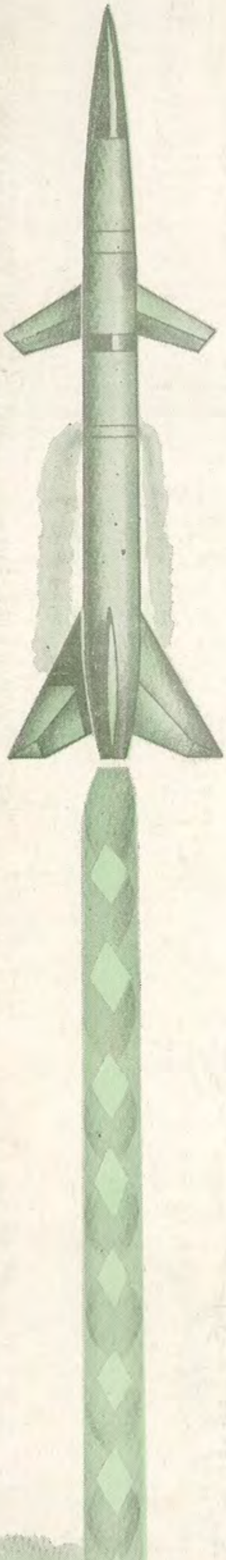
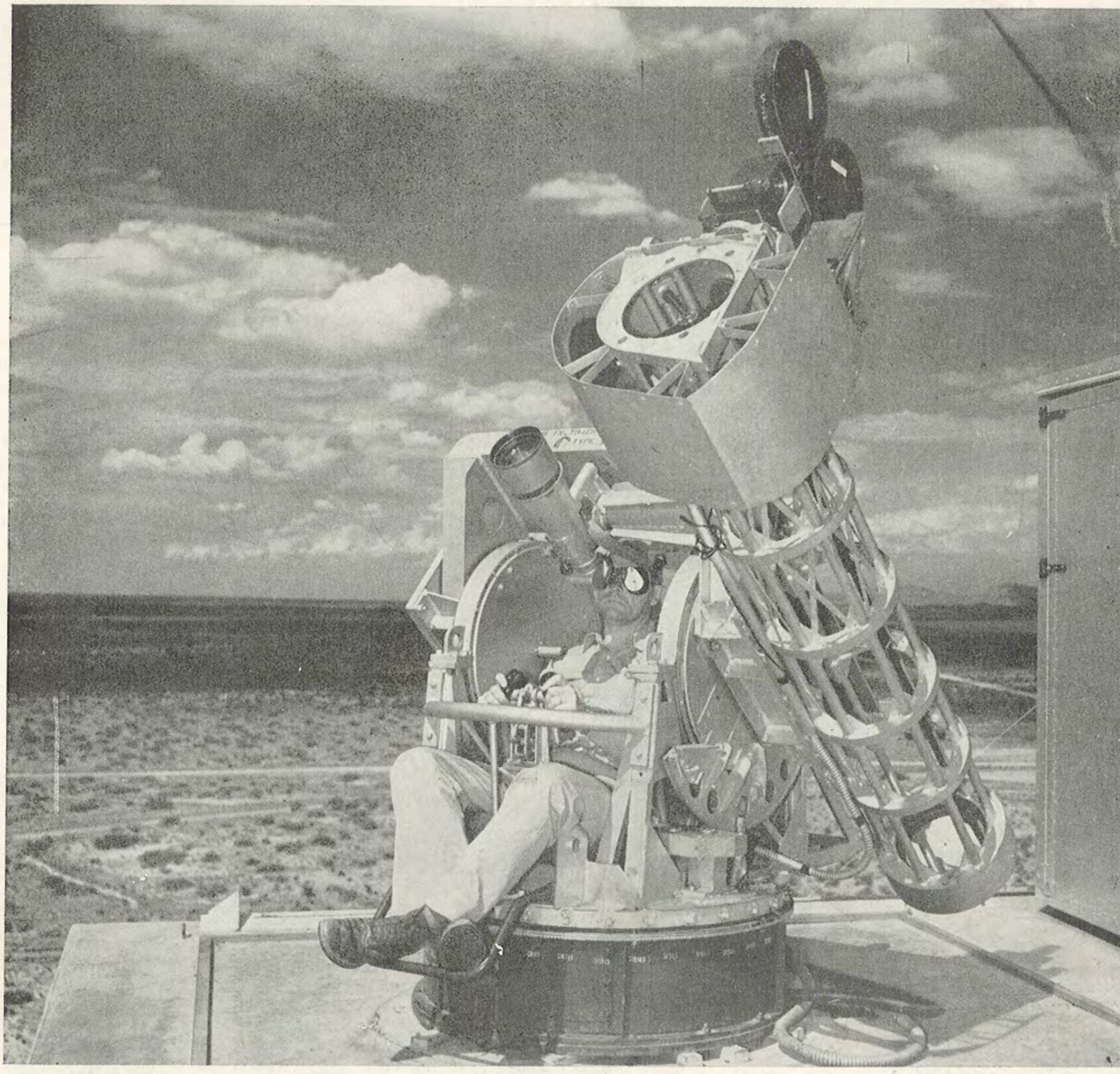
Vol. II, No. 3
FALL
1954

"Missile Away!"

THE NEW MEXICO - WEST TEXAS SECTION
OF THE AMERICAN ROCKET SOCIETY





TRACKING
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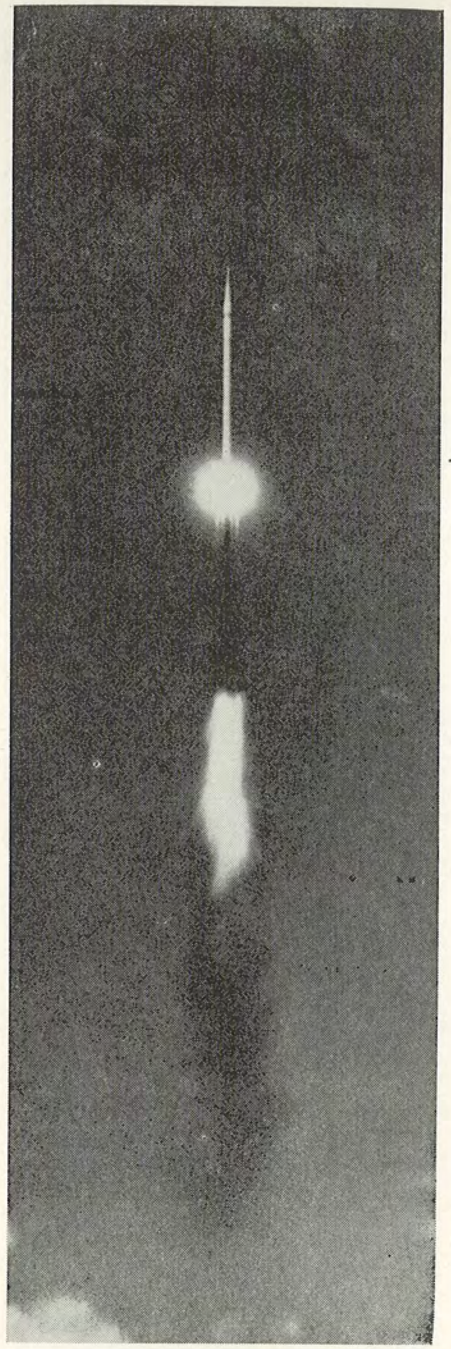

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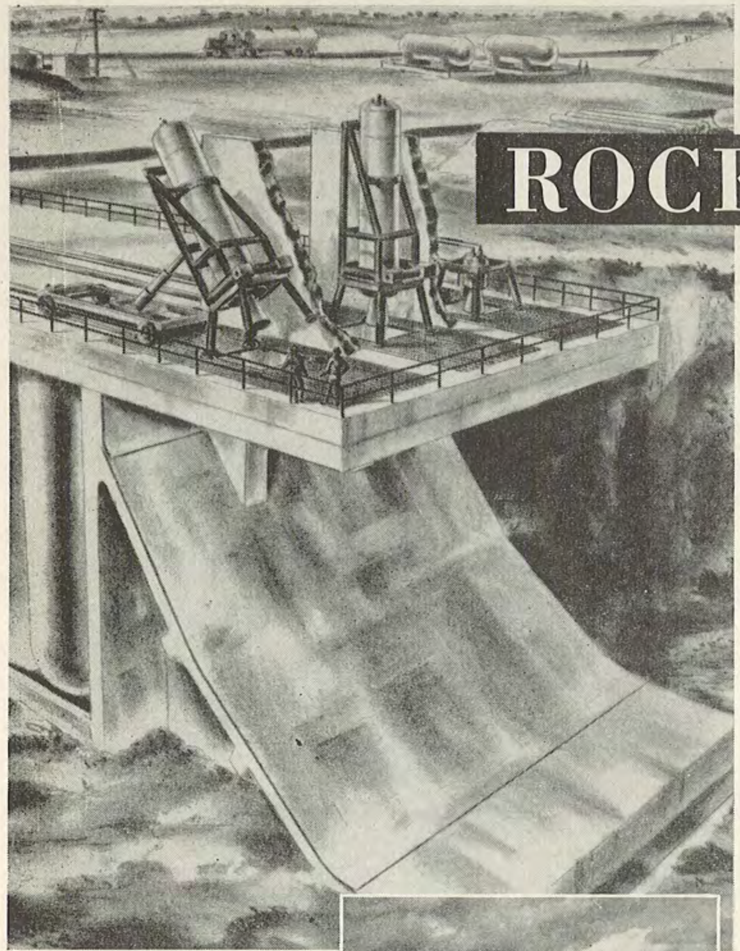

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"MISSILE AWAY!"

Vol. II, No. 3
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Editorial: *the voice of rocketry*

WE have heard loud, long, and vociferous comments from our members regarding the **Journal** of the American Rocket Society, "**Jet Propulsion**". While nearly everyone admits it is a fine technical magazine, the most frequent comments by far have been that it is **too** technical. We are inclined to agree with this, but are quick to point out that a technical organization should have a technical magazine for the exchange of technical ideas.

But we are forced to agree when the remark is made that it requires considerable background in the field with which the paper is concerned before the average member of the ARS can begin to understand it at all. "Why don't those guys print something about missile electronics or launching and handling techniques?" "I have to wade through five pages of differential equations before I can understand what the author is talking about!" Or, "Why don't they print some articles with broader scope?" And most frequent: "I just read the news articles in the back and skip the rest."

All right, so you're not interested in a highly technical magazine. But many people who join the ARS **are!** It is—and rightfully so, we think—the finest if not the only American publication dealing with the technical side of rocketry.

If we need and must have a magazine of this tremendous technical quality, must we still be confronted with a magazine which does not present the entire scope of rocketry?

Scientists and engineers require facts and figures to work with, so we sent one of our staff members to a file of bound **Journals** to make the following survey of articles appearing from Vol. 21, No. 5, September 1951 to Vol. 24, No. 2, March-April 1954 inclusive:

1. Theory of Propulsion Systems: 33 articles.
2. Theoretical Chemistry and Physical Chemistry of Propulsion: 8 articles.
3. Materials for Rocket Engine Construction: 3 articles.
4. Literature Survey: 1 article.
5. Theory of Space Flight: 5 articles.
6. Thermodynamics of Rocket Engines: 10 articles.
7. Guidance: 1 article.
8. Fuel Handling: 1 article.
9. Instrumentation of Propulsion System Tests: 11 articles.
10. Aerodynamics: 3 articles.
11. Solid Propellant Rocket Engines: 5 articles.

Okay, so it doesn't represent the rocket and guided missile field in a balanced manner. What can we do about it?

The answer lies with you.

If you would like the ARS **Journal** to become the kind of magazine you want, **you** will have to make it that way. **You** will have to write the articles on ground equipment, radar, guidance, servos, environment testing, component testing, photography, range instrumentation, launching techniques, safety, or whatever your special field happens to be.

It will do no good to keep on complaining and wishing things were better. If wishes were horses, beggars would have callouses in places other than their feet.

You, dear reader, can bring about the change in the ARS **Journal.** The editors can only print what is submitted. If Joe Doaks over in the next section writes technical articles and you don't, you have no call to complain about the fact that the work of your own section is receiving no attention.

Our policy with "**Missile Away!**" is to present general interest articles of a semitechnical nature. In asking you to write articles for this magazine, we are not discouraging you from writing a real sockeroo of a technical article for the ARS **Journal.** It is a well-known fact that an engineer or scientist isn't worth his salt at all until he has turned out at least one tightly reasoned, concise, high-qaulity technical paper. Many of you in authoring for this magazine have discovered that writing isn't as difficult as it seems, for no stern-faced English IIA professor is standing over your shoulder now to mark you down for a misplaced comma.

So . . . **write!** A good friend of ours, an engineer-author, once quoted the prime rule which authors should follow: "You must write." And as Walter Bagelot once put it in a way which is also applicable to the case of a technical article: "The reason why so few good books are written is because so few people who write know anything."

—G. H. S.

RED STAR IN THE SKY?

