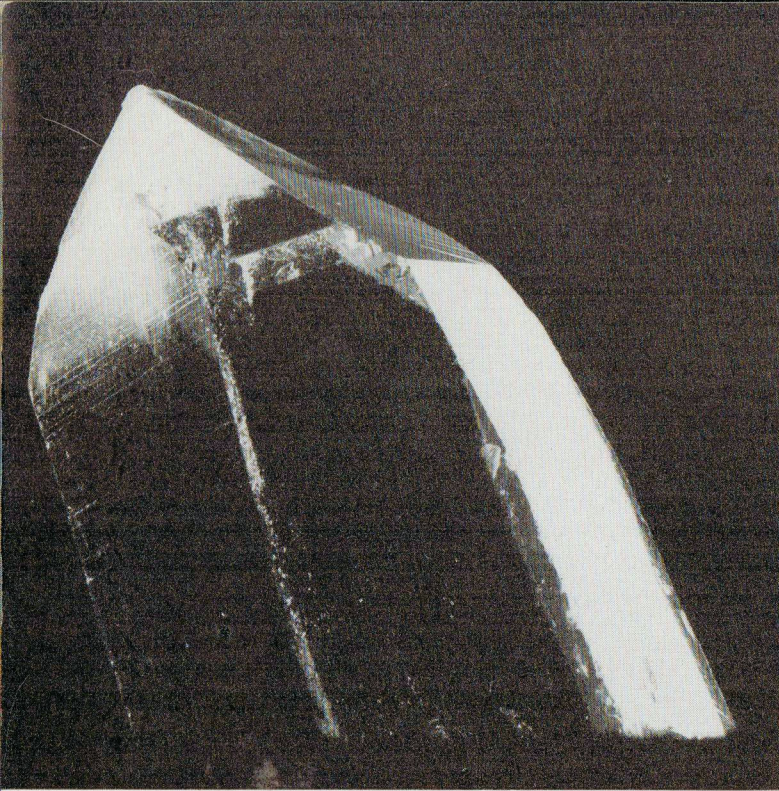






The Story of  
**MONITOR**  
*Crystals*





**This specimen** is raw quartz crystal for either one oriental crystal ball or numerous precision radio crystals.

**F**OR 7000 years or more the mystic purity of clear quartz crystals has been a fascinating challenge to all that is artistic in man. Since long before the dawn of civilization he has seen in it a means of capturing and expressing with rare permanence the art forms of his age.

#### IN PREHISTORIC ART

The Greeks believed quartz to be permanently frozen water and therefore called it *krystallos*, their word for ice. But ages before their civilization, prehistoric man had crudely cut and polished crystals for rough charms and ornaments. All men and women admired and valued these bits of rude art. The next easy step was their use



## THE ROMANCE OF QUARTZ...

as a form of money in exchange for other goods of value.

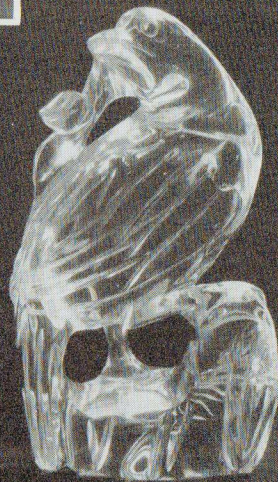
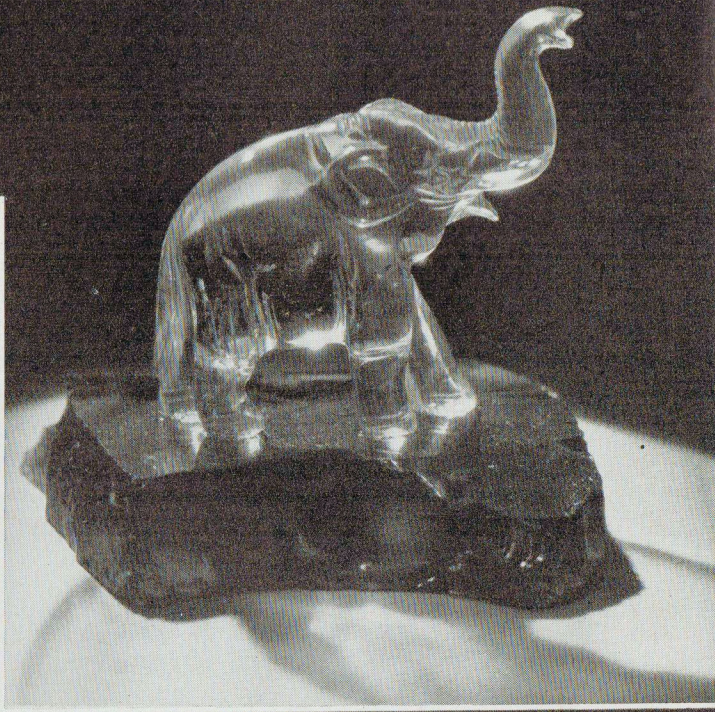
#### THE ART OF CARVING

To the care and patience of oriental lapidaries, who passed on their art of cutting and polishing from generation to generation, goes credit for the use of transparent quartz as crystal-gazing balls. The carving of quartz into decorative and useful art pieces was the life work of thousands of early artisans.

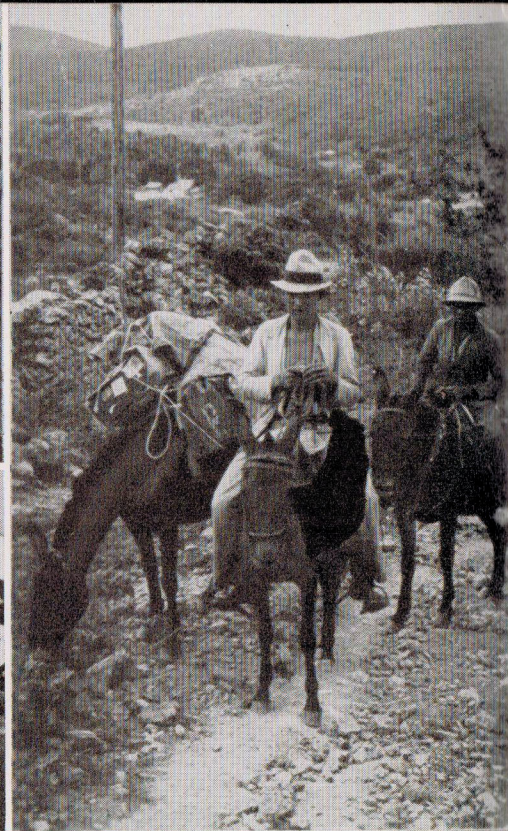
#### ITEMS OF GREAT VALUE

About 200 B. C., the Egyptians brought the art of quartz carving to a high level. While there are earlier examples of crystal art that have great value, working in crystal became a means of artistic and religious expression which has endured through the ages. The art museums and many private collections throughout the world contain priceless pieces. They include findings from the tombs of the earliest Egyptian rulers, through the magnificent art objects in crystal encrusted with silver, gold, enamel and precious gems of the oriental and European craftsmen.





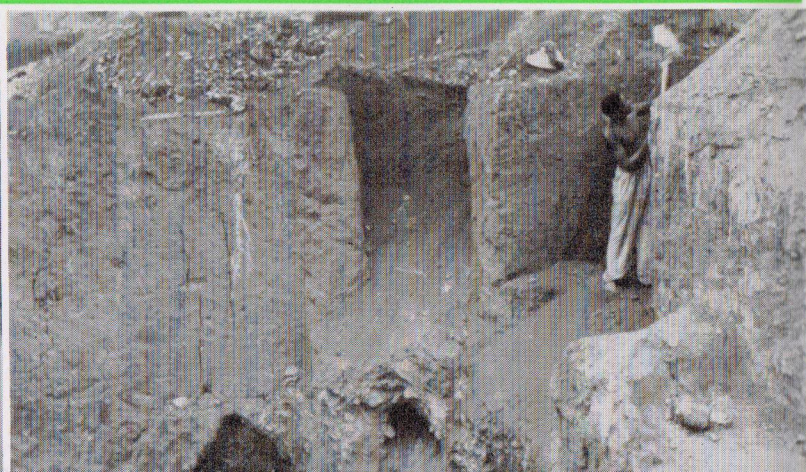




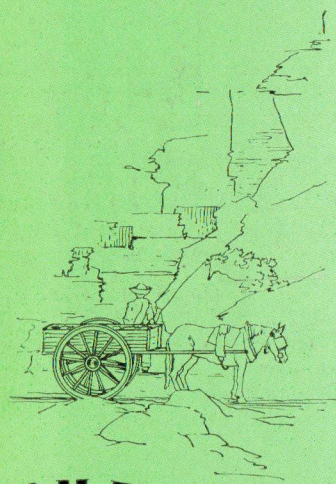
Quartz mining. These pictures, taken in the heart of Brazil, show how the mining is carried on as an open quarry operation in a series of descending benches.

The transparent crystals of quartz are pried off, waste is shoveled up from bench to bench until it reaches the surface where it is loaded on mule carts.

Hundreds of Brazilians unearth crystals of the world's purest water-clear quartz, found in the ancient veins and gravel beds of prehistoric rivers in the heart of Brazil.







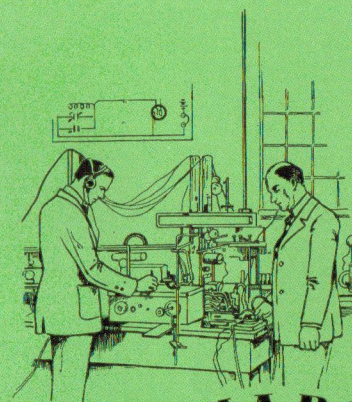
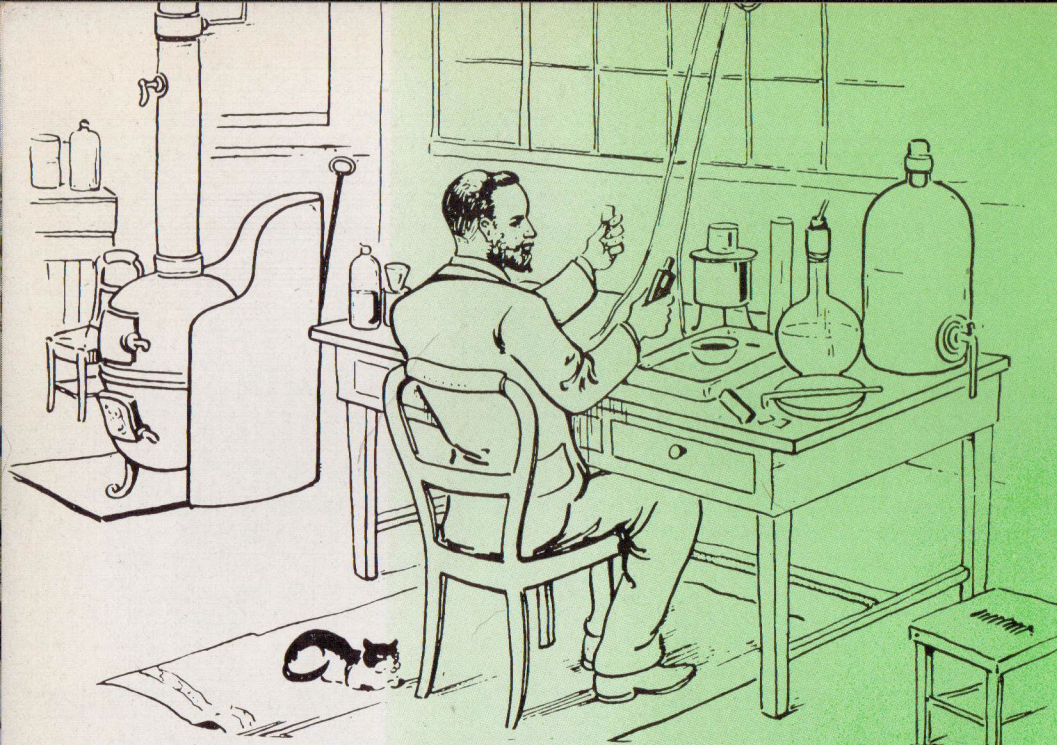
## THE MINING OF QUARTZ

**N**EXT to oxygen, silica, the non-metallic element in quartz, is the most abundant element in nature. However, the pure water-clear quartz suitable for Monitor crystals comes chiefly from the heart of Brazil.

