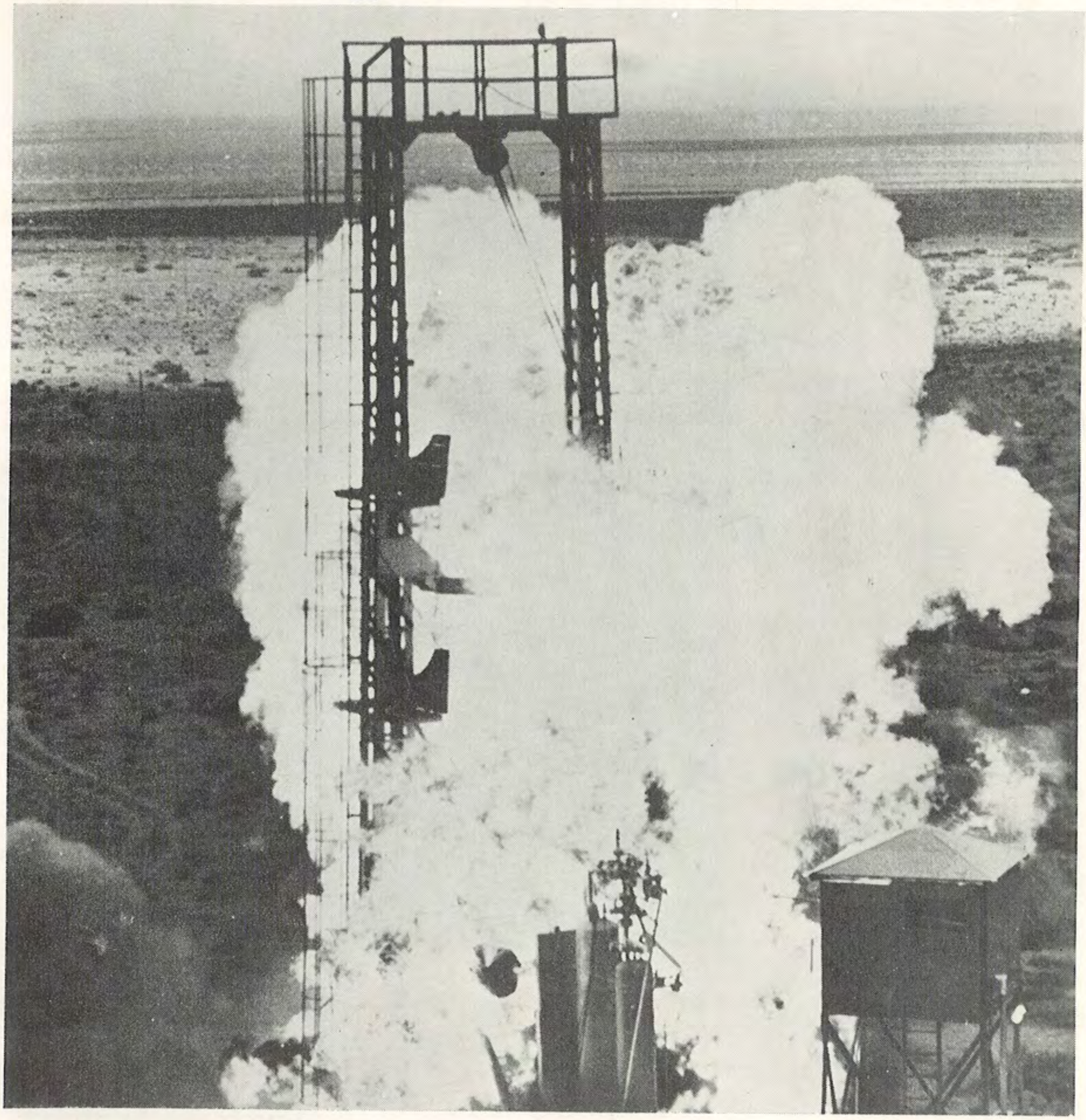
Vol. III, No. 1
SPRING
1955
35c

"Missile Away!"