ACCORDING to George P. Sutton, member of the National Board of Directors and engineer for the Aerophysics Department of North American Aviation, Inc., Russia's rocket technology has advanced to the point where the Soviets could develop both long-range intercontinental rockets and earth satellites. Speaking before the Third Symposium on Space Travel at the Hayden Planetarium in New York, Mr. Sutton declared that the Russians have improved upon Ger-

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man findings of the last war to build powerful rocket engines and other rocket equipment.

According to his information—the sources of which he declined to comment upon—he stated that the Russians are working on a number of projects, the most ambitious of these being a rocket engine, "Model 103." Operating at about 800 psi chamber pressure with kerosene and liquid oxygen, Model 103 is reported to have a thrust of 264,000-lbs. at sea level, gulping propellants at a total flow rate of over 1333 gallons per second.

The Soviet rocket program must be taken seriously, Mr. Sutton warned. It would be dangerous for this country to underestimate the Russian engineering skill, particularly after tangling with the MIG-15 fighter. They are working with German scientists and technicians, and they have definite plans for the establishment of an earth satellite.

"ONWARD, UPWARD, EXCELSIOR!"

From the **New York Times,** August 3, 1954:

"INNSBRUCK, Austria—An executive committee of rocket experts at the International Astronautical Federation meeting here has been trying to frame a program midway between what has been aptly described as 'Utopia and reality.'

"On the Utopian side there are various projects for manned and unmanned space platforms encircling the earth perpetually in a satellite orbit from which, it is hoped, space explorers eventually will be able to explore the moon and the planets, if not the stars.

"Professional rocketeers are agreed that a space platform probably will be launched before the end of the century and is as yet the only practical idea envisaged, or so it was aid today.

"An apparent preponderance of members of the American Rocket Society here has caused some jealousy among other delegates, particularly as the executives of the American society are also executvies of the federation.

"Fred C. Durant, a past president of the Rocket Society, is also the retiring president of the federation, while Andrew G. Haley, president of the society, is vice-president of the federation."

It will be interesting, no doubt, to look back on these fifty years from now, just as it is interesting to read "Fifty and One-Hundred Years Ago" in the **Scientific American.** It is gratifying to know that the majority of rocket people have finally come around to agreeing that space flight will be accomplished. Somewhere in the last twenty years, this goal was overshadowed. Perhaps, like the moon moving out of the earth's shadow after a lunar eclipse, the idea of space flight has moved into the light in the minds of the men who will eventually do the job. Perhaps we will again be a rocket society which is aimed at space flight.

After guided missiles come inhabited missiles. The way lies before us. ● ● ●

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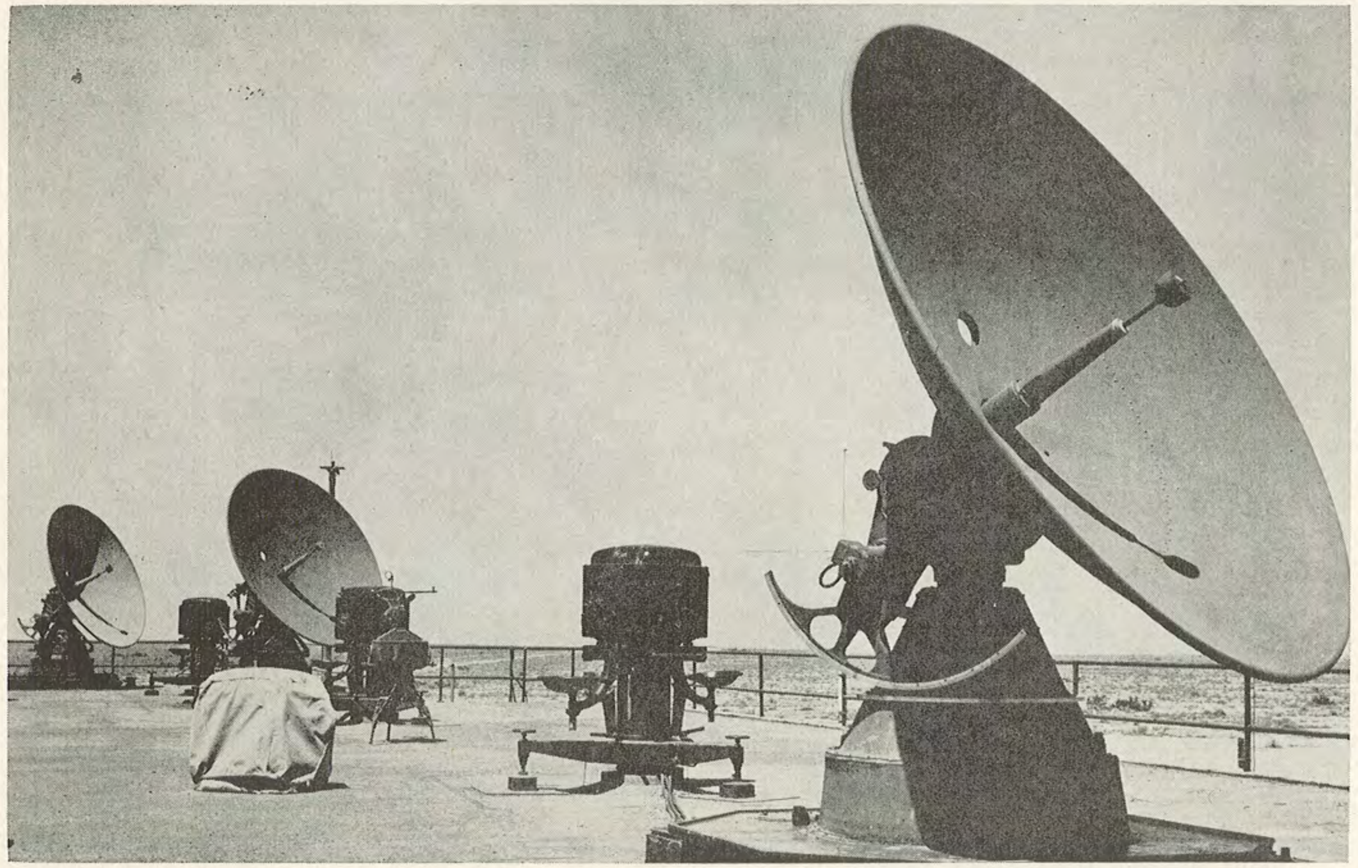

Fundamentals of RADAR

by
DUDLEY M. COTTLER
White Sands Signal Corps Agency
White Sands Proving Ground

Many sciences band together to permit a guided missile to go aloft in search of its target. Not least among these is the electronic science of radar which can not only guide a missile but also perform the important function of showing human beings where the target is . . . and where the missile is!

THE term radar is one which was coined from the expression "Radio Detection And Ranging." Successful radar systems were developed independently in the United States, England, France, and Germany during the years 1930 to 1940. It was Heinrich Hertz however, who in 1886 discovered radio waves and established that these waves had optical properties identical to ordinary visible light. He also showed that radio waves are reflected from solid objects. In 1922, Marconi championed the use of short waves for radio detection. In 1925, the pulse-ranging technique was put to use by Breit and Tune of Carnegie Institution of Washington for the measurement of the ionosphere heights. The next logical step in the sequence was the development of radar. In November, 1938, a radar set later to be known as SCR-268, designed and built by the Signal Corps Laboratories, was tested by a Coast Artillery Board for control of antiaircraft guns and searchlights. In early 1939, the Naval Research Laboratories were giving extensive fleet tests to radar equipment installed on the USS New York. The British, in 1936, began an installation of five early warning radars near London which were based on an experimental radar system suggested by Sir Robert Watson-Watt. Tremendous impetus to radar development was given by the onset of World War II. Development of new equipment still continues.

A simplified radar set is made up of some fundamental major components. They are an antenna or antennas, a transmitter, a receiver, an indicator and a timing device. (See Fig. 1 and 2).

With this equipment we are interested in making at least two measurements for search radar equipment, namely, range and azimuth to a target; the third measurement of elevation or height being furnished by an auxillary radar known as a height-finder.

However, a gun-laying radar or precision tracking radar must measure all three parameters, namely, range, azimuth angle, and elevation angle.

The measurement of range is primarily based on the velocity of propagation for radio waves. If we transmit a very short burst of radio frequency energy and measure the elapsed time required for this burst of energy to reach a target and be reflected back to the radar set, we can then determine the total distance of the round trip, if we assume a propagation velocity. The distance to the target would then be, of course, half the round trip distance. The normal propagation velocity used is $C = 3 \times 10^{10}$ cm/sec, which is the free space value. However, the problem of tracking in the earth's atmosphere or through it as the case for rockets requires a different value for precision range measurement. This variation is due to the changing dielectric constant caused usually by a change of moisture content with height. As a result we get refraction, again an optical characteristic, hence a slightly curved radar beam which yields a larger range measurement than the actual range. This effect can be compensated for in the time generator if we use a new average propagation value. The methods of connection for precise range measurement will be covered in a later article. Since the variation occurs in the fourth decimal place, we will continue to use 3×10^{10} cm/sec for this article. This value is also equal to 328 yards/microsecond for the round trip or 164 yards/microsecond for the one-way trip. Then numerically if the elapsed time between transmission of energy and receipt of the echo is 10 microseconds, then the target is 1,640 yards

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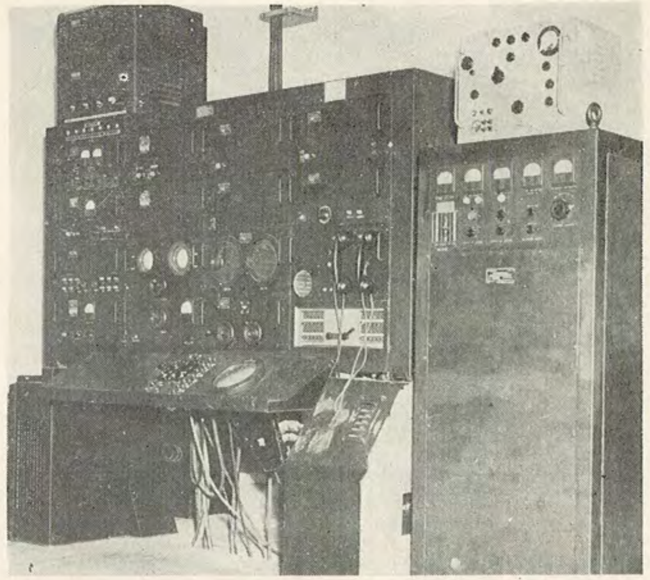

A typical radar operator's console with all controls, screens, and power supplies grouped together for easy operation and maintenance. (U. S. Army photo.)

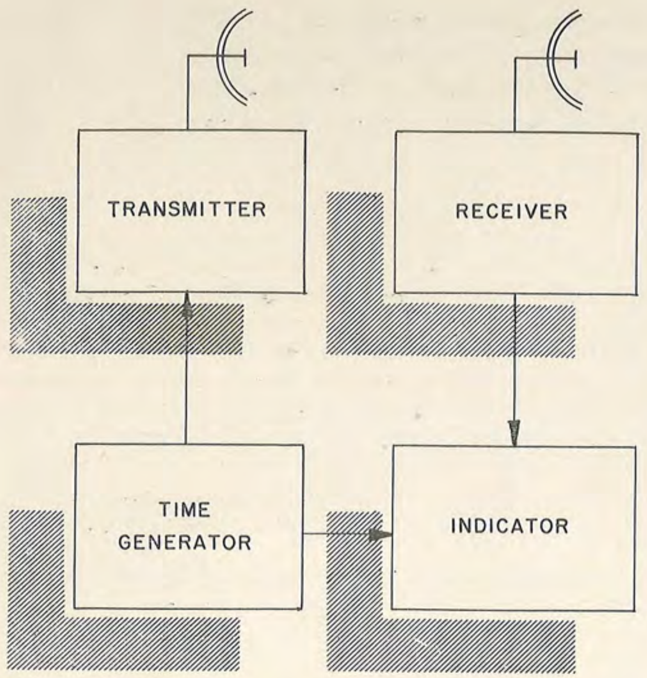

Fig. 1: The block diagram of a radar system with two separate antennas, one for transmitting and another for receiving the reflected pulse.