This mineral-rich area is about 450 miles north of the beautiful and busy world port of Rio de Janeiro. The most productive de-

posits of large clear crystals having the greatest commercial value are at Fazenda Pacu, State of Minas Geraes. Even in this rich area, less than one per cent of the crystals found have any commercial value. Only a few hundred quartz crystals, valuable for Piezo-electric use, may represent a full day's findings of a thousand miners.





## SCIENCE DISCOVERS MAGIC IN QUARTZ

**P**IERRE CURIE, professor of physics at the Sorbonne, Paris, in collaboration with his brother Jacques, discovered and investigated certain qualities in quartz, later to be known as Piezo-electricity.

In 1880, the famous Curie brothers published the results of their experiments on quartz after determining the quantity of

electricity generated by unit pressure along the crystals' various axes.

Gabriel Lippman, professor of mathematical physics at the University of Paris, in 1881, predicted the "Converse Effect" or vibration of crystal. His calculations had shown that crystals expand and contract when placed in an electric field. The Curies



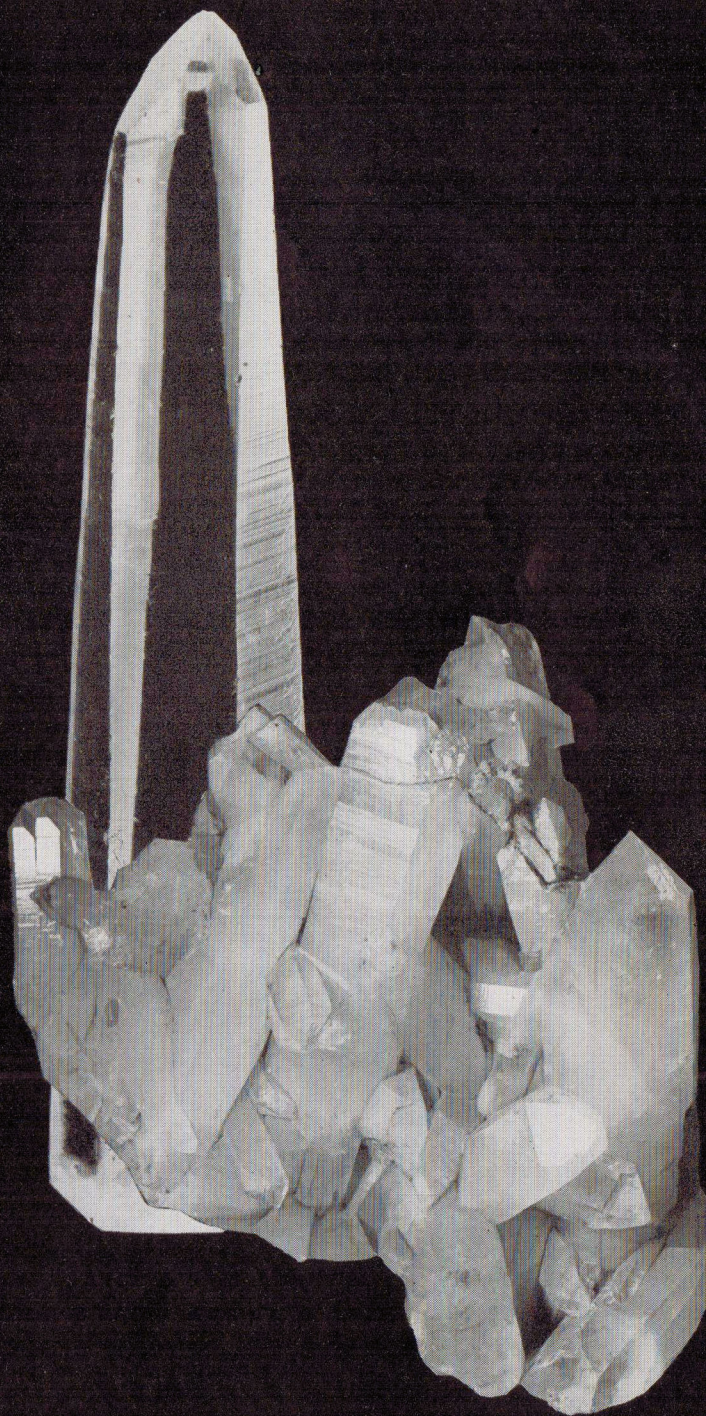
verified his predictions through their observations of the behaviour of crystals.

Wilhelm Gotfried Hankel of the University of Leipzig, through his independent discoveries, introduced the term Piezo-electricity. This expression is derived from the Greek "piezein," meaning to press. According to Columbia University "Piezo" is correctly pronounced "p-ed-zo."

Dr. Walter G. Cady of Wesleyan University, in 1922, took out patents on electrically vibrating quartz crystals as a method of measuring and controlling frequencies in radio broadcasting.

In 1922 there were very few broadcasting stations in the United States. However, all had great difficulty in keeping to their assigned wave lengths.

Today, through the extensive use of the Piezo-electric crystal, more than 100,000 radio transmitters are operating simultaneously without interference.





[illegible]



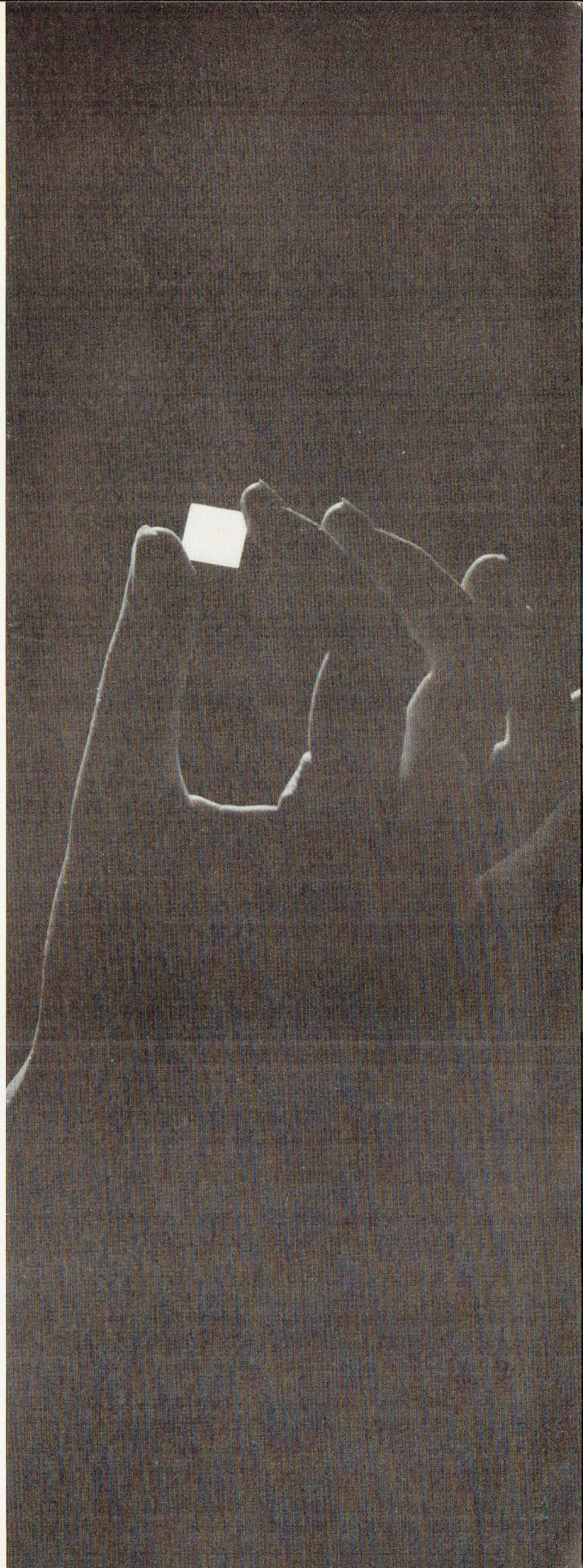
**P**RIOR to Dr. Cady's findings, Prof. Paul Langevin of France, in 1917, applied the Piezo-electric properties of quartz to the transmission of ultrasonic waves through water.

Up to 1925, quartz was mostly used for frequency standards and precision measurements. In 1926, the "Y" cut was developed by the General Electric Company and the American Optical Company.

Further refinements and important discoveries in connection with the processing and use of crystals in transmitters were made by R. Brown, R. K. Potter and D. K. Martin of Bell Laboratories.

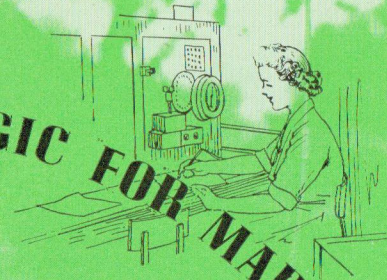
Other Bell radio engineers and technicians made valuable contributions and experiments with quartz which have resulted in the AT, BT to NT cuts familiar to all radio engineers. These cuts are shown in the model opposite.

Later developments and precision modifications by engineers of the Radio Corporation of America and other firms and individuals have brought the modern quartz crystal to its present high level of efficiency, accuracy and dependability.





# MONITOR CAPTURES QUARTZ MAGIC FOR MARS



**W**AR, of course, brought the rapid development in facilities and production that has established Monitor as a leading supplier of radio crystals for use by the armed forces of the United States.