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



TEST STAND
EXPLOSION
(U. S. Army photo)

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"MISSILE AWAY!"

Vol. III, No. 1
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Editorial: "rocketry and the news"

Not long ago a widely-circulated newspaper carried a Viking photograph with the identifying caption ". . . . the 72½ ton Viking . . ."

Amusing? Perhaps. Those of us who know the missile recognize a typographical error. A lot of readers, though, were badly misled.

Did you hear of "Los Alamos Rocket Proving Ground?"

I have. In fact, I once read a newspaper story which identified me as ". . . physicist from . . . the Los Alamos Rocket Proving Ground . . ." as well as from the "University of New Mexico." And this happened after I had **written down,** quite carefully, a statement that said my work was at the New Mexico **A. & M.A. College** and at **White Sands** Proving Ground!

This sort of thing goes on all the time: garbling of facts; half-reported developments; misleading statements; sensational claims—distortion of one sort or another.

And it is not doing those of us in rocket development any good.

Here is an example from the Science section of one of the biggest weekly news magazines in the country:

"Herman J. Schaefer of the Navy's School of Aviation Medicine wants to use the (unmanned temporary) satellite to find out how animal tissue is effected by cosmic rays".

And so Dr. Schaefer would. But what the reviewer for the weekly magazine did not bother to say was that Schaefer isn't sure it can be done. Here is Schaefer in the article "Biological Experimentation with an Unmanned Temporary Satellite," **Jet Propulsion, February, 1955:**

"It should be pointed out from the very beginning that the last-mentioned condition (recovery of the satellite) imposes serious restrictions on any biological cosmic-ray experimentation to the degree whether useful experiments can be designed at all."

And this gets even better (or worse) as you go along. In the same article, Schaefer had said this about weightlessness:

"Animal experimentation (on the effects of weightlessness), therefore, can be of limited value only, though some disorientation studies have been successfully performed with mice in a rocket flight." But so far as the reviewer was concerned, he had said this:

". . . he (Schaefer) hopes that even space-born mice will develop a few space neuroses."

The dissemination of false information — whether through intent or ignorance — is bad for us in rocketry. When a person sees frequent errors occurring in news, and when he has first-hand knowledge and can judge its accuracy, he soon becomes skeptical of the validity of the other reports — the news that he has no way of judging. A certain amount of discrimination and cross-checking with other sources is usually possible; but it would be much better if a higher degree of reliability could be maintained.

Perhaps the average number of errors in any particular magazine or newspaper could be compared to the number of correct statements, and thus we could arrive at a probability factor for each newspaper. The reader (or listener, in the case of radio) would then be able to keep this factor in mind and so take each article along with the appropriate dosage of salt.

In fact, he is continually doing this subconsciously by his opinions of various publications—opinions based on his personal experiences and on the reputation of the periodical. But because of the ways he forms these opinions, (his parents read the magazine; Joe Smith told him that that columnist or commentator really had the dope; he is simply predisposed to believe a particular story) his conclusions can be far from correct.

How much better it would be if he did not have to apply his probability factor at all. Or, at least, if that factor could become a reliability factor of a very high order.

I think it can. And I think we can do something to help it, so far as the reporting of missile developments is concerned.

Everybody concerned with public misinformation is guilty to a certain extent by tolerating sloppy activities, such as the ones I've quoted.

As long as the customer is willing to accept a mediocre product, that is very likely what he will get.

The publishers and broadcasters are probably as much to blame as anyone else for not striving for higher standards.

Reporters are to blame, too, perhaps more than others. Their lot is not an easy one. They have deadlines to meet. The editor cuts, slashes, and sometimes alters their material. Then the linotype operator puts more scars on it. But beyond that, some reporters do not take the time to understand their stories before they write them. Some are merely interested in getting something down, regardless of the accuracy of the message. Others may pay more attention to their writing style than to the facts that they are dealing with.