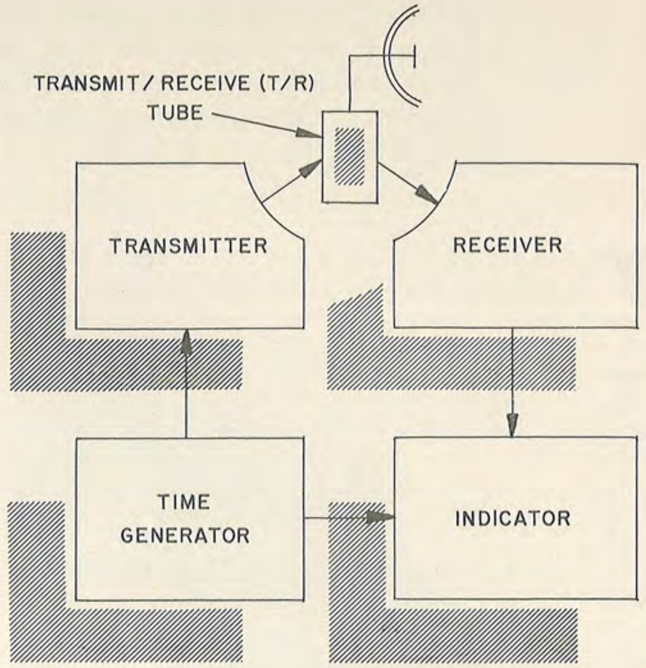

Fig. 2: A common type of radar system using only one antenna for both transmitting and receiving. The t/r tube switches the antenna at a rapid rate, allowing it to send a pulse and then pick up the reflected echo.

away. This distance can be displayed on the indicator which contains a cathode ray tube (CRT) and associated circuitry. In one particular type of scanning known as "A scan", the beam of the CRT is caused to begin a sweep from left to right at the instant a transmitted pulse is sent out by the transmitter. The sweep crosses the face of the tube at a uniform and predetermined rate. When the echo is received by the receiver, the beam of the CRT is deflected from its horizontal course for the duration of the received signal. The CRT normally has a scale on a bezel or electronic range machine calibrated directly in range so that the operator can read the range at anytime during the tracking operation. (See Fig. 2).

The transmission of pulse energy is a cyclic process and is known as the pulse repetition frequency or PRF. The PRF normally determines the maximum range at which the measurement of range can be effectively accomplished without ambiguity. If a second pulse leaves the transmitter and a new sweep starts (the sweep start and transmitted pulse are normally synchronized by the timing generator) prior to the return of the echo from the first pulse, then an incorrect range measurement will be made unless the operator can interpret the indicator reading. There are special circuits which can be used to blank out unwanted information, but are not incorporated in our simplified radar set. The duration of the burst of RF energy from the transmitter is known as the pulse width. This value is one microsecond for long range search type radar sets. The widths of the pulse is determined by a number of factors.

The longer the pulse duration, the greater the quantity of energy transmitted in one pulse for a given peak power output. Therefore, the capability of the particular transmitter tube will be the limiting factor on energy transmitted. The pulse width, peak power, and pulse repetition rate all enter into computation of average power consumption and transmission of the transmitting tube. Normally low repetition rates (on the order of 100 to 400 pulses per second) are used in search systems to allow for long-range tracking. The length of pulse duration will also affect the detection of very close targets. A 10 microsecond pulse width will prevent the detection of a target within 1,640 yards, since some energy from the transmitter will block the receiver for that time. Actually this undetectable range is usually higher because the receiver will not recover to full sensitivity immediately after the transmitted pulse. Therefore, for gun laying equipment, the pulse duration is usually less than one microsecond to allow for tracking of close targets.

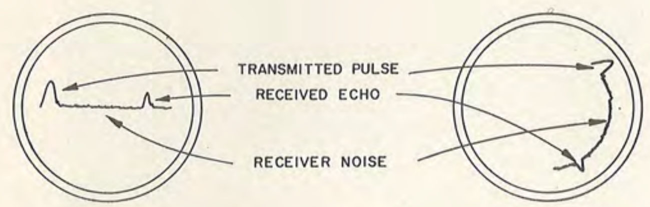

Fig. 3: An "A" scan on the left, one of the earliest types of radar presentations. On the right, a "J" scan or circular scan, a later innovation.

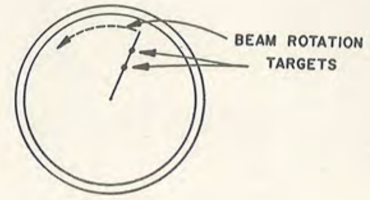

Fig. 4: The "PPI" or "Plan Position Indicator" scan.

We now have been able to measure range by the use of a time measurement. If our time generator contained a 100,000 cycle per sec. oscillator then the period for one cycle would be 10 microseconds or a radar equivalent of 1,640 yards. By causing the CRT beam to move across the face of the tube in one cycle or 10 microseconds we have been able to set up a time or range base of 1,640 yards. If we divided this sweep or base into 300 equal parts we would then be able to measure 1/300 of 1,640 yards or approximately 5 yards, which is equivalent to 1/30 of a microsecond.

Our next problem is to measure bearing or azimuth angle. The relationship of radio waves and optics have led the way toward the design of highly directional antennas similar to the beam produced by a flashlight. The use of ultra high frequencies have reduced antenna sizes to physical realities. A ten foot parabolic reflector at 3000 megacycles has a beam width of approximately 2½ degrees measured at the half power points of the antenna pattern. This means that the antenna must be pointing at a target within the 2½ degree beam width before an echo can be received. The strongest echo is received when the antenna points directly at the target and decreases in signal strength as the antenna moves off the target. Thus the bearing of the target can be determined by noting the bearing of the antenna at the time the strongest return signal is received. One of the basic methods for making this angular measurement makes use of an indicator called a Plan Position Indicator or PPI. By causing a sweep to start in synchronization with transmitted pulse at the center of the CRT and move toward the circumference radially, we can have a visible bearing indicator. The presence of a target is indicated by intensification of the beam at the range from the center equivalent to the position of the target. The radial CRT beam is caused to rotate about its center in synchronization with the antenna so it rotates in the horizontal plane in order to scan a 360° area about its center. (See Fig. 3). Intensification of the CRT beam at any point on its length while it is being rotated indicates the presence of either an airborne or ground target at that bearing depending on the type of antenna being used.

In the event that a radar set has an antenna radiating pattern which is fan type; i. e. narrow in the horizontal plane and wide in the vertical plane (typical of search sets) or let us say 2° in horizontal plane and

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hi!

Any moment, now, it will happen . . . a little hand reaching . . . a puppy-tail wagging . . . and suddenly a boy and his new dog will be tumbling together in the beginning of love.

Here, in such a moment, out of the heart's deep need for love begins the reaching for security that all of us need all our lives.

Only in the freedom of a country like ours can each one of us have the privilege of working for the security of those we love. And building that security yields a double reward: happiness in our homes and strength for America.

For the strength of our country is simply that of one secure home joined to another's.

Your security and that of your country begin in *your* home.

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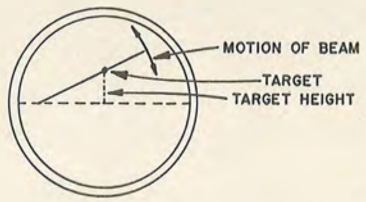


Fig. 5: The Height Finder Scan used to determine both the distance and altitude of a radar target.

30° in vertical plane it would be impossible to determine elevation angle of the target to better than 30° accuracy. If we have an auxilliary radar set with an antenna which has a vertical beam width of 2° and a horizontal beaw width of 30°, then we could scan this antenna in the vertical plane as compared to the previous antenna which scanned in the horizontal plane. By using the same technique as in the PPI, we now have a Range-Height Indicator or RHI. The starting point of the beam is shifted off center to allow more CRT beam length. (See Fig. 4). This type of radar set is known as a Height Finder.

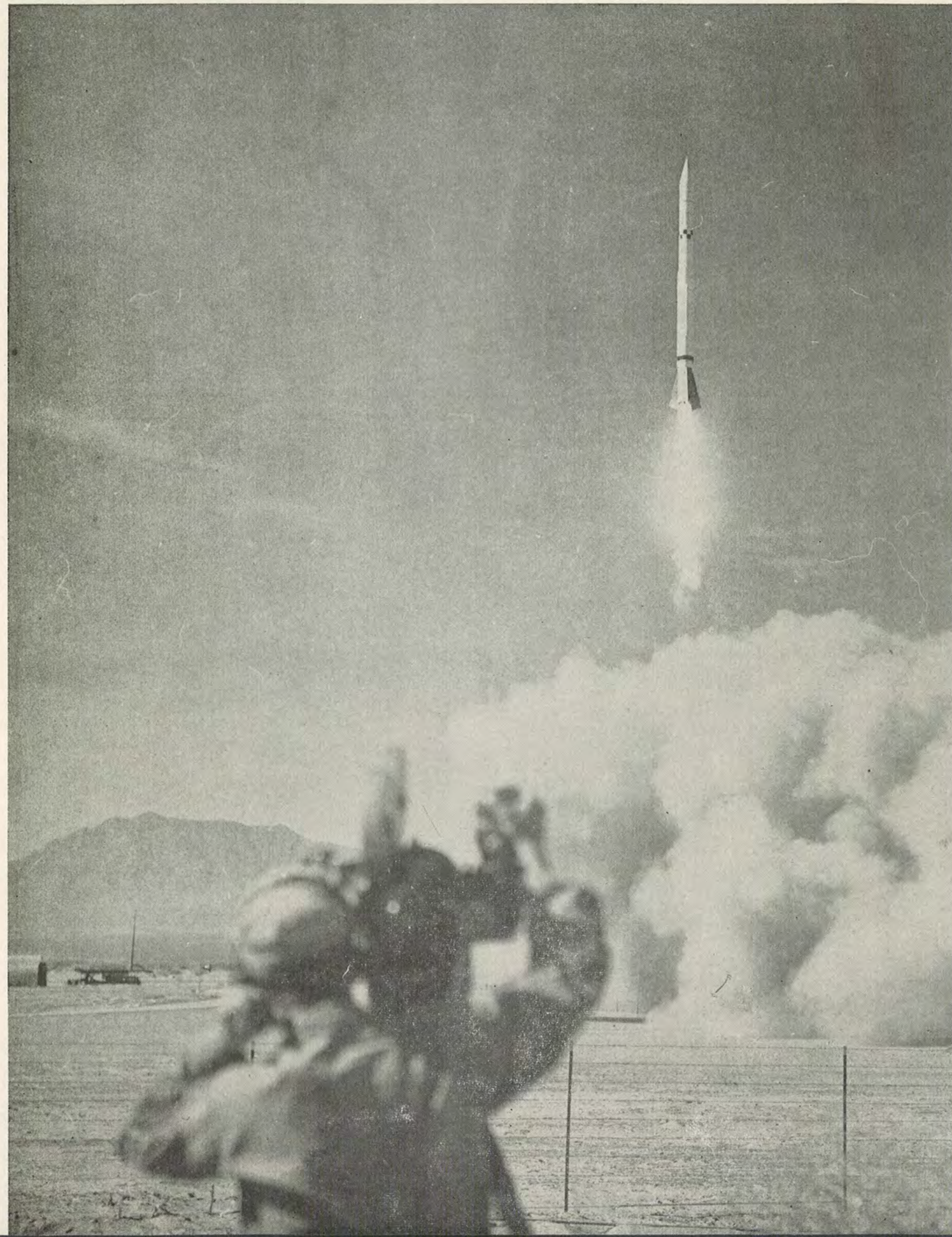
Gun laying radar sets must be capable of measuring bearing or azimuth angle and elevation angle with one antenna. This is accomplished by the flashlight type beam produced by a full parabolic antenna similar to the type described previously which has a beam width of 2½° in horizontal and vertical planes. Since the signal strength return from the target decreases if the antenna goes off target in either azimuth or elevation, we have a suitable source of information which can operate a servomechanism designed to drive the antenna in the direction of maximum received signal in both azimuth and elevation planes.

We have now discussed the basic parameters which are obtained from a radar set normally, range, azimuth and elevation. Further articles will cover applications of the radar set to electronic instrumentation in the rocket field including capabilities of radar in terms of accuracy of measurements.

"MISSILE AWAY!"

photo coverage

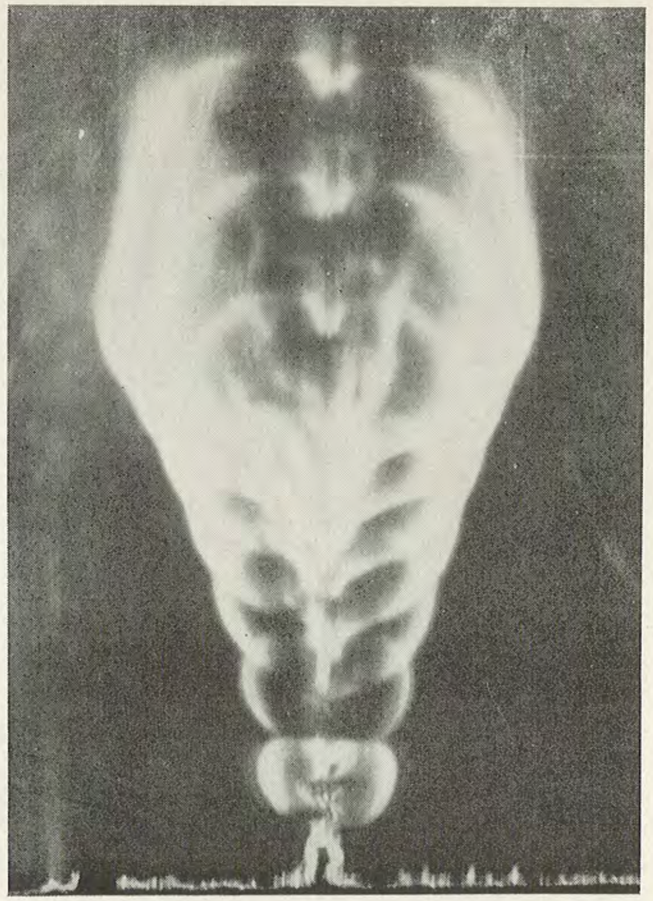
U. S. Army's **Corporal** and the unsung Photographer—(U. S. Army Photo)



BURNED UP!

by

DR. RUSSELL K. SHERBURNE



A schlieren photograph of a combustion research experiment conducted by the author. Although it looks like an X-ray photograph of a Martian, research men can determine combustion characteristics from studies such as this.