America's winning strength has derived in large part from the ability of thousands

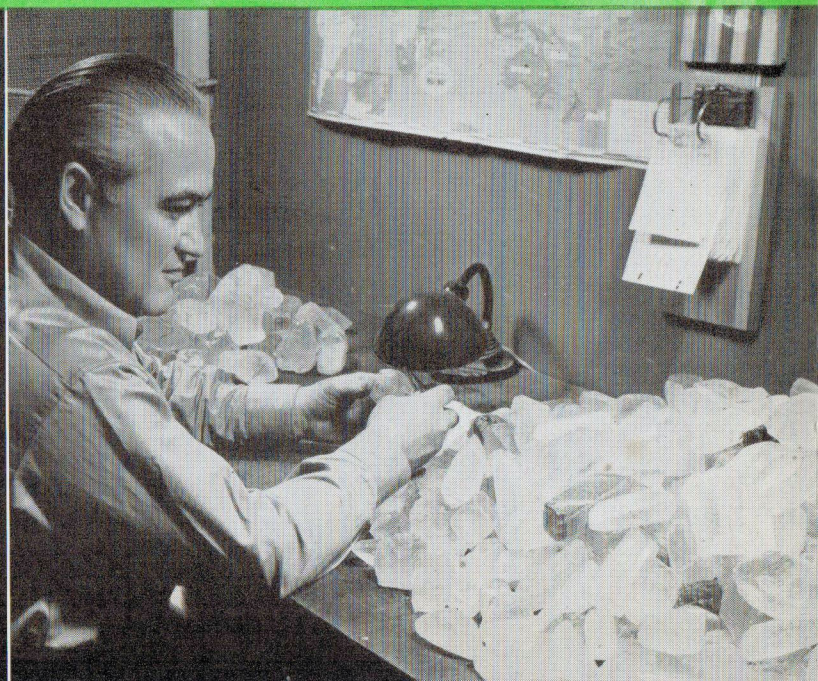
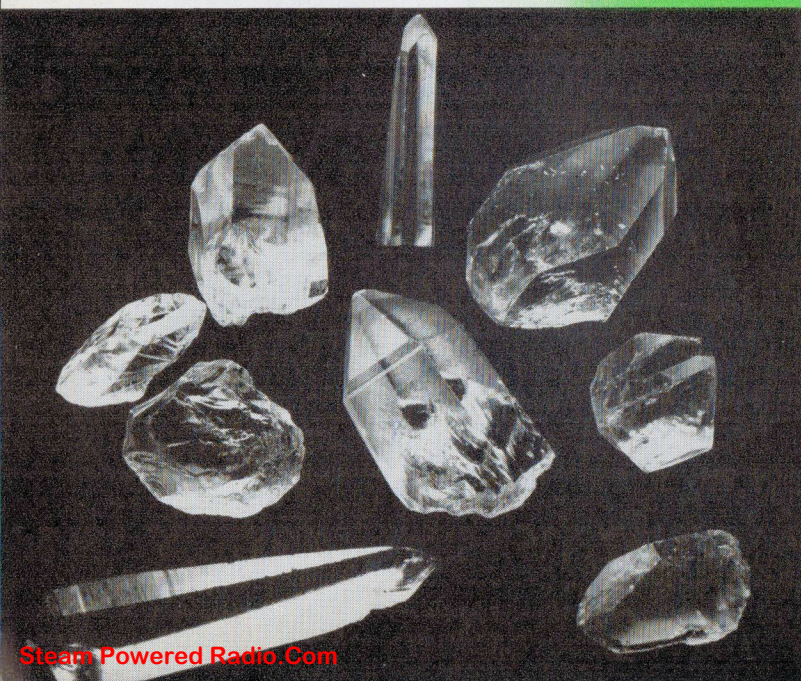
of small firms to expand their capacities and radically improve equipment and methods, almost overnight.

## MONITOR'S RAPID EXPANSION

Monitor, an excellent example of rapid growth with outstanding improvement in precision quality, is today one of America's

RAW QUARTZ CRYSTALS AS WE RECEIVE THEM

GRADING OF QUARTZ, ONE OF FIRST STEPS



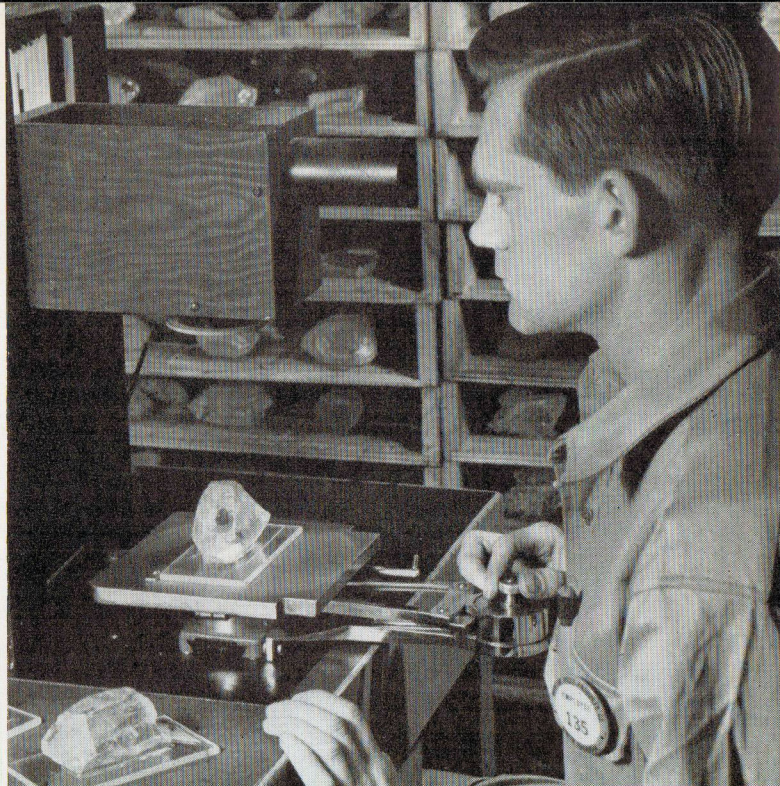


thousands of war-important plants. This importance to the war effort is a reward in itself, because it means we have helped save lives, shorten the war, and preserve a way of life that we believe is the right way for America and for the world at large.

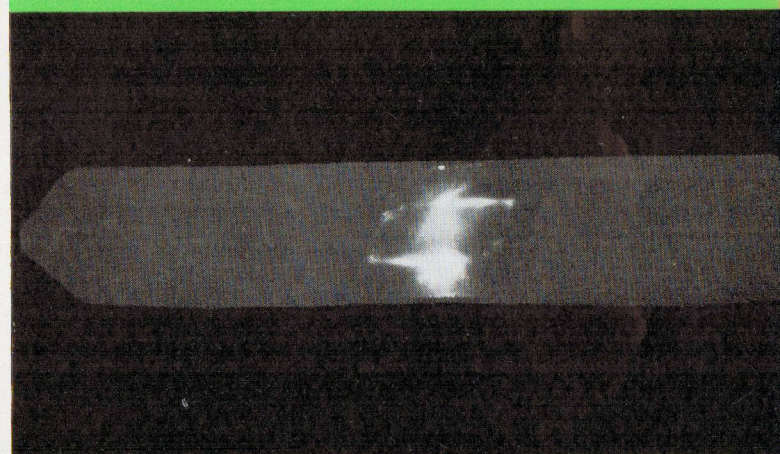
Behind Monitor's growth and improvement, though, stand interesting facts that made it possible to meet the challenging demands of war. It is a story that will interest many of us who have shared in Monitor's growing pains as well as helped in its war production accomplishments.

#### HISTORY OF MONITOR

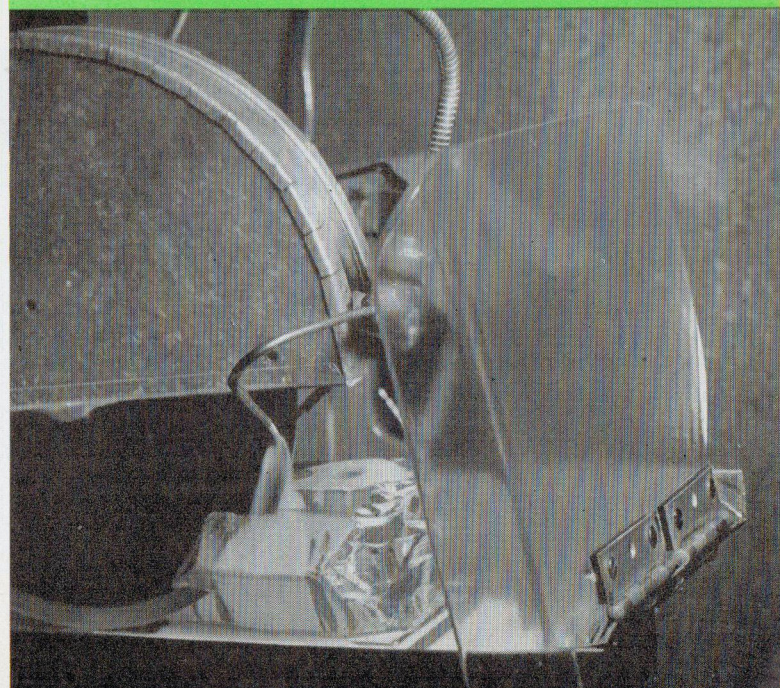
The story starts in 1909 when Monitor's president, Herbert E. Blasier, first became interested in radio, taking up the study of



**Polariscopic alignment**, above, is done in preparation for rough cutting after quartz' polarity is determined through pin-hole inspection, below.



**Rough cut** operation, below, is similar to rough sawing operation in lumbering. Rough squared "logs" or blocks are left, waste material has been removed.





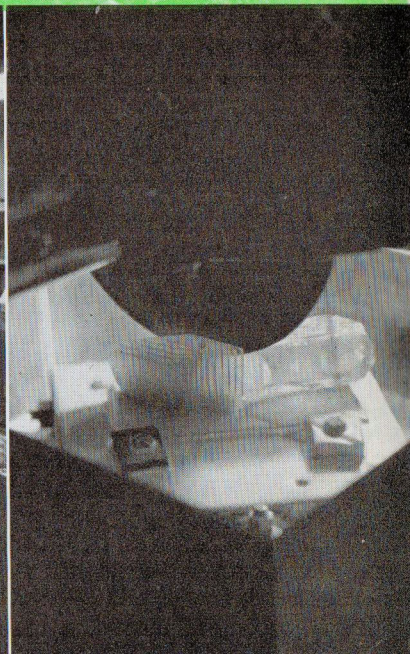
what was then an erratic and novel experiment that relatively few understood and none had yet completely harnessed for commercial or wartime use.