And we in missile development are guilty, too. As sources of the news itself, we sometimes feel that we do not have time for reporting and, as a result, do not make sure that our points are properly understood.

Sometimes we explain only in the language of our field, and the reporter is left to his own devices to find out exactly what we meant. In the rocket business we have to be especially careful in this respect.

Rocketry is growing rapidly in the public eye, and the glamorous nature of the business with its attendant possibilities lends itself readily to dramatization. This fact can easily lead unscrupulous or unthinking reporters to over-emphasize the dramatic in order to obtain a market for their material, and in so doing, to create an almost completely false picture.

It is up to those of us in rocketry to continually strive for greater achievements and to look forward to future goals. But simultaneously we must be extremely careful to see that a realistic viewpoint is maintained lest we run the risk of seeing a disillusioned public eventually condemn rocketeers as a group of irresponsible dreamers.—R. K. S.

Editorial:

"this is yours"

In October 1953, three men who happened to lunch together at White Sands came to the conclusion that a pictorial magazine of rocketry was not only feasible but exactly what was needed in this complex and ever-growing field. So they launched an experimental issue, the memorable (if somewhat facetious) issue of December 1953.

Today it has grown into a small business involving several thousand dollars per year, but not one of the staff members touches a cent of it. Staff meetings are filled with talk of copyrights, contracts, policy, organization, and of course the usual discussions of editorial content and advertising and deadlines. It is no easy job, but it is fun. People have joined the staff who had absolutely no knowledge of how a magazine is published, but today they could probably hold their own in any bull session with professionals.

Contrary to what some people think, this magazine is not the work of a single individual any more than the field of rocketry is the result of any one man's work. No organization of the type we have could ever exist under one-man rule, nor would you ever see a magazine published at all under those conditions.

We like to point out with considerable pride that "MISSILE AWAY!" is the only pictorial, semi-technical magazine devoted to rocketry which has survived more than a year of publication. Several large national magazines have tried to start missile sections—and they have unceremoniously died after two or three issues.

It sounds as though we were patting our own backs. Such is not the case. The purpose of what we have said is to bring home to many of our members just what they are a part of. And it serves to lead up to something the magazine has needed for quite some time: a published statement of editorial policy.

We have spent many long hours ironing the following points out. Until just recently, the magazine was growing and developing at such a great rate that no fixed policy could be set forth. Now, a few things have crystalized:

1. "MISSILE AWAY!" is on a paying basis. It does not, never will, and never has cost the membership of the Section a single penny. Once we have built up a sinking fund to forestall the possibility (very remote at present) of going bankrupt, all monies gained from the magazine will be used to support section activities and other worthy causes determined by the Section Board of Directors. This magazine will never become a standard publishing effort apart from the Section.

2. It is not, nor ever will be, the intent of this magazine to devote itself to one phase of rocketry. It is, however, our purpose to bring to every man in rocketry a glimpse of what is being done in other parts of the field. We will not become so erudite that you cannot read the contents of this magazine — although we reserve the right to make you stretch your thinking a little bit now and then!

3. We are firmly of the belief that the men working in rocketry can contribute more to the general literature of the field than any outsider, be he free-lance writer or science editor. We think the work in rocketry has basic excitement and adventure to it, in spite of how you or the rest of us may feel about it as we go about our day-by-day tasks. Someday, perhaps historians of the future will look back for information on the "early days" of guided missiles and rocketry; we think they will find more in the written works of the rocketeers themselves than in the smoothly-written essays of professional writers. The rocketeers will continue to speak in "MISSILE AWAY!" although occasional specialists in other fields will be asked to write for us because they have something of interest to say.

4. The magazine is at present being set up with an eye for the future. We want it to continue, to grow, to thrive. Since it is an instrument of some power, we do not want it to be controlled by a single man or clique. At all times the Section Board will be able to step in and correct bad basic polciy.