This is not an editorial! It is, instead, an article on the elements of combustion theory written by a combustion research scientist. Certainly, fire comes out of a rocket engine. But why? And what is oxidation? And why are some propellants "hypergolic"?

TWO longs and a short! That would be on the Potash Hill Road! Before the last siren blast died away, I had run across our neighbor's lawn and had opened the door to the fire house. Others poured in, and within a few minutes the Tyngsboro Volunteer Fire Department was careening along the Potash Hill Road. Soon we saw it—a grass fire out of control and moving toward the woods. Rakes, shovels, extinguishers, and backpacks quickly squelched it, however.

Events of this nature were repeated frequently during the 1930's, giving me my first direct interest in combustion. Of course I had had some earlier contact with burning processes such as shoveling coal into the two furnaces which heated our houses. This could hardly be classed as "interest in combustion" however, since my thoughts here were directed only toward completing the job. And by now my thoughts in this field have undergone a complete reversal since those days fifteen or more years ago. Then I was interested in putting fires out whereas now I like to start them and keep them going (please read the rest of the article before calling the insurance company).

During this same period, tremendous advances were made in rocket development. These improved missiles were made possible by increased knowledge in a number of fields, one of them being the study of propellant combinations. Combustion or burning is often thought of as the combination of oxygen with another material in some process which is self perpetuating once it has been started. This process may proceed quite slowly or may be very fast, behaving very nearly like an explosion, in the latter case. However it is not necessary that one of the reactants be oxygen, since in a more general sense combustion can be regarded simply as a chemical reaction in which sufficient energy is released to keep it going until the reactants are exhausted. Generally speaking more energy is released than is required for continuing the reaction and this excess energy can be put to some useful purpose. This is where the rocketeer becomes interested. He makes use of the excess energy to raise the combustion products to a high temperature and then allows these same products to expand out the rear of the missile, developing the thrust which drives it. Further, the rocket engineer usually wishes to expel the product gases at as high a speed as possible in order to obtain a large thrust with a minimum expenditure of mass. It is found that the jet speed which can be achieved depends to a large extent on the temperature of the jet gases in the combustion chamber before they are expanded and on the reciprocal of the average molecular weight of these gases. The combustion chamber temperature is determined by the amount of excess energy released in the chemical reaction of the propellants and the average molecular weight depends on the nature of the products. Hence it is desirable to use highly energetic combination which result in products of low molecular weight. A number of such combinations have been investigated and are now in common use.

Until comparatively recently all rockets used solid propellants which were closely related to gunpowder mixtures. In spite of certain limitations which make them undesirable for some applications, particularly for large missiles, the improvement of solid propellant combinations has maintained their importance in many rocket applications. However, the introduction of the liquid propellant rocket has greatly broadened the scope of rocketry.

Even though the use of liquid propellants was suggested much earlier, Dr. Goddard was the first person to experiment extensively with their use. His Roswell rockets were powered by gasoline (approximately C_8H_{18}) and liquid oxygen, O_2. The performance of this combination is comparable to that of methyl alcohol, CH_3OH, and liquid oxygen which is now more widely used. Another combination which gives very good results is nitric acid, HNO_3, and aniline, $C_6H_5NH_2$. Naturally there are others, but notice in these few examples the presence of the low atomic weight elements carbon and hydrogen with oxygen and nitrogen of fairly low values. As a result these reactions give products of low molecular weight. It also goes without saying that the combinations are also highly exothermic.

The improved methods for the production of hydrazine, N_2H_4, have recently increased its importance as a propellant. This highly reactive compound was the fuel employed in the World War II German rocket planes.

The liquid oxygen-liquid hydrogen combination often appears in articles on propellants. It has very good performance characteristics but the low density of liquid hydrogen necessitating a large rocket structure counters most of its advantages.

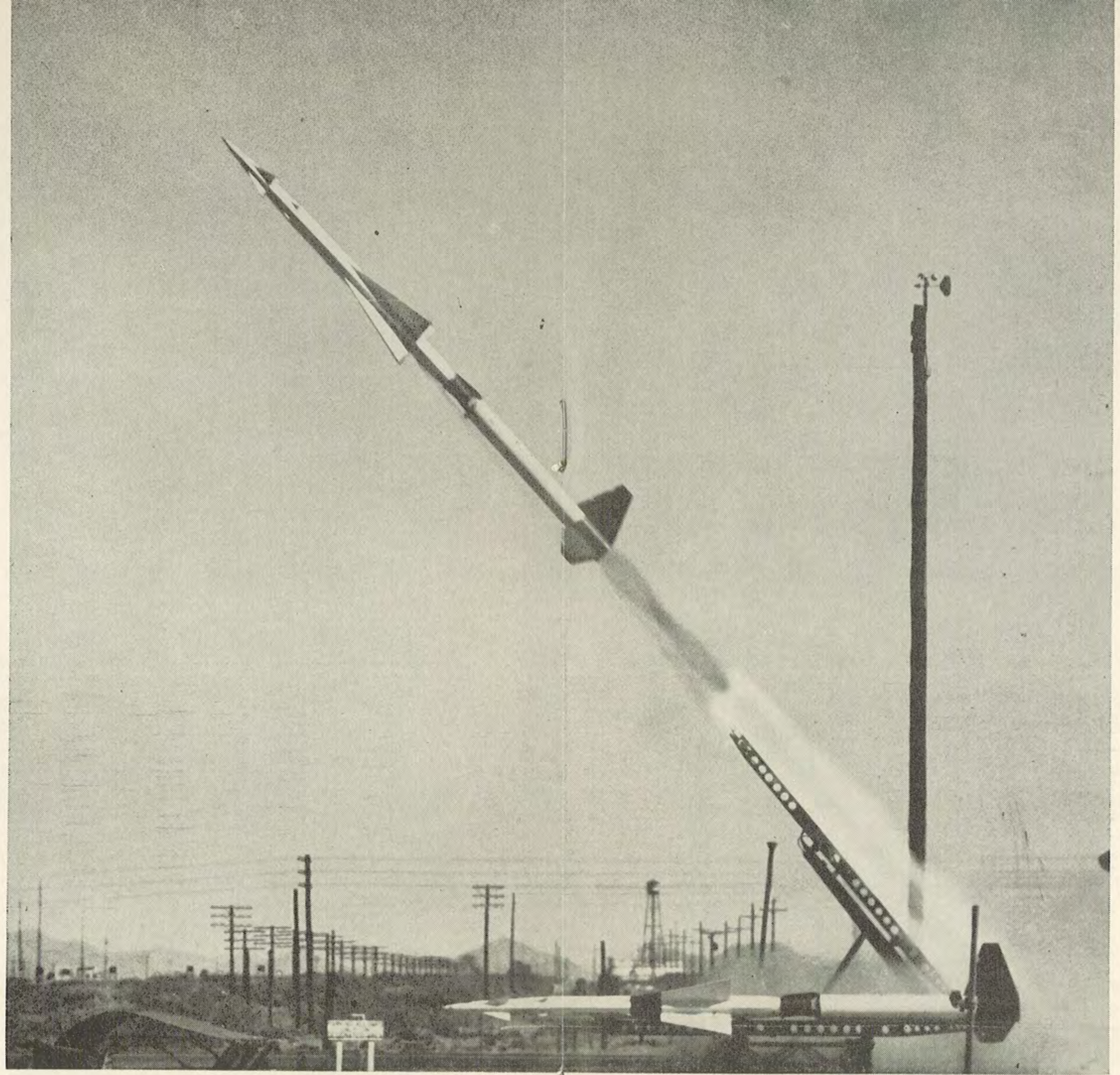
The possibilities of such materials as ozone (O_3), activated compounds, and free radicals for propellants are enticing, but these must be regarded as still in the experimental stage.

The common types of propulsion systems use two chemicals which react when brought together in the combustion chamber. A more simple scheme is to use a single compound which decomposes in its "combustion" process.

There are relatively few such mono-propellants, ethylene oxide, C_2H_4O, being one of the most promising.

The actual choice of propellants for a particular application is not quite as simple as these few comments might indicate. Here we have jotted down the qualities which would be most interesting to a propulsion man. However there are other properties which affect the selection when the entire rocket project is considered. Such things as toxicity and stability are important for safety; corrosiveness, ignition characteristics, behavior on storage, state at ambient conditions, availability as well as others must receive their share of attention. But whatever the propellants may be, the improvements which we have seen to date are probably only an indication of what we may expect in the future

"Missile Away"



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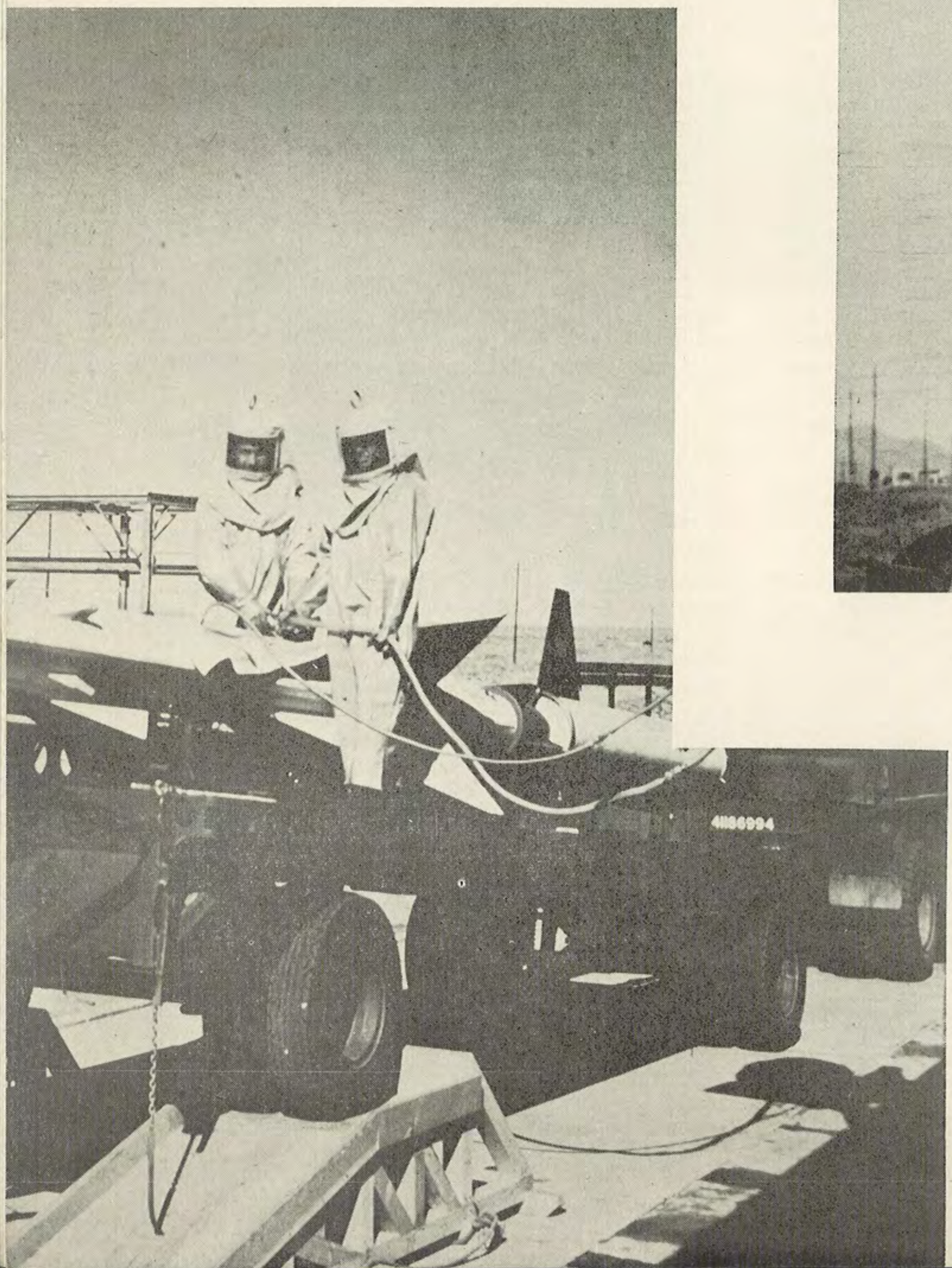