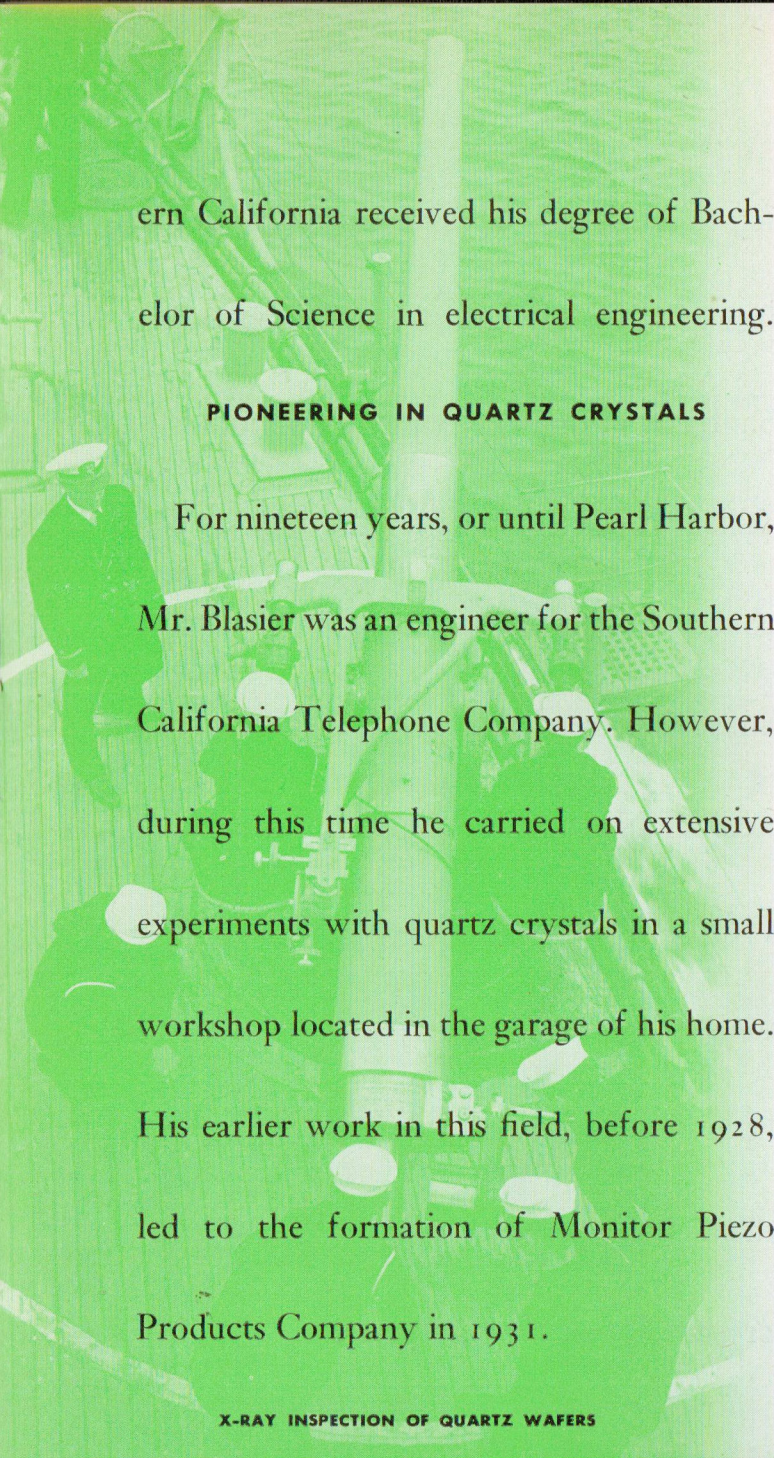
**Philips X-ray** inspection, above, assures correct wafer cutting in relation to crystal ZZ' angle. In room below, the rough crystal blocks are cut into wafers. Close view, right, shows how high-speed, diamond-edged circular saw cuts through hard quartz with ease, slicing off wafers which are then separated for further processing and frequent inspection.

A licensed “ham” radio enthusiast in 1912, Mr. Blasier developed his hobby in 1916, first by two years as a communications operator for the old Marconi company, and then to an unbroken career in radio communications and electrical engineering ever since.

After the war and with his sights firmly set on study, experiment and work in the field of electronics, he attended Iowa University, and later at the University of South-







ern California received his degree of Bachelor of Science in electrical engineering.

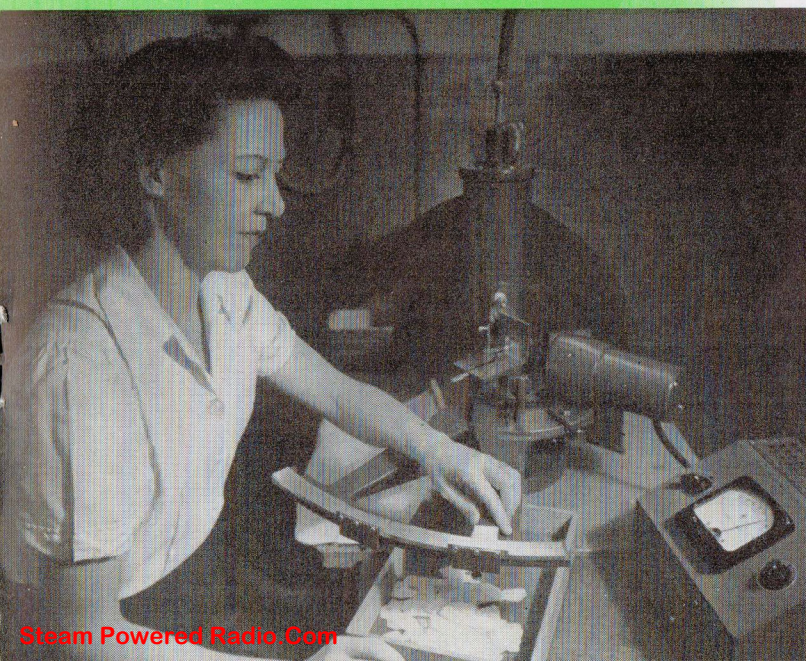
#### **PIONEERING IN QUARTZ CRYSTALS**

For nineteen years, or until Pearl Harbor, Mr. Blasier was an engineer for the Southern California Telephone Company. However, during this time he carried on extensive experiments with quartz crystals in a small workshop located in the garage of his home. His earlier work in this field, before 1928, led to the formation of Monitor Piezo Products Company in 1931.

**X-RAY INSPECTION OF QUARTZ WAFERS**

Headed by Mr. Blasier, a small group of Piezo-electricity specialists devoted their efforts almost entirely to designing and improving the quartz crystal for radio use. Their training and experience, of course, formed an unusually valuable nucleus of proven ability that was vitally necessary for the creation and management of the rapidly expanded facilities and production demanded by World War II . . . an expansion that, in less than two years, added over 900 people to Monitor's payroll.

**POLARISCOPE REVEALS UNUSABLE "TWINNED" AREAS**





## WAR'S PRODUCTION PROBLEMS

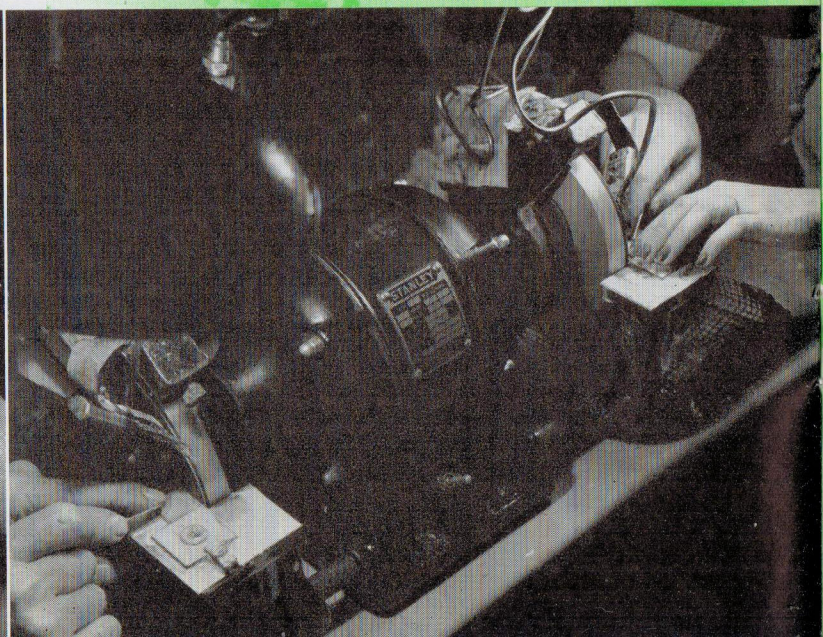
Those who have been at Monitor since the United States entered the war well know that the improvements in design and process-

ing effected, have been accomplished in the face of seemingly insurmountable obstacles.

Shortages of tools, equipment, materials and skilled workers have been overcome by the collective initiative and ingenuity shown in improving and designing "around" our difficulties. New methods have been developed and machines created from parts of other tools whose original makers might never have imagined the use we are now putting them to in our precision processing of crystals for wartime purposes.



**Wafers are diced** into "blanks," above, on high-speed circular saws. Close view, below, shows how wafers have been stamped as a guide in cutting so that the greatest number of blanks are obtained from each wafer. Two sides of each blank are "squared," below, to fit the vise-like "jig" holder used in truing the blanks to perfect squares.





All of us have earned the measure of pride we take in our contributions to the modern art of crystal-making. We can point to the evidence as shown in the pictures of operations and equipment on these and following pages. We have all had a hand in their preparation and daily use.

But probably what we want most to remember is the part all of this plays in the general scheme of things. With this in mind, we think you will be interested in the importance of the oscillating quartz crystal in the electronics world of today and tomorrow.

#### IMPORTANCE OF CRYSTALS

There is no question in the minds of scientists that the dependable "heart beat"



**Electric micrometer** checks thicknesses to .0001". Below, blanks are "lapped" or ground to desired thicknesses in these machines.