5. Our advertising agency will continue as it has, presenting advertising material of basic interest to rocket people no matter where they work. Not only do we want to give our readers something to read, but to the advertisers we wish to offer an attractive means of presenting interesting advertising.

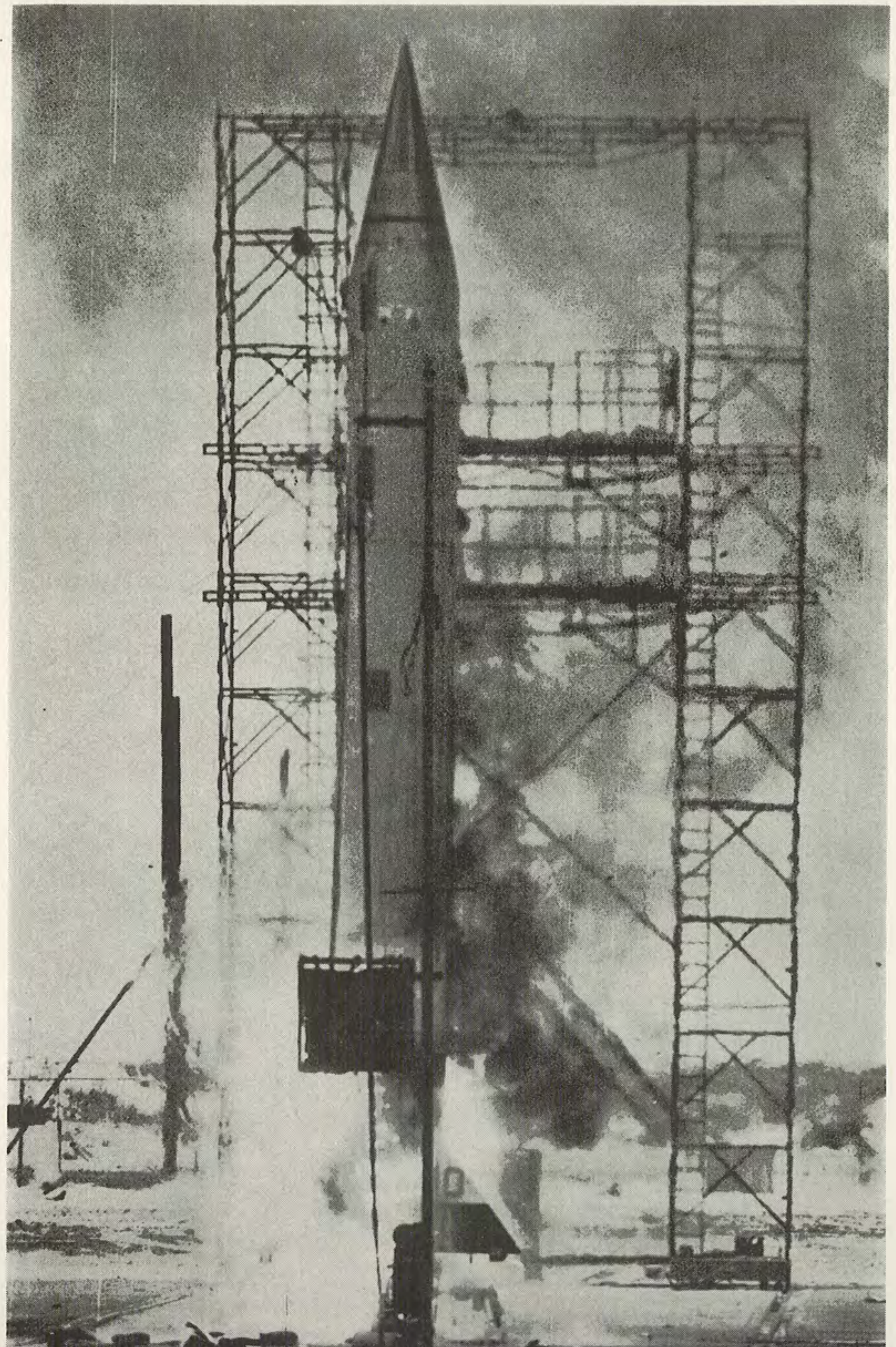
6. Our circulation is expanding on a national level. This we will continue to push.