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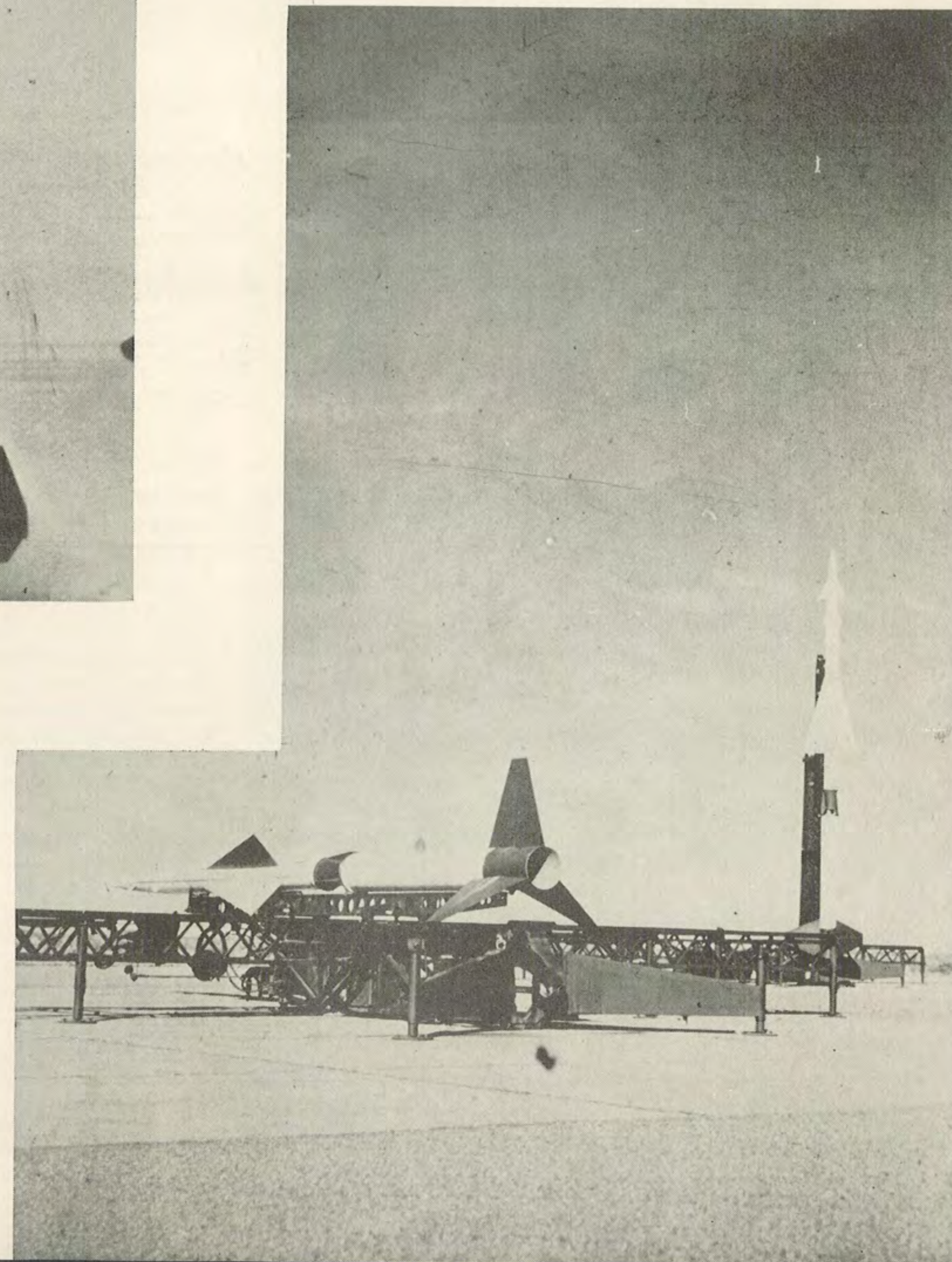

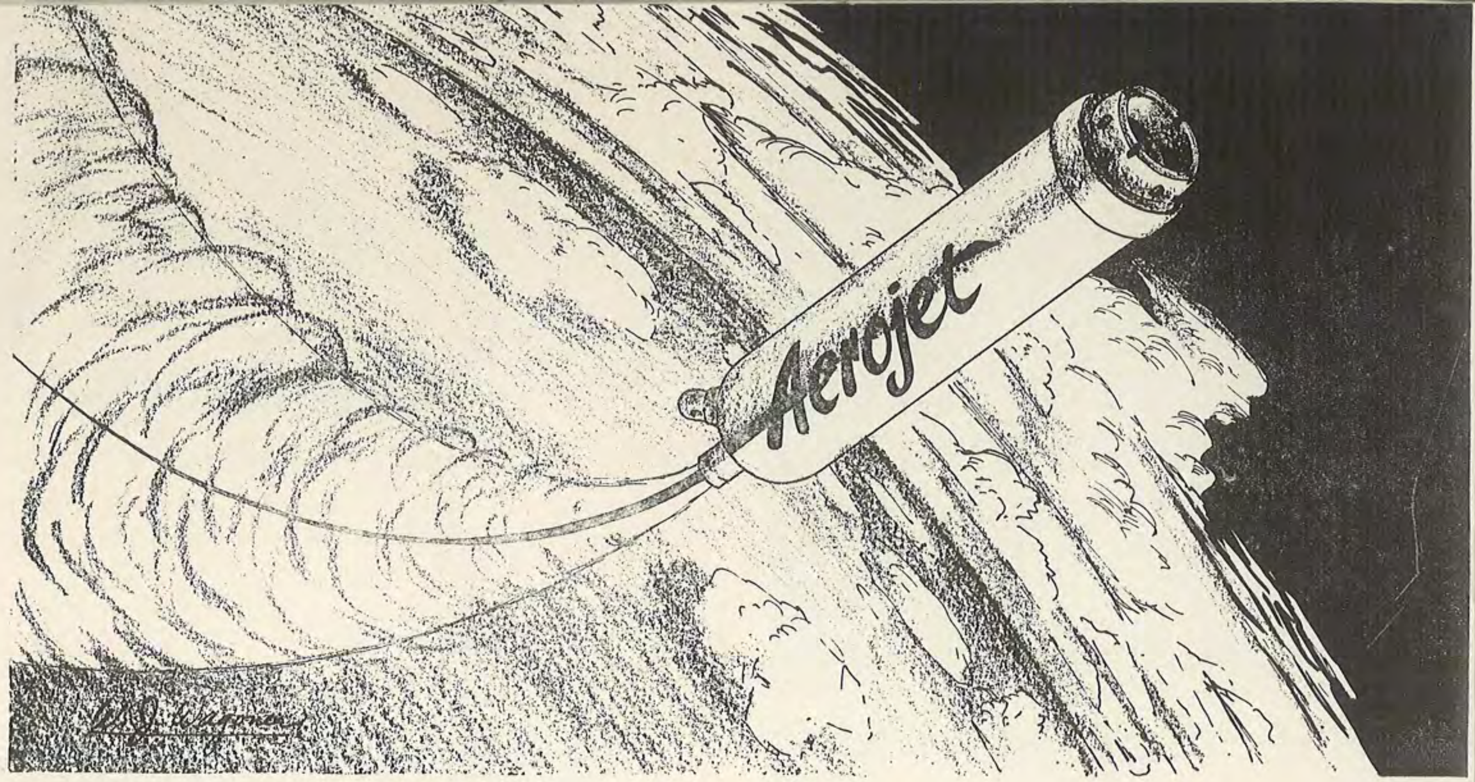

UP *in a Hurry*

The Story of Aerojet-General

by

F. L. KOEN, Jr.

Given: the problem of assisting loaded bombers and transports off short runways. Out of a war-time need to get them "up in a hurry" grew one of the world's largest rocket engine manufacturers. This is the second article in a series covering the nation's rocket and guided missile builders.

TODAY the world's largest commercial developer and manufacturer of rocket motors, components and propellants is the AEROJET-GENERAL CORPORATION, a subsidiary of the General Tire and Rubber Company. This, however, has not always been the case, for slightly over a decade ago Aerojet existed only in the minds of a very few people, and nowhere could you find a commercial developer or manufacturer of rocket motors, components and propellants.

It all started back in 1939 in a discussion between the late General H. H. "Hap" Arnold and the Director of Cal Tech's Guggenheim Aeronautical Laboratory, Dr. Theodore von Kármán. Their discussion dealt with what were then the problems the Air Force anticipated in getting their giant bombers and transports, then only on the drawing boards, off Combat Area runways and in establishing an American counterpart of the reported German jet propulsion research centers. Dr. von Kármán thought that there ought to be a way of getting aircraft "up in a hurry" and with perhaps a 20% to 50% greater pay load. An Air Corps Jet Propulsion Research Project was officially established about the latter part of 1941 under Mr. von Kármán's direction; he assembled a four-man team to assist him. This team consisted of Dr. Martin Summerfield, Dr. Frank J. Malina, Ed Forman, and Jack Parsons—the former of whom were working at the new established JPL. The Army assigned the Project the code name of ACJPRP-GALCIT.

In a little over a year, this team came up with two working models for "jet assist take-off" (Jato) motors. These prototypes, one utilizing solid propellants—the other hypergolic liquid propellants—looked so promising that the Air Corps urged the group to go into immediate commercial production. Production could not be undertaken so long as the group was directly associated with Cal Tech's Jet Propulsion Laboratory, however. So they talked to numerous manufacturers; but apparently no one wanted to get into so crazy a business as Rocket Manufacturing. These pioneers didn't give up easily, and soon a friend of Dr. von Kármán's turned up who could see the myriad potentialities of these Model T-vintage prime-movers, having previously been associated with the group as a Major in the Army. He was Andrew G. Haley, an attorney in Washington, D. C., and so Haley and this quintet decided to incorporate and form their own business. Andy put up the first two thousand dollars cash and became the first president of the AEROJET ENGINEERING CORPORATION in 1942. (The A. E. C. was incorporated under Ohio laws Aug. 6, 1945, and on March 31, 1953 they acquired the automobile and engine assets of the Crosley Corporation, and adopted the present name of Aerojet-General following the merger.) Headquarters was initially located in a building at 267 West Colorado Blvd., Pasadena, California. Business did not initially pour in as was anticipated. A few liquid propellant units were contracted for and purchased by the Navy, mainly to see just what the Air Force had up its sleeve along the Jato line. A little later the Air Force placed an order for sixty liquid propellant JATOS and advised Aerojet to prepare for a two-hundred-thousand-dollar order that would soon be forthcoming. Andy Haley roamed the country for engineers and technicians with the necessary know-how to assist in producing this big order—which incidentally hung fire for some time. In the meantime the group was held together by borrowing pay-roll money on their homes, automobiles, etc.—everything of monetary value that they owned. Then it happened, disaster—the Air Force decided they didn't need the JATOS after all. It looked like Aerojet, the little war-baby with so promising a future, was all washed up. Kismet had other plans, however.

In the spring of 1943, Navy Task Forces were ranging deeper and deeper into Japanese waters. In order to maintain their initial one-thousand-plane raids on enemy strongholds, more and more airplanes had to get into the air and with heavier and heavier pay loads. This was a tactical headache. Fate again was kind, as two of Dr. von Kármán's former students were key officers in the Navy's new Jet Propulsion Research Program which had recently been established at Annapolis, Md. They knew that if anybody could cure this tactical headache, the incomparable little scientist at Aerojet could.

The Navy was concentrating all the Rocket Technical "know how" that they could muster at the Annapolis Experimental Station. Dr. R. H. Goddard, and his staff had been brought in from New Mexico on a special contract in July 1942. Ralph Fearn, "Sampan" Bellais, "Flat top" Johnson, and "Switchie" Gilpin, were assigned with the Navy Crew while Charley Mansur, Al Campbell and "Axil" Randall, were employed with the Goddard group.

About this time VPB-16 Squadron, operating outside the breakwater off Saipan, urgently requested some sort of practical device for getting their big flying boats off choppy water. Also the DUMBO squadron operating in the Marshall and Gilbert Islands had a dire need for a similar device as their prime worry was how to get off choppy water—once down.

Most of the work at Annapolis had been conducted utilizing liquid propellants. It became more evident each day that there would be numerous logistics problems, and that the liquid Jatos would require a long personnel training period prior to combat use. These latter factors seriously threatened the continuation of the project. As soon as it was learned that Aerojet had a reliable, working solid propellant JATO motor, the Navy investigated.

The first Aerojet solid propellant Jato (12 AS-1000) purchased and used by the Navy was static tested at Annapolis on a PBM No. 48212, in July 1944, by Charles Bellais and crew. The original combat consignment ordered by Lt. J. P. Layton was 30 units of 12-AS-1000 Jatos which were shipped to Admiral Price at Cmdr. Fair Wing No. 2, VPB-19, a PMM Squadron Operating out of Kaneheoe Bay, Oahu, Hawaii Islands. Some of this original consignment was used later by VPB-19 at Iwo Jima. There VPB-19 proved the combat effectiveness of these Aerojet Jatos, and so 19

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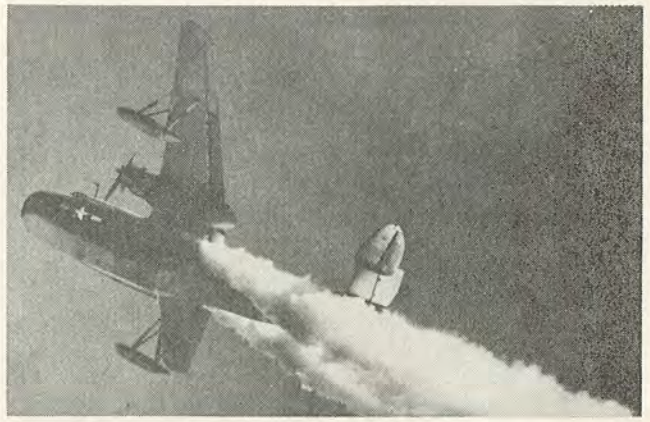

The take-off of a Martin "Mariner" with rocket-assist. The ability to get such large aircraft into the air after a short take-off run was one of the things which "sold" the armed forces on the practicality of rockets. (Aerojet-General photo.)