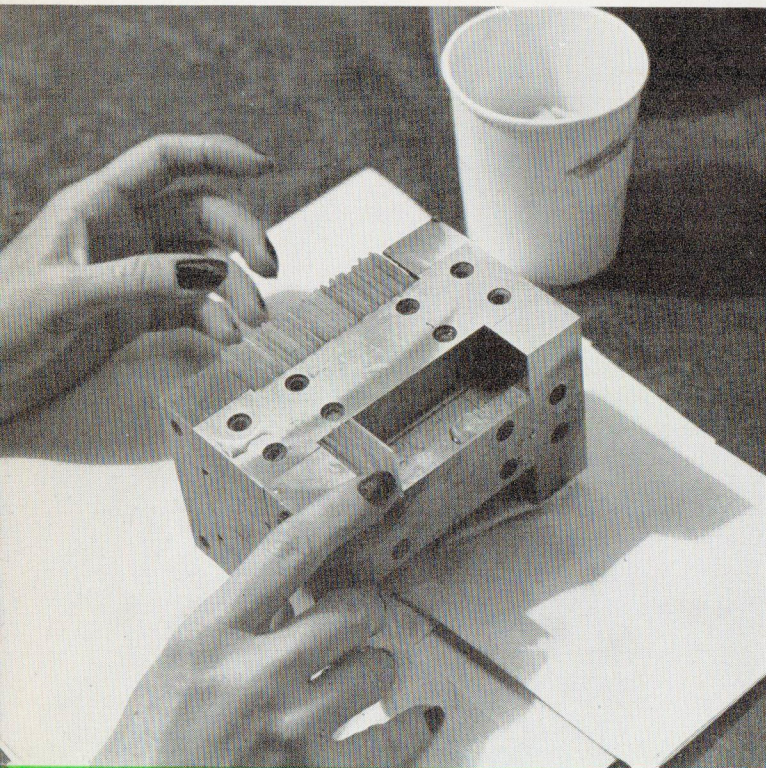




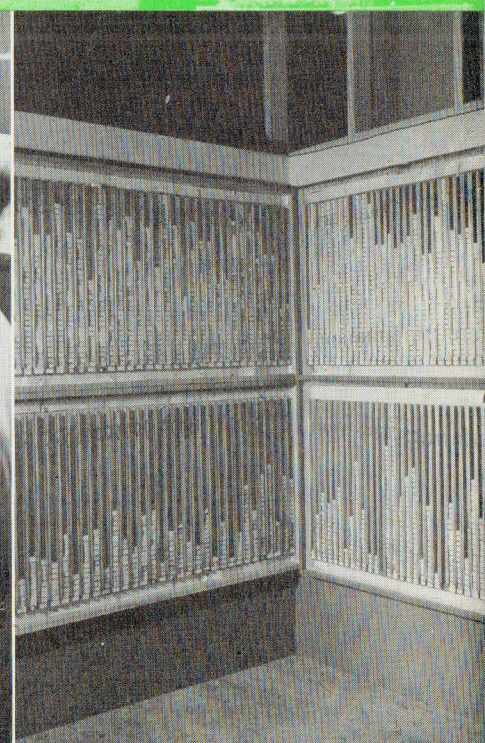
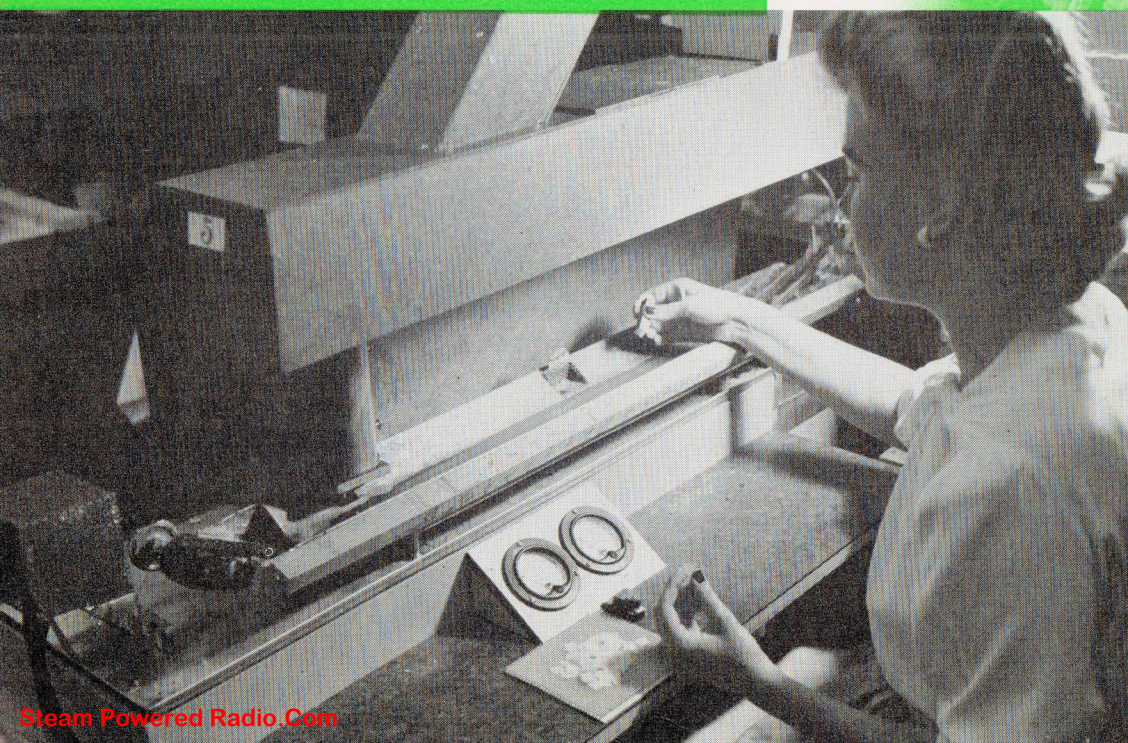
of the quartz crystal is an expression of the underlying and all-pervading rhythm of nature. The ancients' belief in the mystic

and occult powers of the crystal-gazing ball and quartz carvings is, doubtless, an inept hint as to the connections in nature not yet revealed and proved by modern science.

Most of us feel, therefore, that we must adhere to the conclusions that have been reached in the light of day, and that have enabled engineers and technicians to harness the crystal's "beat" in bringing order out of chaos in radio broadcasting. Because crystal wafers of given thickness expand and



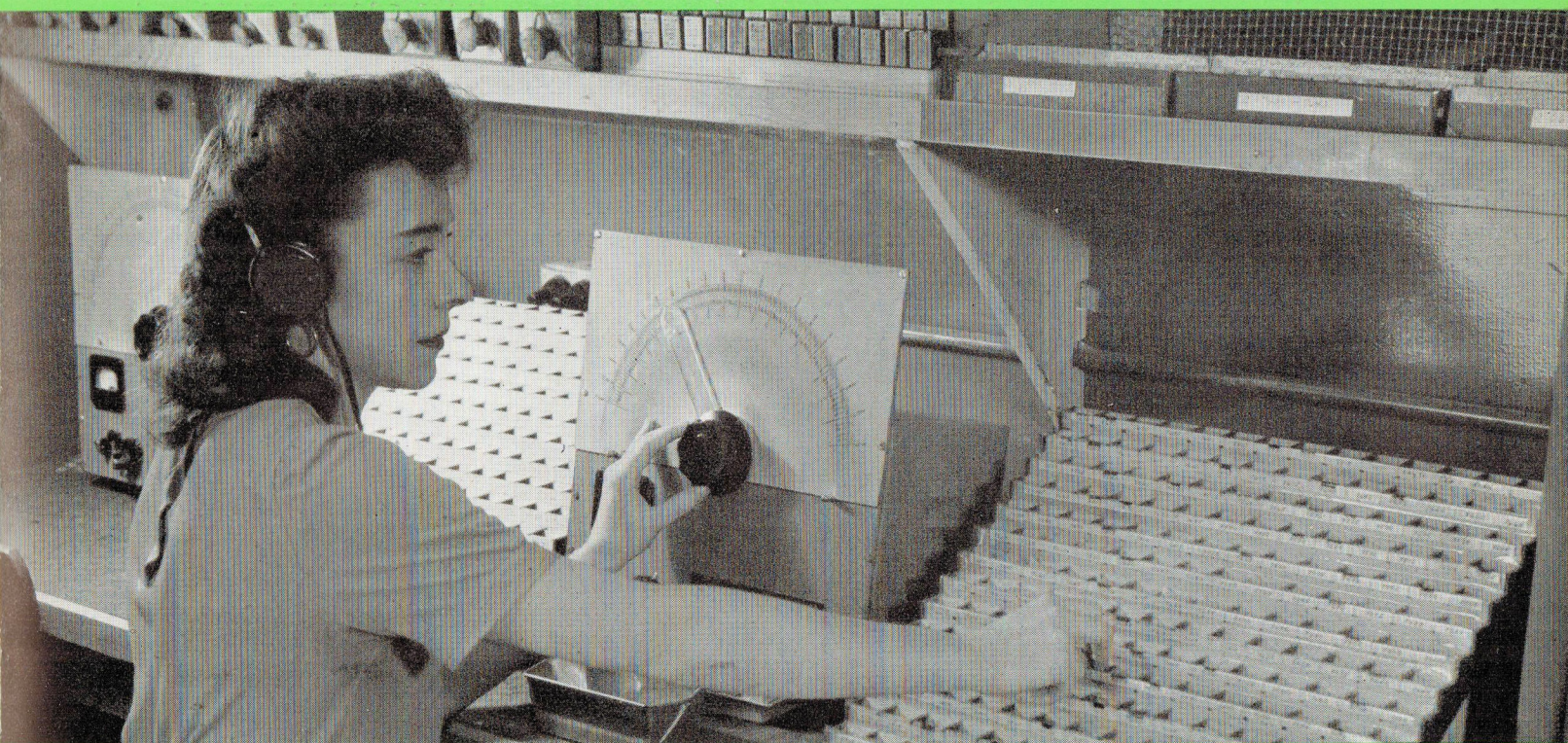
**Jig is loaded,** above, with blanks for final squaring operation which is shown on opposite page, lower right. Below, by the use of etching process, crystal blanks are brought to predetermined frequencies. Center below, Monitor stock of crystal blanks are stored in this file-lined room, sorted as to frequencies for subsequent etching process.



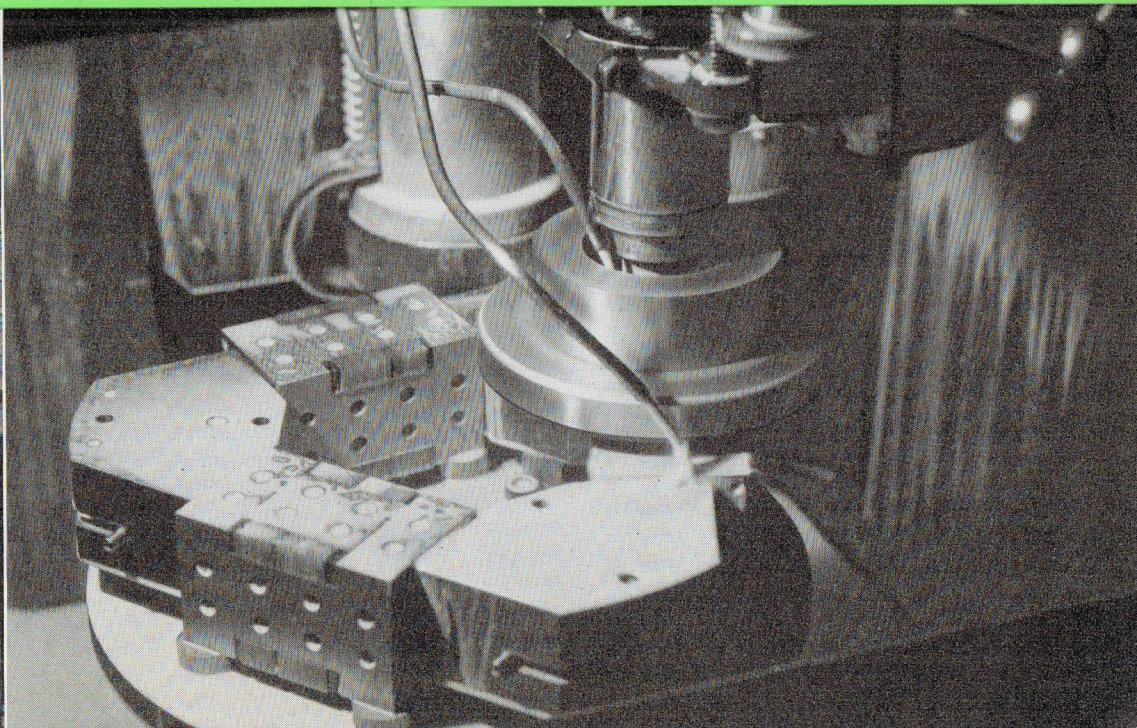




ETCHING PROCESS. HERE CRYSTAL BLANKS ARE BROUGHT TO PREDETERMINED FREQUENCIES BY USE OF ETCHING MACHINES.



CRYSTAL BLANKS ARE NOW "CHANNELED" OR SORTED AS TO THEIR FREQUENCIES AND ARE GROUPED IN FREQUENCY RANGES OF 25 KC PREPARATORY TO ETCHING.





contract at determined rates of speed per second when stimulated by an electric cur-



**Holder assembly.** The pictures appearing on this page were furnished through courtesy of Cryco, Inc., showing assembly of contact plates in plastic holder above, and stamping machine below, engraving identifying marks on the plastic crystal holders.



rent, they have become the *traffic managers* of the air waves throughout the world.