7. We will endeavor to include a special supplement with each issue, and to print as many photographs of missiles and activities as we can . . . and print them as big as we can!

8. Most important of all, "MISSILE AWAY!" is **yours,** fellow members! The success or failure of the magazine will always be in your hands, not those of the staff. **You** have the power to make it what you will. There is where the **real** power of "MISSILE AWAY!" lies.

—G. H. S.

FIRE!



The thunderous bellow of the Viking rocket in flight has been heard many times now as this sounding vehicle plunges upward bearing instruments. Recently, the 12th rocket in the series was fired. But all has not been success in the gradual, 10-year development program of this beautiful and impressive rocket . . .

by

LTJG F. M. ANDERSON, USNR

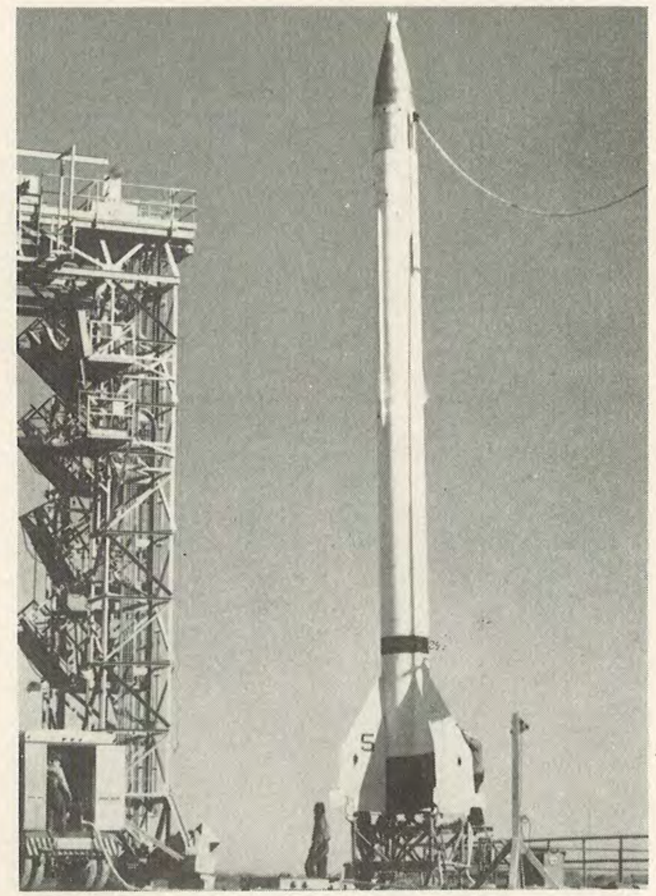
"FIRE!" With that word, Lt. J. C. Pitts, USN, Viking and Naval Research Laboratory Project Officer at the U. S. Naval Ordnance Missile Test Facility, White Sands Proving Ground, New Mexico, completed the count down at the Navy Blockhouse and gave the command to send the Navy's RTV-N12a, Viking No. 10, on its journey into the ionsphere carrying more than 750 pounds of instruments for the purpose of furthering man's knowledge of the upper reaches of the thin layer of atmosphere covering earth. This moment climaxed five weeks of preparations by the field crews of the Glenn L. Martin Company, manufacturers of the Viking, the Naval Research Laboratory, and the Naval Ordnance Missile Test Facility. This 10th missile in the Viking series was the third of the Vikings with redesigned fuel capacity. It was expected to climb farther above the surface of the earth than any single staged missile had been able to do before.