Aerojet-General's plant in Azusa, California. (Aerojet-General photo)

additional Squadrons were equipped immediately—4 VH Squadrons (PBM and PB 2Y **Coronados**) and 15 VPB Sqds.

The DUMBO squadrons' worry now changed from "how to get off—once down" to "how to get down, now that I know damm-well I can get back off again."

This Navy Jet Propulsion Research project was originally started by Ensign Bob Truax and later was under the direction of Lt. Fisher, and Lt. Comdr. Warfel, when Truax was at Pensecola for flight training. The "hottest" test pilot at Annapolis was Capt. William "Bill" L. Gore, US Marine Corp. Bill and his inseparable testing partner, Lt. Ray Stiff, flight-tested every type "jet assist take-off" unit available. Bill and Ray lived charmed lives; from literally thousands of take-offs conducted, some good—some close calls, utilizing every type of airplane the Navy had (and some Air Force models), they reduced the Aerodynamists' and Design Engineers' theories to practical application and jelled them into simple Standing Operating Procedures for fleet personnel training. Convinced by this careful tabulation of data, which invariably proved that take-off run distances could be cut from 30% to 60% (depending upon the type Aircraft used), the Navy went all-out for JATO motors—and Aerojet's immediate future was assured. In late 1944, the Navy placed an order for forty thousand 12-AS-1000 which amounted to an investment of approximately eight and one half megabucks. One spectacular Navy-Aerojet incident which many of you readers may recall occurred locally at El Paso, Texas.

When the General Tire and Rubber Co., bought controlling interest with the Navy's blessing back in 1944 (but did not hold voting control of the Company until April of 1953), there was much surprise as to why a rubber company would be even interested in the rocket business. However, it seems that mixing uniform lots of solid propellants for JATO'S isn't such a far cry from mixing large uniform batches of rubber for automobile tire and tube production, and furthermore rubber makes an excellent base for certain types of solid propellants. General Tire and Rubber's president, William O'Niel and their director for Government Operations, Dan Kimball, were just as "jet-minded" as any man in Aerojet's organization, and so no fear was held for the predicted post war decline. (The current director of government operations for General is John Cowen.) The 12-AS-1000 was improved and modified in 1943 and became the 14-AS-1000, Mk 2, Mod 3 Jato. As this rocket engine came into civilian hands many additional applications were soon found. South and Central American Airlines discovered that they were helpful boosting heavily laden airplanes from short airstrips hacked out of the jungles and from mountanous strips over 2 miles above sea level. Incidentally this unit is the only JATO approved by the Civil Aeronautics Authority today for use on passenger-carrying airplanes in the United States and over a quarter of a million have been produced.

Today, there is even a newer improved version, the 15-KS-1000, X107 D2, which utilizes a smokeless propellant, Aeroplex AN-583 AF, and which develops eighteen seconds higher impulse with an overall weight saving of fifty pounds. A loaded B-47 uses thirty-three of these units for take-off, an addition of thirty-three-thousand-pounds of thrust.

Aerojet has also been in the liquid propellant business since its very beginning. Its most well known product is the Aerobee Sounding Rocket.

Since 1947 the Aerobee has been the economical workhorse for the Army, Navy and Air Force where-ever upper atmosphere research was concerned. Unmodified, it can carry a maximum 150 lb. payload 430,000 feet—straight up. The missile is only fifteen inches in diameter and two hundred and forty-two inches long, with a nominal gross launching weight of 11,143 lbs. The propulsion system is helium pressurized, with red fuming nitric acid as oxidizer (497 lbs.) and aniline-furfuryl alcohol as fuel, 65/35, (181 lbs.) developing four thousand pounds sea level thrust for a nominal burning time of thirty-four seconds. A solid propellant, eighteen-thousand-lb. thrust, two and one-half second rocket (JATO 2.5KS—18 000 x 103CID) boosts the missile out of its one-hundred-forty-two-foot fixed-rail launching tower at approximately 9-11g's, (330 ft/sec). Take-off spectator acoustics are fabulous.

Numerous Aerobees have been flown over White Sands Proving Ground, Holloman Air Force Base, off the coast of Peru and over the Gulf of Alaska. Nine additional sizes and types of gas-pressurized liquid propellant rockets with a thrust range from one thousand pounds for four minutes to nearly one hundred thousand pounds for a few seconds have been designed and built by Aerojet, in addition to untold units classified for military security reasons or which have too small a thrust to mention. All liquid propellant engine development is headed by Chan Ross.

Today Aerojet owns property in Cincinnati, Ohio-Marion Ind.-Sacramento, Calif., and Azusa, Calif.

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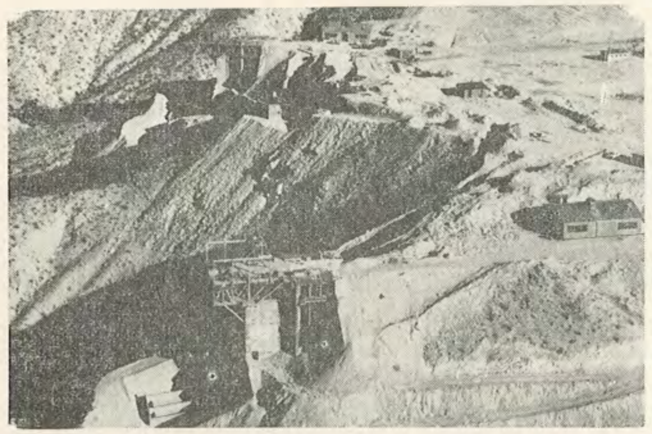

An aerial view of the Aerojet-designed rocket test stands at Edwards A.F.B. in California. — (Aerojet-General photo)

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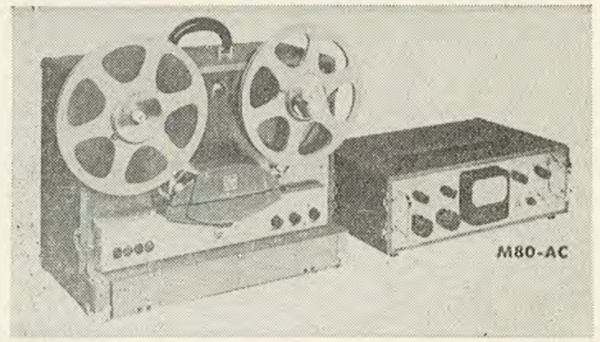

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Research, development and testing are done at the main plant in Azusa, a suburb of Los Angeles just 12 miles east of Pasadena on Highway 66. Since 1951 most solid propellant production has been done at the new 2.1-million dollar eighty-four-hundred-acre plant, sixteen miles east of Sacramento on the South side of Highway 50.

Aerojet is alert for new products on new applications for jet propulsion. Aircraft engines, tractors, miscellaneous machines, launchers, pump parts, radar mounts, catpults, bomb shackles, turbine starters, metal parts, and a host of gadgets, including the Aero-Vee drive marine engine, are fabricated at the Cincinnati or Marion plants. Recently, Aerojet began producing several models of a small recreational submarine called a MiniSub; one model has an underwater top speed of seven and a quarter miles per hour. (A man with fins has a maximum speed of approximately one and three quarter miles per hour). In twelve years the staff has grown from the original team of von Kármán, Summerfield, Malina, Forman, Parsons and Haley to more than 4,000 employees, many of whom are world-famous such as Fritz Zwicky. Its original life's-blood backlog of two-hundred-thousand-dollars in 1942 had grown to well over $159,822,738.00 as of Nov. 30, 1952.

Aerojet leads in the production and engineering of both solid- and liquid propellant rockets. New processes and industrial techniques have been developed concurrently with new rocket design. Aerojet solid-propellant rockets are reported to be economical, rugged, thoroughly reliable, light-weight and operative throughout very wide environmental ranges. Numerous rocket propellants are Aerojet-patented inventions based upon research work performed for the Armed Services under the direction of Dr. A. L. Antonio. Aerojet produces solid propellant rockets for almost any application, and in practically all sizes, from short duration, low thrust midgets such as the 12KS-250 T43 rocket engine which develops 250 lbs. of thrust for 12.5 seconds at 60°F to the large, economical, giant sizes of long durations and extremely high thrust such as the2.2KS—33,000 X105 H1 rocket engine which develops 33,110 lbs. thrust for 2.2 seconds at 60°F. This latter unit is unique in that its nozzle is of ball joint type construction allowing the nozzle to be canted from one degree above the chamber center line to twenty-two degrees below and to four degrees either side of the principle plane of adjustment as desired.

Yes, but how accurate is your test facility instrumentation? This question is constantly asked in rocketry, and Aerojet is no exception. The need for more accurate and definite test data has resulted in the development of a number of special measuring devices

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and accessories by Aerojet. Many items of instrumentation, such as their versatile one-hundred-thousand psi condenser pressure pick up, can and are being adapted to a variety of uses in other industries in addition to their basic test stand data-gathering use. A special Aerojet Study Section is staffed to investigate a wide variety of engineering problems. Fundamental experimentation and theoretical investigations have been conducted on boundary-layer control and circulation control with respect to airfoils. This staff includes experienced personnel specializing in fluid mechanics and servomechanisms as well as thermodynamics, stress analysis, optics and what-have-you.

Aerojet has had extensive experience in the design, development, and testing of underwater propulsion devices under the able direction of Calvin Gongwer. Plant facilities include two ring channels for underwater testing. (Note Azusa Plant Photograph). The work performed in the Aerojet Chemical Laboratories includes the determination of chemical and physical properties of propellant ingredients, the development of analytical procedures, and the maintenance of accurate quality control methods. The principle function of this work is to support Aerojet's chemical and propellant manufacturing in order to insure reliable products tailored to each customer's particular desires or needs. Quality control is eagle-eyed by Director Richard D. Geckler.

Pilot-plant production of organic and inorganic chemicals is carried out at Aerojet not only for solid propellant ingredients but also for new types of high energy liquid propellants (See ARS **Journal**, Vol 22, No. 6, Nov-Dec 1952, Pg 309, "Large Scale Production and Handling of Liquid Hydrogen"). Aerojet designed, constructed and operates America's largest hydrogen-liquification plant. This continuously-operating plant utilizes liquid nitrogen pre-cooling of the gas at high pressures. A design study has recently been completed for a much larger unit capable of producing approximately one and one-half tons of liquid hydrogen per day.

Incidentally, Aerojet-General was one of the earliest firms to take out a Corporate membership in the ARS.

In the few short years since von Kármán's and Arnold's "idea", Aerojet and rocket power have become vital factors in American defense. Aircraft, guided missiles, and other defense vehicles are built around rocket propulsion systems or devices. Aerojet must assuredly be very proud of the part that they have played in rocket development and production, yesterday, today and tomorrow.

[Author's Note: My sincerest thanks go to Bill Gore for providing me with much of the data and all the photographs used . . . . . .]