#### PRECISION IS OUR BUSINESS

Oscillation is simply another name for expansion and contraction. Thin crystals oscillate more rapidly, or at higher "frequency" than thicker crystals. Therefore, it is possible to predetermine the frequency of a crystal by reducing it to a designated thickness. Although this is basically simple, we know from years of actual experience that it takes real craftsmanship in design and exquisite care in manufacturing to produce a finished crystal of the degree of exactness desired for war and other uses.



Precision in all phases of our manufacture is absolutely necessary. To realize this fully we need only consider the fact that millions of radio signals are originating at hundreds of thousands of radio transmitters in the seconds it takes to read this, and are traveling unerringly at the speed of light (186,000 miles per *second*) to receivers near and far which are *tuned* for their reception.



**Final assembly**, where finished crystals are checked for frequency and activity and mounted in crystal holder as shown in close view below.



**Another view**, below, of the final finishing, assembling and frequency tests operations which assure extra precision quality in Monitor crystals.







**All Monitor Crystals** are subjected to activity and frequency tests under extreme temperatures ranging from as low as minus 50° Centigrade to as high as 90° Centigrade in the special equipment shown above. Below, The Army Signal Corps' civilian resident inspector subjects all Monitor crystals to a final, rigid inspection before acceptance for delivery.



## THOUSANDS OF USES

The unerring *sending* and the *selective* tuning for individual signals or messages make it possible for a single telephone wire to convey hundreds of messages at once and for radios everywhere to carry on the business of commerce and war.

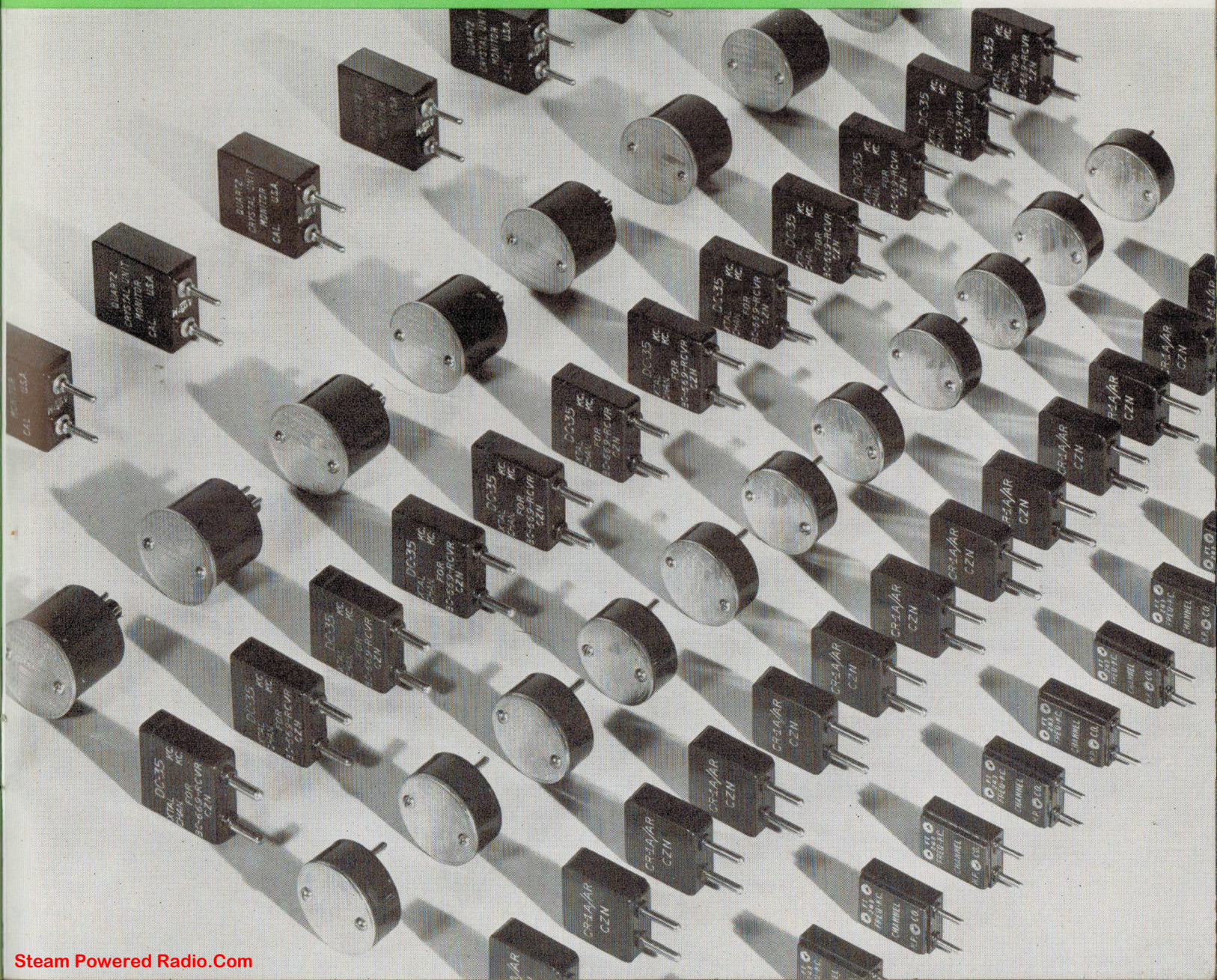
Without confusion, through the controlled frequencies of the oscillating quartz crystal, police cars may carry on two-way conversations with headquarters, earthquakes are accurately registered and located on seismographs, longitude at sea and in the sky is determined by chronometer, musicians tune their instruments by a contin-



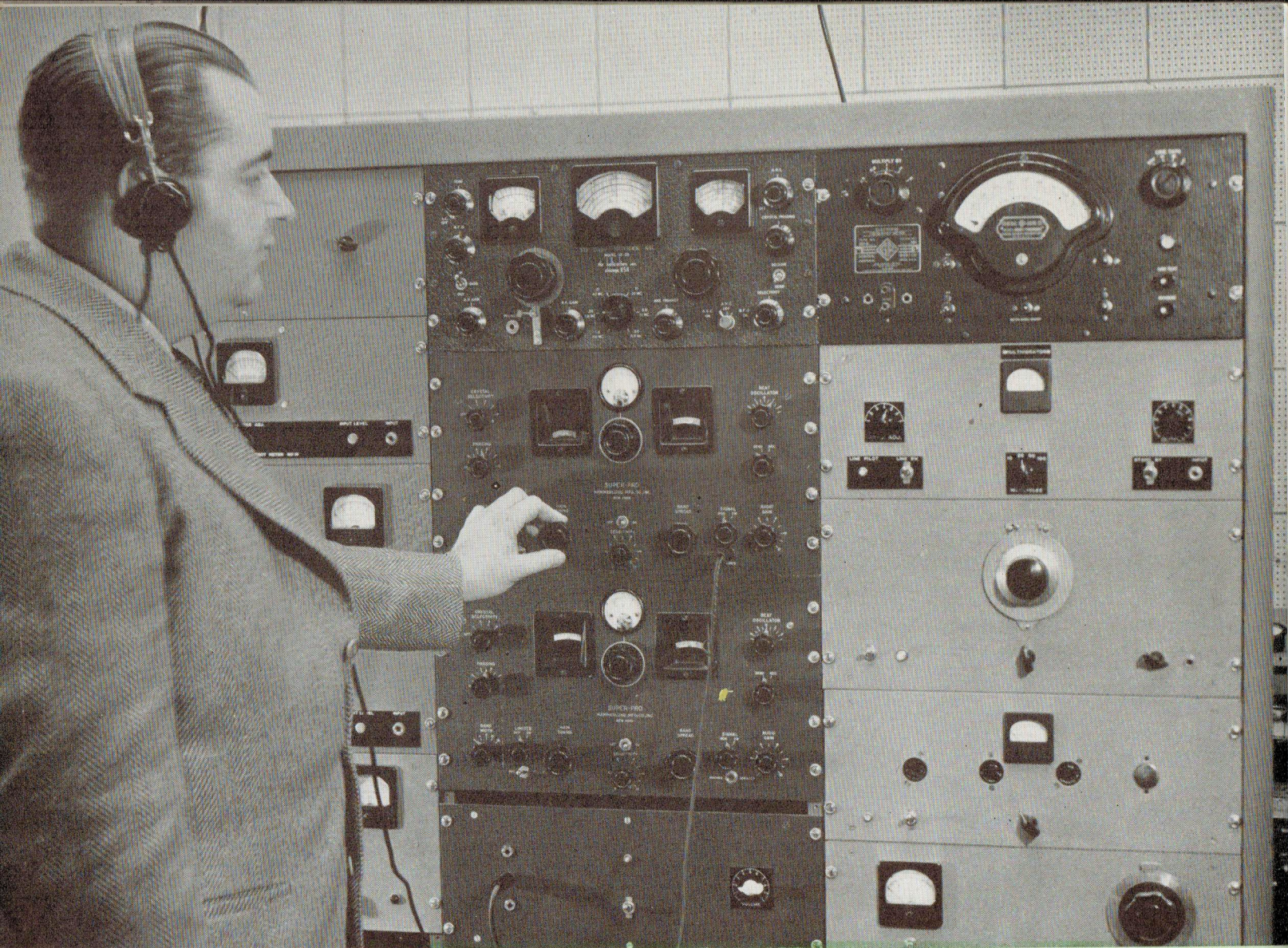
uous tone broadcast from the Washington Naval Observatory, and thousands of instruments of war and science determine distances, sizes, pressures and depths by means of the dependable and precise quartz crystal.

On all war fronts combat units consisting of fighters, bombers, warships, tanks, scout patrols, paratroopers, jeeps, walkie-talkies and handie-talkies are daily using millions of crystals of various frequencies.