The Viking project was originally set up to obtain a rocket capable of carrying loads as great as 2000 pounds above an altitude of 100 miles. Under the direction of Milton W. Rosen, director of the Rocket Sonde Branch of the Naval Research Laboratory, a contract had been awarded to the Glenn L. Martin Company for the study and design of such a rocket. The Research Test Vehicle No. 2 was the result, and seven of these rockets were manufactured and fired with varying success. Viking No. 7 was the most successful of this series, reaching an altitude of 136 miles on 7 August 1951. Following the record breaking flight of Viking No. 7, the rocket was redesigned and designated the RTV-N12a. One of the more important features of the new series was a greater fuel capacity and consequently longer burning time.

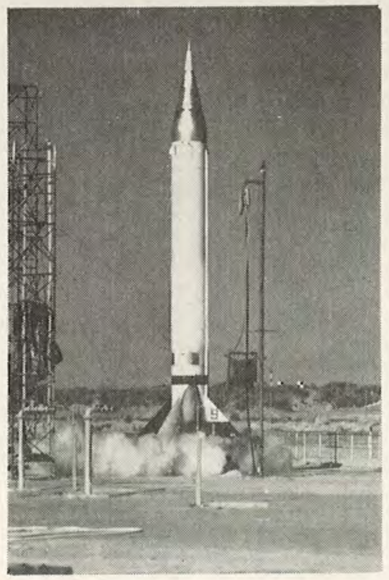
The crisp words of the countdown in the Blockhouse by Lt. Pitts had alerted range and project personnel in the Blockhouse, at "C" Station three miles behind the Blockhouse, at Parker Station adjacent to Highway 70, at ION Stations scores of

(Continued on next page)

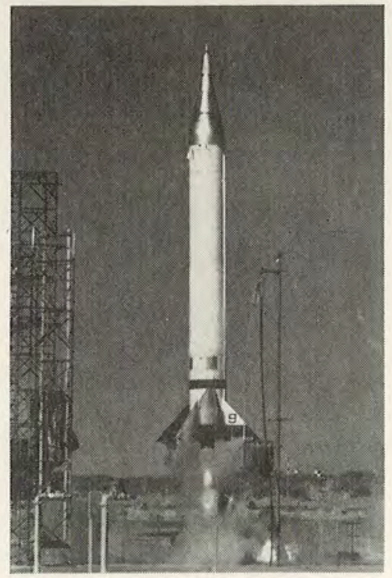
In the photograph at the left, Viking 10 burns on the launching stand after the first attempt to fire. Heat-haze distorts the outlines of the temporary gantry behind the Viking. When this photograph was taken, the Viking still contained its full flight-load of alcohol. For a later and more successful launching of this rocket, see the photograph on page 12. (U. S. Navy photos)



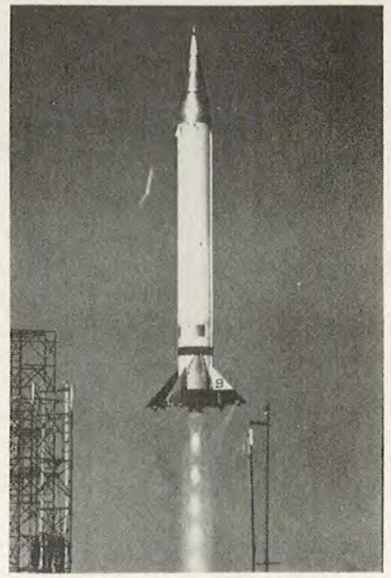
The photograph above shows Viking 5, in the thinner and taller version used for the first seven Viking flights. As may be seen from the gantry in the background, it was fired from the Army launching area. Unlike later versions, which are fired vertically and then programmed to the North, this Viking was fired from a launcher tilted about three degrees from the vertical.