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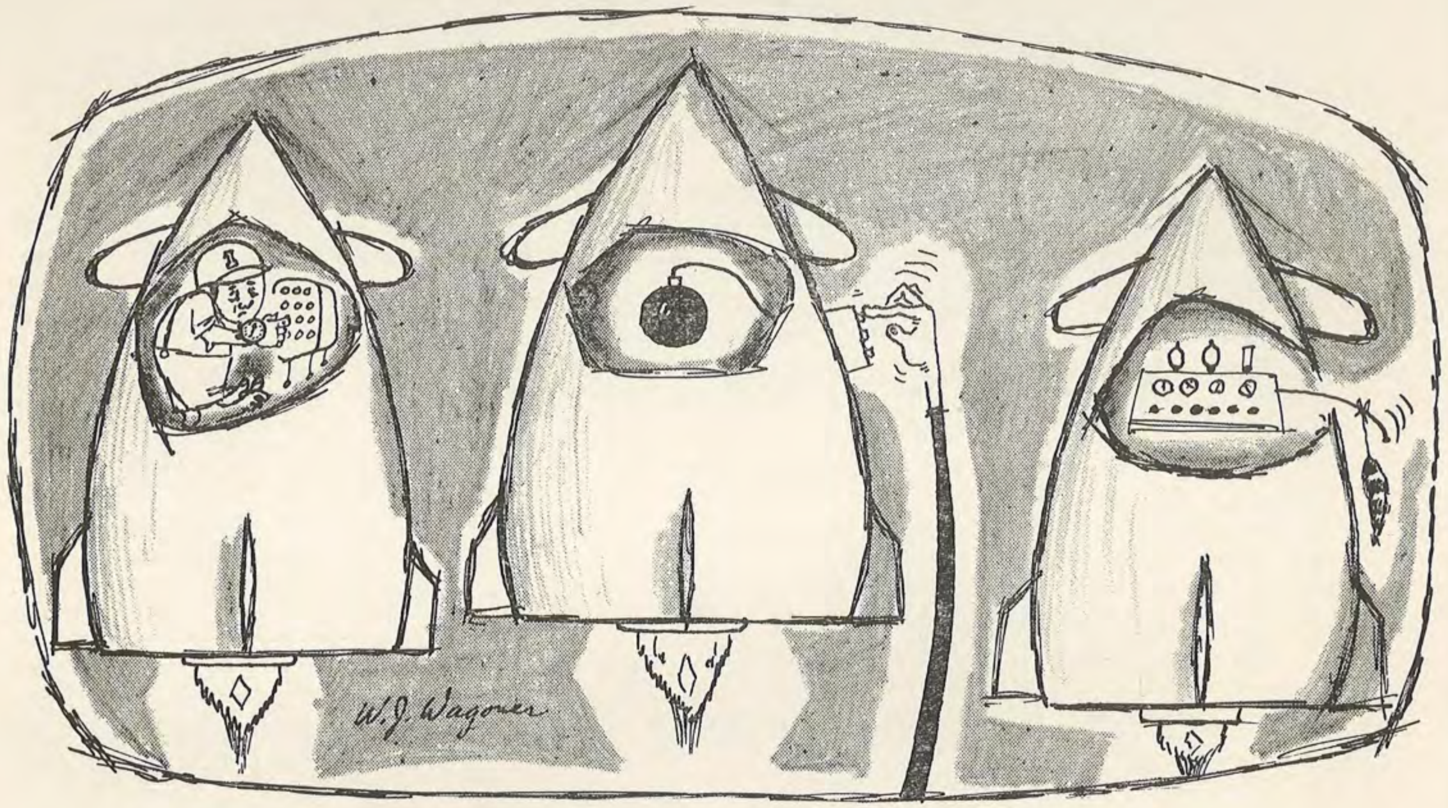

by GEORGE MEREDITH

Presenting herein both humor and fact, the story of the long arm of radio links which reach out toward a missile flying in space to perform operations essential to the flight. The little men in the little black boxes may be replaced with real men in cabins . . . someday.

SEVERAL years ago at White Sands Proving Ground, when the V-2, Aerobee, and Deacon were the principal rockets fired and the majority of the work was in high-altitude research, all of the instrumentation going into these missiles was referred to as "black boxes". Now, as you all know, a black box can be almost anything. There were big ones and little ones, round ones and square ones, long ones and short ones—in fact you could find almost any size and shape that you wanted. But what was inside these mysterious boxes? That was a good question. If you happened to feel brave and a bit foolhardy, you might even have asked one of the characters lounging around the instrumentation racks in the blockhouse. Said character would open his eyes, perk up a bit, and probably answer as follows:

"Well, neighbor, I'm glad that you asked me that question. We are doing a very important job in research here, and nobody seems to give a d--n. It really takes the heart right out of a man to think that his hard work is not appreciated. But just because you have been so nice, neighbor, to ask about it, I'm going to let you in on a secret."

By this time he is on his feet; he looks around warily, then grabs your lapels in his sweat-stained hands and pulls you up close.

"Neighbor," he blasts into your ear in a loud whisper, "We got little men in them black boxes. Yesser, little men. You see, we gotta throw some switches after this thing gets up, so we give this little guy a stop watch and pack him inside the box. The watch has a luminous dial so he can read it in the dark. At the right times he throws the switches. He also has a little radio in there tuned to XELO. If we want anything done we send it through Clint. You can do everything else that way."

Somewhat shaken, you stagger out into the fresh air, cursing the Fates and the City Editor who gave you such an assignment. Here you have a story, a great story, and you can't print it. If you even sent it in, you would be fired before the editor finished reading the first page. So you decide to keep it and do a follow-up later. The story you send in is the usual "Today I Saw A V-2 Climb Into The Skies From WSPG."

The types and applications of radio links are many and varied, yet they fall into two main classes, with some applications covering both classes. The most common class is radio command. You have all seen the radio-controlled plane which can be flown in any pattern by pushing a button or turning a control on the ground. The second classification is the information-gathering and transmitting type. This is in widespread use and is known to the trade as telemetering. The third group mentioned which combines the two previous classes covers such instrumentation as doppler and radar beacon.

It is not the intent of this article to even attempt to cover such a broad field, even if the author's knowledge of radio links was sufficient. The purpose of this article is to describe the peculiar use of a highly specialized radio command system now operating at White Sands Proving Ground. This system operates under the auspices of the Flight Termination Section, Missile Flight Safety Office. Its mission is to provide a reliable method of shutting off or destroying in flight any missile which violates the safety criteria as set up for that mission. The Section had its beginning in 1947, shortly after the mis-guided V-2 raised the dead in Juarez. (It landed in a cemetery.) The first equipment was rather crude and often not too reliable. The transmitting equipment was surplus army equipment (AN/ARW-34 with AM-10 Booster). Later a contract was let to build a 500-watt FM transmitter. This piece of equipment, with numerous modifications, is still in use.

At the present time, the Section uses only two types of receivers. The five-channel AN/DRW-4 is the old reliable work horse of the organization. It has (except in isolated cases) passed every test that could be given. It has very few faults and these are mostly a matter of opinion. It is an eleven-tube, narrow band, crystal - controlled - local - oscillator, single - conversion type receiver. The discriminator is the Foster-Seely type. An L, R, C type tone filter is used to separate commands. The principal objections are:

(1) It is heavy. In rocketry, each pound of dead weight means decreased altitude or range. The receiver weighs fourteen pounds.

(2) It requires a fairly heavy battery pack. The regular battery weighs almost as much as the receiver—thirteen pounds, nine ounces. A smaller pack available for short runs weighs much less.

The AN/DRW-3 (XE-2) is the latest addition to the list of acceptable receivers. It is a development of Evans Laboratories and built by Link Radio Company. The RF and IF sections follow the same general design as the DRW-4. However, the packaging job is much neater and actually more sturdy. The receiver is the single channel type, using audio control. The control circuit is based on the oscillating thyratron principle. It is seldom that a user will become enthusiastic about the performance of a new piece of equipment, but this little receiver is good. Fifteen different tests were devised to prove or disprove the claims of the designers. The receiver passed all tests, including the centrifuge at 80 G's and the shake-table at 18.5 G's. There was no evidence of failure.

At present, the F.T.S. has two transmitting stations —one fixed and one mobile, with plans for a third mobile station. The fixed station is located at "C" station and consists of two transmitters, one a Collins 732-A (modified), the other the modified version of the first 500 watt transmitter mentioned earlier; a control console where one operator has complete control of both transmitters; and a test and monitoring rack which enables the operator to check his equipment quickly and accurately. Every effort is made to insure peak operating conditions from all equipment.

Now that equipment, both airborne and ground, has been discussed, suppose we observe a missile operation to see how it works. To choose a simplified operation, suppose we look in on an N.R.I. Aerobee firing and the preparations preceding it.

At approximately X-2 weeks, the project officer calls and reports that the tail section of the missile is ready for an antenna check. One peculiarity of the Aerobee is the use of notch antennae on the tail fins for both safety and telemetering. These antennae must be tuned to the frequency at which they will be used.

(Next page please)

LOCKHEED MISSILE SYSTEMS DIVISION

Lockheed Aircraft Corporation : Van Nuys, California

An Invitation to
Physicists and Engineers:

Missile systems research and development is not confined to any one field of science or engineering. Broad interests and exceptional abilities are required by the participants. Typical areas include systems analysis, electronics, aerodynamics, thermodynamics, computers, servomechanisms, propulsion, materials research, design and fabrication.

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OF THE
AMERICAN ROCKET
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El Paso
Sept. 22-24

For the convenience of those attending the Conference, Karl E. Zint and C.T. Petrie of our Technical Staff will be at the convention hotel. For interview, phone 3-3491.

Lockheed
MISSILE SYSTEMS DIVISION

research and engineering staff

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The tuning of the safety antenna is quite critical since it is being used at a frequency other than that for which it was designed. The tuning is done using an impedance bridge and tuning for no reactance at the operating frequency. This method has been proven in the last few years, and though it is time consuming, it is still used because of the high degree of accuracy possible. Anyone interested in this method of antenna tuning may contact the author.

With the antenna tuned, the receiver modified and installed, and the missile wiring checked out, the next step is a hanger check. This test is performed in the assembly shop, with the missile in a horizontal position. For this test, F.T.S. uses a small local transmitter.

The missile is then transported to the launching area where at X-1 day, a vertical interference test is performed. All equipment and instrumentation in the missile must be in operation during this test. The flight termination tests at this time are run using the main transmitting station at "C" station. If no trouble is encountered, the missile is "buttoned-up" until firing day.

At X-6 hours on firing day, the activities begin again. Batteries must be installed and final checks run. With fueling completed, the missile is released for the final preparations. The Flight Termination representatives must perform a local test before installing the explosive devices used to terminate the flight of an Aerobee. When the installation is complete and the missile area is clear, the missile receiver is turned on and a final check with "C" station is run. If it is successful, word is passed to the project, "Safety OK".

Missile preparations continue, X-20 minutes, X-10 minutes, X-5 minutes—Instrumentation on. The blockhouse rep picks up his private phone.

"Hello, transmitter, ready for test. Give me a tone 7. Normal operating power."

("Roger, blockhouse, tone 7 on."

"Tone 7 received, reduce power."

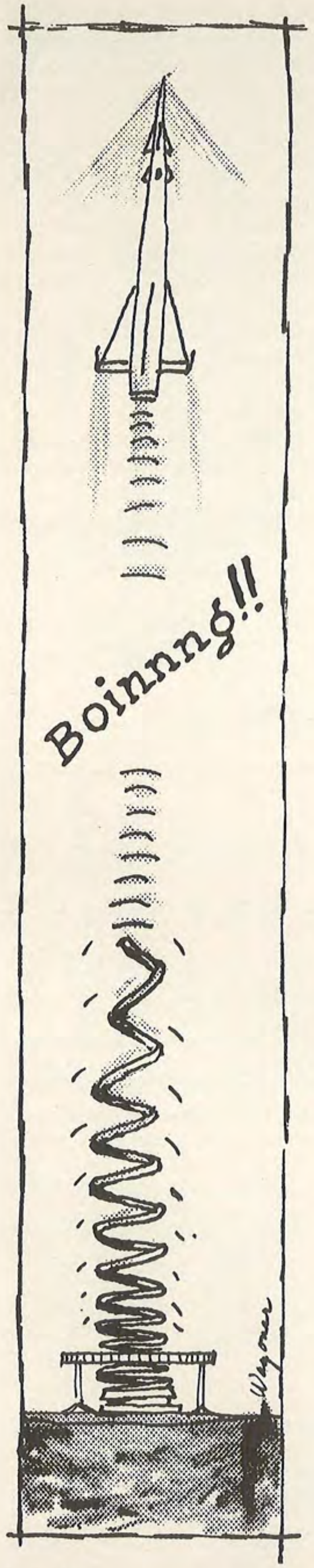
"Power coming down; say when."

"Out-intermittent. In solid. Hold that level! What's your power?"

"Power output 10 watts. We are ready to go."

"Roger, blockhouse, Hello, Range Control, Safety is in the green."

X-10 seconds—zero—Missile Away! As the safety people watch the missile visually or on a plotting board, there is a feeling of confidence that should this missile go wrong, they have the means of stopping it before it becomes dangerous. These people have a long arm—long enough to reach the missile and shut it off. They call it a radio link.



MISFIRES

THE TESTING MAN

by

M. M. NYBORG

"Oh, Testing Man, oh Testing Man!
  How did the last run go?"
Thus queried the harried Engineer.
  "Speak, man, for I must know!"

The Testing Man he scratched his neck
  And settled in a chair.
"I'm not too sure, oh Engineer,
  But I think 'twas pretty fair."

"That's fine! That's fine, oh Testing Man!
  But how did the motor start?"
"Well, maybe a little rough, you know
  For it upset a barrel cart."

"To me it didn't sound too bad;
  Seemed to start pretty well.
But one of my boys he swears to God
  It sounded hard as hell!"

"I think I saw some greenish fumes
  Before she started to run.
Probably acid, or maybe fuel,
  Or both, or neither one."