A FEW TYPES OF MONITOR QUARTZ CRYSTAL FREQUENCY CONTROL UNITS NOW IN USE BY ARMED FORCES ON ALL FIGHTING FRONTS





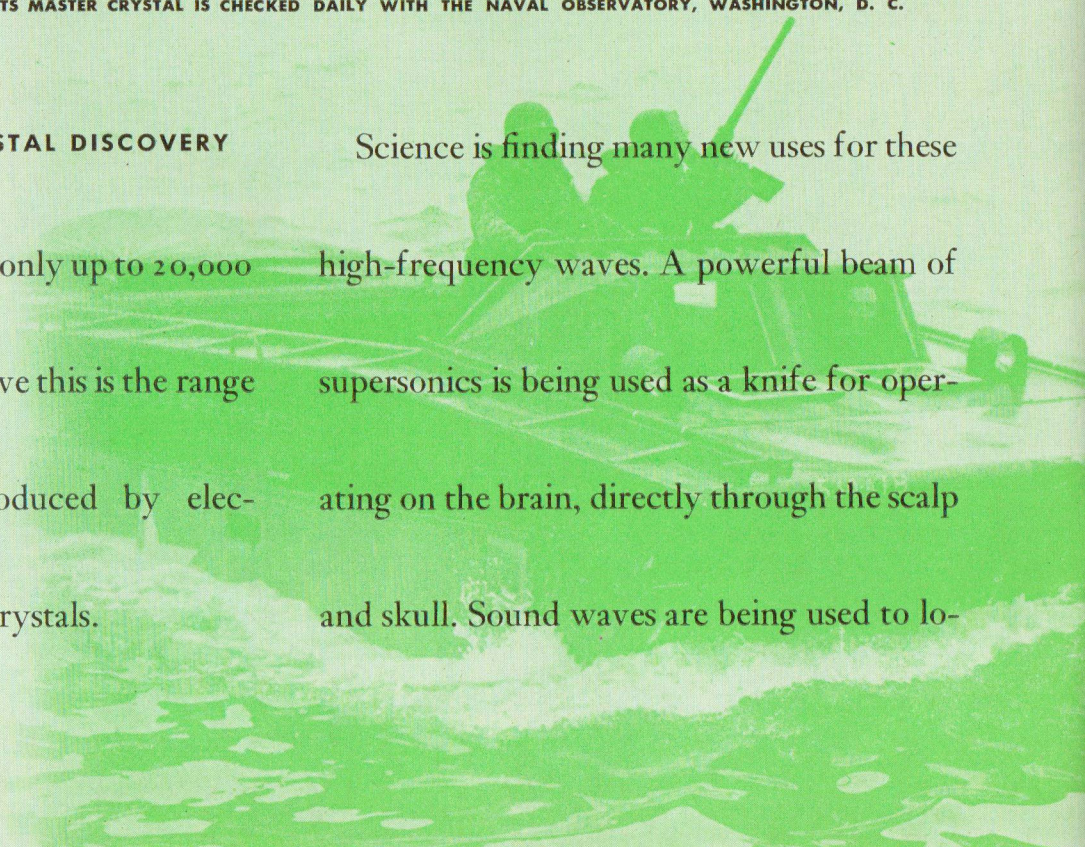


MASTER FREQUENCY STANDARD AGAINST WHICH ALL MONITOR CRYSTALS ARE DIRECTLY OR INDIRECTLY CHECKED. THE CONSTANCY OF OSCILLATIONS OF ITS MASTER CRYSTAL IS CHECKED DAILY WITH THE NAVAL OBSERVATORY, WASHINGTON, D. C.

### "SILENT SOUND," A CRYSTAL DISCOVERY

The human ear can hear only up to 20,000 vibrations per second—above this is the range of supersonic waves produced by electrically vibrating quartz crystals.

Science is finding many new uses for these high-frequency waves. A powerful beam of supersonics is being used as a knife for operating on the brain, directly through the scalp and skull. Sound waves are being used to lo-





cate shrapnel in any part of the body of a

wounded soldier . . . and also used to grind

minute microorganisms to release their inner

toxins for medical study. Ultrasonic vibra-

tions change starch into dextrose—water into

hydrogen peroxide. Milk is being homog-

enized in enormous quantities today by this

sound wave.

## THE BUSINESS OF THE FUTURE

Looking ahead, we envision the men of

science discovering many more uses for

ultrasonic waves. These unknown millions

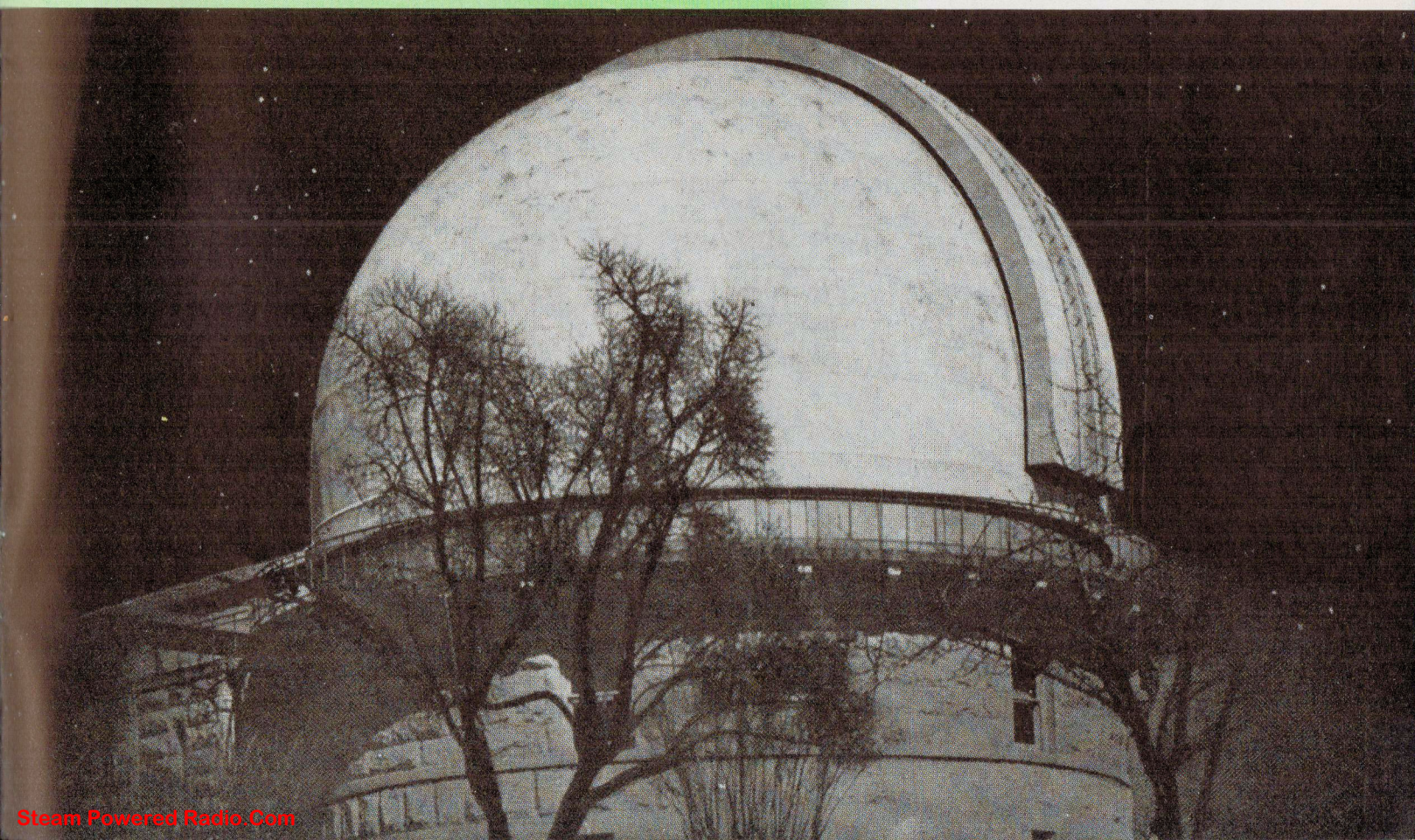
of other bands or wave lengths are the future

business of precision quartz crystals. And,

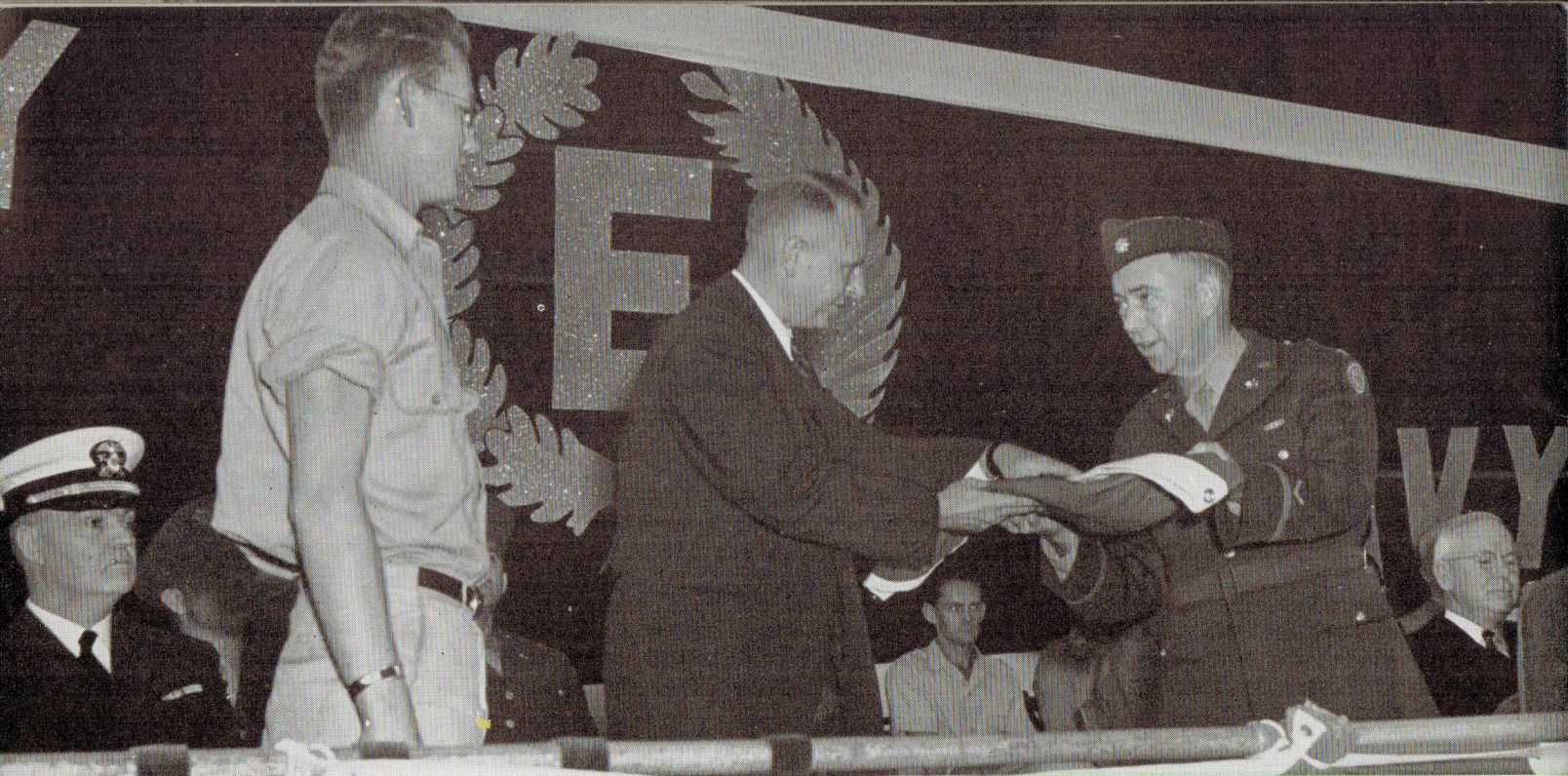
therefore, they are the future business of

Monitor Products Company.

THE WASHINGTON NAVAL OBSERVATORY CHECKS ITS TIME DAILY WITH THE PERFECT TIME STANDARD OF THE UNCHANGING STARS







## WINS RECOGNITION...

**M**ONITOR's first "E" Award, made October 10, 1942, by representatives of the Army and Navy, was commemorated on November 6, 1942, by the ceremonies pictured on these pages. Most of us recall the impressiveness of this presentation and now that we have the distinction of receiving a fourth Award for excellence in production it may be helpful to restate the significance of the awards.