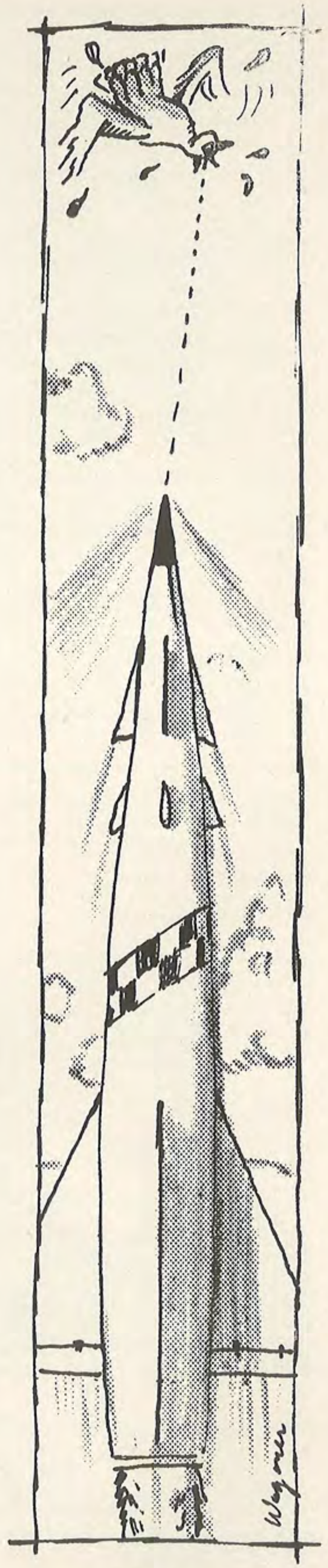
"It might have chugged a little bit
  Before it got good and hot.
But it's hard to tell with your ears plugged up
  Just whether it did or not'.'

"Oh, Testing Man! Oh, Testing Man!
  How did the thrust gauge go?"
"Well, she might have been a little high,
  Or maybe a little low."

"Some jackass forgot, before the start,
  To turn the recorder on.
I got a glimpse of a pressure gauge,
  But I'm not just sure which one."

"But I'll bet we got a right smart thrust
  "Cause it bent the frame, by God!
And it must take a right smart force
  To bend a half-inch rod."

"And just to be absolutely sure,
  We decided to calibrate.
But after we got the cable spliced,
  We couldn't find the weight."



"MISSILE AWAY!"

"Oh, Testing Man! Oh, Testing Man!
  What ratio were you using?"
"Well, that's curious thing, you know.
  Confusing and amusing."

"For we stuck the tanks with a rusty rod
  To get the final level,
And though we had a foot in one
  The other was dry as the devil!"

"So I figure the ratio was pretty high.
  Maybe four or five to one!
Or else we forgot to fill one tank
  Clear full before the run."

"Were there any leaks in the lines or valves?"
  "Well, a few, just here and there.
It looked like maybe the shutoff valves
  Were oozing just a hair."

"Yes, all in all, the unit's good
  As all our records show!
But you might just add some extra valves
  In case of a serious blow."

Thus spake the stalwart Testing Man,
  And after he had done,
He strode off to his fiery pit
  To make another run.

(Reprinted by request)

RARE BIRDS OF THE AMERICAN SOUTHWEST
Compiled by R. K. AUDOBURNE

LESSER MAN-O-WAR BIRD (Western): Corporala Feminea

Field Marks: 15-17 feet long and 16 inches in diameter. Black nose and tail with white midsection. Two black rings are discernable, one just behind the nose and the other just forward of the tail. Tail surfaces exhibit white markings.

Similar Species: The Lesser Man-O-War Bird (Eastern) is slightly longer but nearly the same diameter. Careful attention to detail is necessary to distinguish between the two species.

Range: Restricted to the region of New Mexico between Las Cruces and Alamogordo, and to southern Florida.

Comments: Although generally restricted to the New Mexico region reproduction ordinarily occurs on the Pacific Coast. In 1949 (Feb.) mating with a Veetoo in New Mexico was attempted, which left the smaller bird very much up in the air. These experiments have been continued in Southern Florida. The bird has difficulty getting off the ground for a successful flight and has the assistance of a "Tiny Tim" (a parasitic bird in this case) during its takeoff. In general a moderately high-flying bird.

Other Names: Wac Corporal.

BULLETIN!

The following is a transcription of a lecture by Dr. Raus von Haus delivered at the last monthly meeting of the Society for the Propagation of Electronic Engineers .Dr. Raus von Haus is in the United States to conduct a three-week seminar on "Ectoplasm and Its Efficacy in Interplanetary Travel." The S.P.E.E. was very fortunate in securing this famed scientist as guest speaker. His deft handling of his subject and his careful avoidance of confusing terminology mark him as a lecturer of no mean ability.

DER E-16 FIRE CONTROLLEN SYSTEMER

Vas ist der E-6 Fire Controllen Systemer.

Der E-6 Fire Controllen Systemer ist ein schemen vas ist controllen mit signallers ein airplaner. Ein kleine machinen ist gesteeren der airplaner. Ein computeren ist gecontrollen der machinen. Der impulsers mit das radar ist directen der computeren. Ist ein ingeniousen littler waven vas ist gemaken das grosser airplaner outgaben mit donner und blitzen. Der piloten ist gesitten mit dar handsers gefolden.

Ist der airplaner kaput? Nein, das ist der E-6 Fire Controllen Systemer.

Vor examplen: ein bomberen ist gekommen. E-6 Fire Controllen Systemer is outgaben mit "ACHTUNG!!"

Der piloten ist getooken ein looker mit der scopen. Das littler pipsen is gejumpen ober der screener. "Vas ist das?" der piloten ist remarken.

"DUMBKOFF!! IST EIN BOMBER!!" der E-6 Fire Controllen Systemer ist geroaren. "PROCEEDEN MIT DER BREAKNECKIN SPEEDEN!!!"

Das piloten ist gepushen ein switchen. Ein red bulben ist geblinken. Der airplaner ist gespeeden mit ein "Zoom!" Und der littlen pipsen vas gejumpen mit der radar ist gechangen. Der E-6 Fire Controllen Systemer ist geroaren mit, "SCHWEIN, RELEASEN DER ROCKETEN!!!"

Der piloten ist gepullen ein leveren. Das rocketen ist gemaken mit ein schwoosh. Und der bomberen? Ach, der bomberen ist kaput!

Und so, mit ein smiler on der face of der piloten, he ist gepressen ein buttonen und ist gesitten mit der handsers gefolden. Der E-6 Fire Controllen Systemer ist gemaken der bomberen kaput. Der E-6 Fire Controllen Systemer ist ein devicen vat ist nicht ein nincompooper, yah?

POST-SHOOT CONFERENCE

THE National Headquarters of the ARS recently moved to newer and larger offices at 500 Fifth Avenue, New York City. We are certainly glad to see progress of this type, which will in its turn bring better support from an overworked and understaffed office.

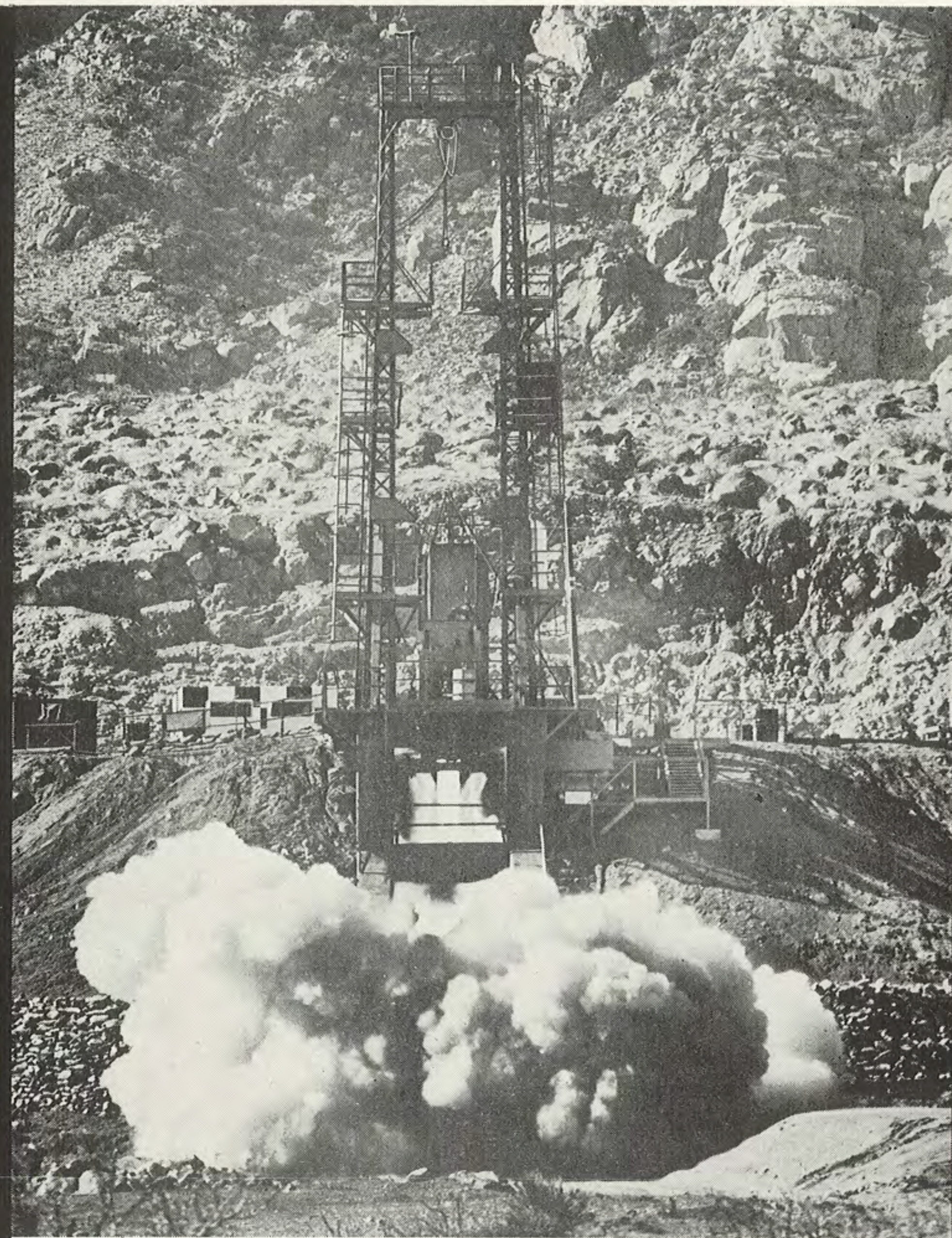
A helpful innovation in the manner of keeping NM-WT Section membership rosters up to date has been instituted by the New York office. A complete roster of the Section, printed on handy 3″ x 5″ file cards was received recently, to be followed several weeks later by more cards indicating new members. It is hoped that this new system will help us keep better track of our wide-spread membership!

We highly recommend to our readers the recent book by Dr. Walter Dornberger, "V-2", published by Viking Press. Until the publications of this book, a great gap existed in the history of rocketry in Germany between 1933 and 1945. In as fine a stick of writing as we have read in many a long moon, Dr. Dornberger tells the exciting story of the development of the V-2 and other weapons at Peenemünde. It would be well for us all to be familiar with the problems, technical, administrative, and production, that were encountered in producing the first of the "big ones."

The NM-WT Section membership has unofficially passed the 200 mark. Although members who recently sent in their applications have not been officially accepted yet, we have put them tentatively on our list. This milestone is a heartwarming point to pass. If the present rate of applications sent to New York continues, we can look forward to having 250 members by the end of the year; but this will require the continued work of all of us. The end is not yet!

The Program Committee is presently hard at work setting up a series of Space Flight Symposiums which will run for the next two years and cover as many aspects of astronautics as possible. Tentative plans call for a number of groups composed of informed people from various fields such as space medicine, structures, propellants, radar, navigation, ballistics, landing of space craft, servicing of space ships, communications, environment control, ship-handling techniques, and others. Many of the problems have not been touched upon before. It is not the purpose of these symposia to provide publicity for space flight, but to explore the problems which are now facing us and which may face us in the future. Not only will the various methods of approach to the problem of space flight be considered, but also the usefulness of space flight once accomplished and the foreseeable goals of mankind's journey into space.

The science world of Hollywood must indeed be a Utopia. It is evident that it is populated by scientists who tackle the most formidable problems and come up with the most unforeseen and unprecedented solutions we have ever seen. It is populated with three kinds of scientists: (a) the famous scientist (sometimes mad) who inevitably wears a beard and monocle, speaks with a foreign accent, and is intimately familiar with all fields of science; (b) the young, eager scientist who smokes a pipe, wears horn-rimmed glasses, and delves into the unknown with such advanced equipment as high-voltage arcs and piles of beautiful glassware filled with bubbling red wine; and (c) the georgeous, sensationally beautiful young female scientist who has her Ph. D. and is death on men. Experiments are always successful. Space ships make 180° turns. Mars and Venus are always in the proper positions so that an erratic flight to the Moon fetches the ship up on one of those planets. Invasions from outer space are always made by monsters who are out to wrench this fair planet from us. Atom bombs are nice, low-order detonations of piles of black powder. And the Earth is always saved. Oh, for the life of a technical advisor!



U. S. Army photo

This U. S. ARMY ORDNANCE facility, engaged in research and development of rocket engines and propulsion systems, is equipped with Potter Flow Meters to measure propellent flow rates.

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