### SIGNIFICANCE OF AWARD

As chairman of the presentation ceremonies Mr. F. N. Rush, vice president and general manager of the Southern California Telephone Company stated, "In 1906 the Navy instituted in the fleet an award for excellence which has been known ever since as the Navy "E". Those of you who sailed through Los Angeles harbor in the old days remember seeing the great square block "E" painted on a few of the battle-ships that used to ride at anchor there. We knew that those ships had been selected for excellence in





gunnery and for excellence in executing tactical problems. It is an honor not easily won nor lightly bestowed.

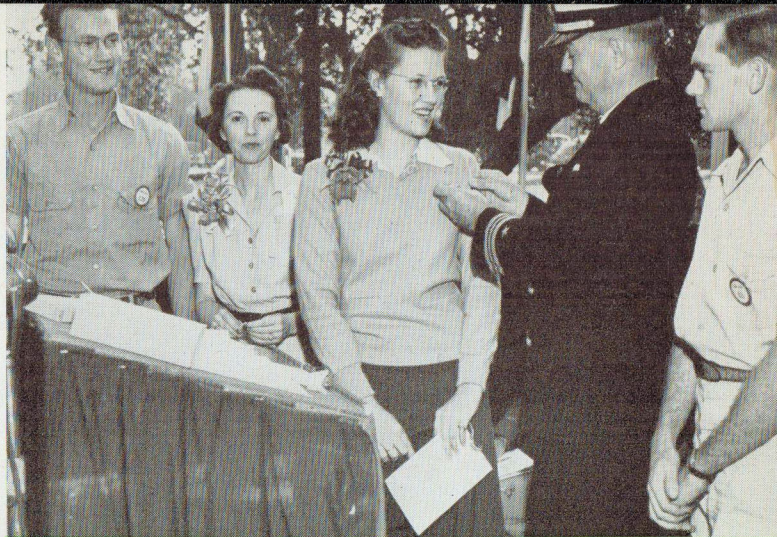
"Following Pearl Harbor there came a demand for war production such as we have never known. From our resolve to win the war and our recognition of the importance of the equipment the fighting forces must have was born the Army-Navy production award—the joint Army-Navy "E" for excellence given only to those organizations which have been outstanding in winning the fight at home."

In making the presentation of the Award Pennant, Lt. Col. H. S. Beardsley said, "In a way the flag you are to receive is a military decoration bestowed upon you by the Army and Navy for courage and devotion to duty. It is as much a military decoration as if you were receiving the Distinguished Service Medal—which you would be receiving if you had performed similar service while wearing the uniform of the fighting forces.

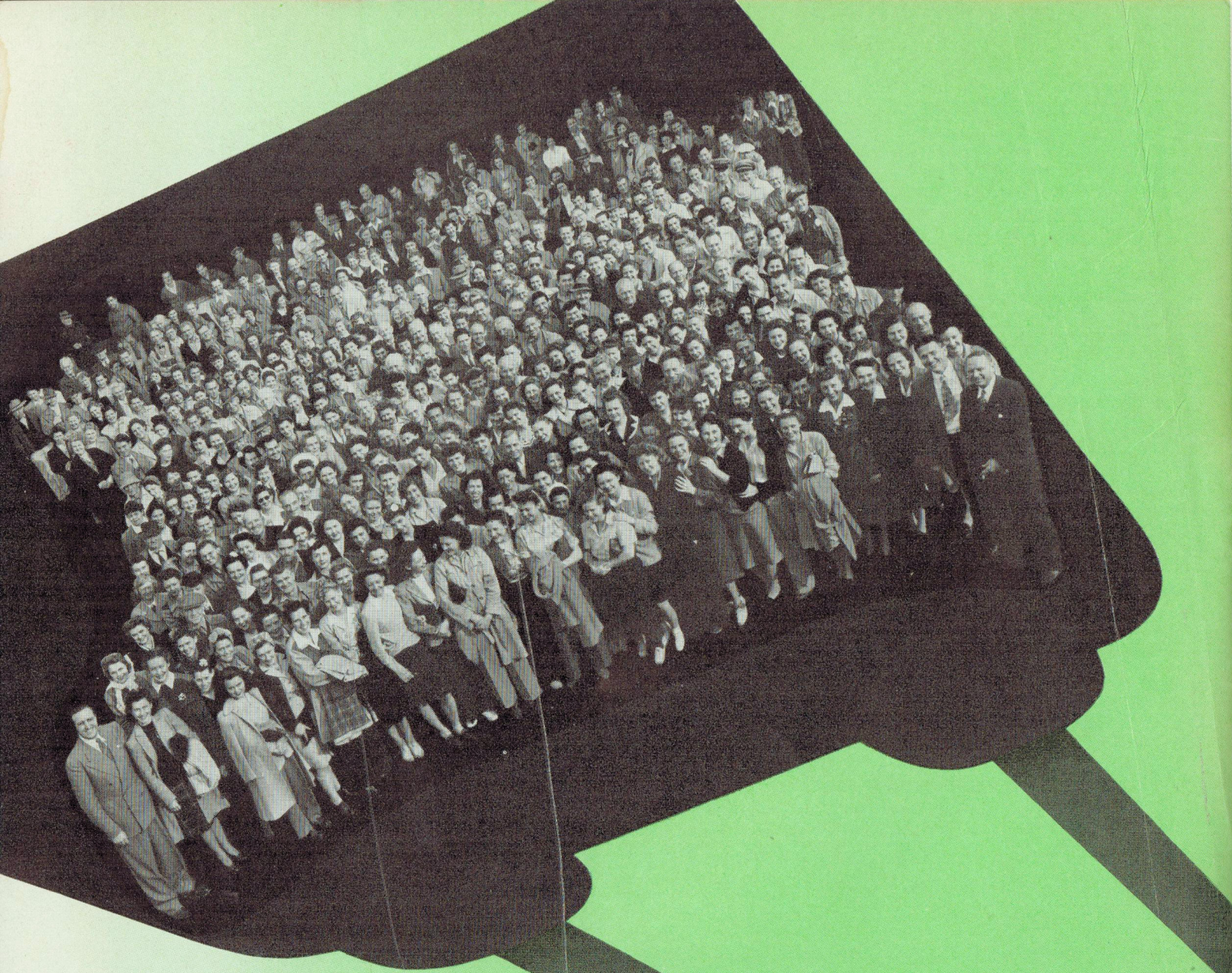
"Your work has just as definite a place in this war as work and service of the men in the Army, Navy, Marines, or the Coast Guard."

#### PLEDGES FOR VICTORY

"In accepting the symbol awarded us today," stated Mr. Blasier, "I want to publicly acknowledge the untiring efforts of each and every employee in my organization. Their efforts, and only their efforts, have made this achievement possible. Also, I wish to pledge our determination to earn a service star every six months." (A pledge which we have met and will continue to meet.)



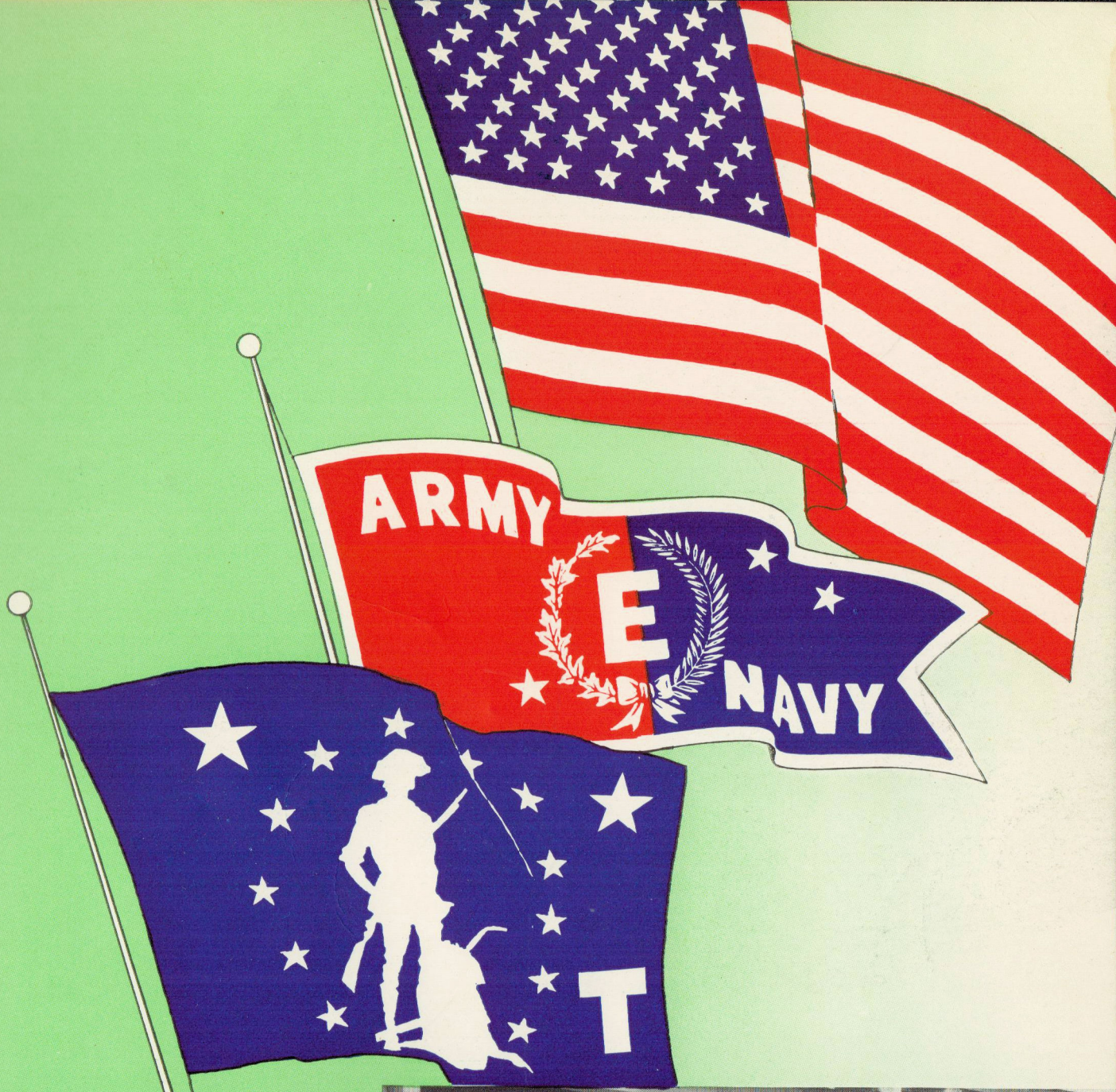




From its humble beginning Monitor, in two short years, has grown to an important position in the field of communications, a vital link in the fight for freedom. This growth has been accomplished by the spirit of cooperation and friendly endeavor of the men and women of Monitor who have combined their efforts to win the recognition of our Army, our Navy and our Government for . . . "a job well done!"

Background pictures used in this booklet are through the courtesy of United States Signal Corps and Ford Machinery Corp.









## MONITOR PRODUCTS COMPANY

815 FREMONT AVE. • SOUTH PASADENA • CALIFORNIA