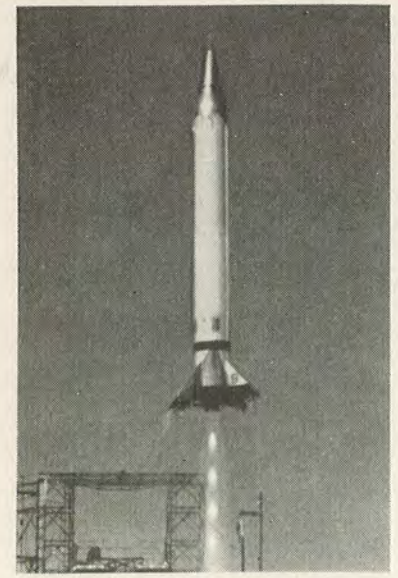
Zero Seconds . . .



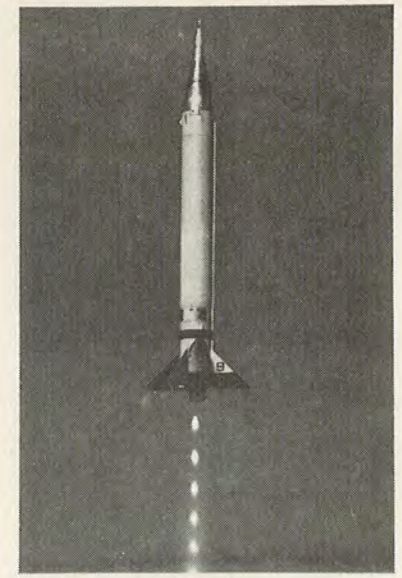
X + 1 . . .



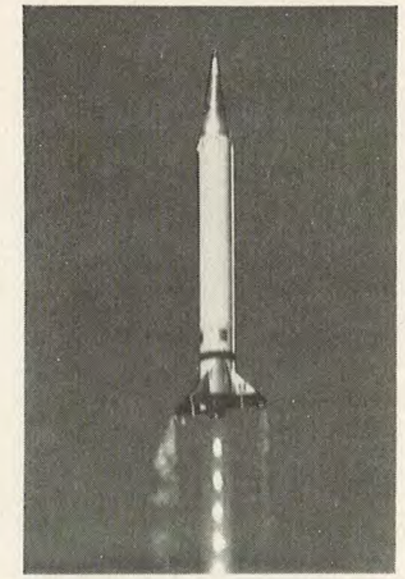
X + 2 . . .



X + 3 . . .



X + 4 . . .



X + 5 . . .

This remarkable series of unretouched photographs shows Viking 9 starting its climb from the Navy launching area at White Sands to a then record-equalling altitude of 136 miles. The initial upward acceleration is very small—less than one half g—but increases rapidly as fuel is expended. Note the clarity of the "Mach diamonds" in the rocket exhaust. The number of these gives a measure of the velocity of the exhaust gases. Note also the exhaust gases appearing occasionally at the tips of the tail fins (particularly clear in the + 5 second photograph). These gases result from the operation of the fin-tip roll-stabilizing jets. The fuel for these tiny jet motors is a supply of hydrogen peroxide separate from that which fuels the pump-turbines. Similar jets provide pitch and yaw stabilization after the burnout of the main gimbal - mounted oxygen - alcohol motor. Ground electrical connections to the rocket—provided through cabling from the pole visible just to the right of the Viking—is disconnected at x-2 seconds. In the background at the left of the first three pictures can be seen the oxygen blanket which circles the oxygen-tank section of the rocket until about x-9 minutes. At this time it is disconnected by remote control and drops away, pulled clear of the rocket by ropes attached to the scaffolding which can be seen in the pictures. Behind this scaffolding can be seen a portion of the temporary gantry crane used until Viking 12 to service Vikings at the Navy launching area. (U. S. Navy Photos)

FIRE! by F. M. Anderson

(Continued from page 9)

miles down range, at camera stations, radars, road-blocks, plotting boards, safety screens, recorders, switch-boards, firing panels, telemetry stations, and all the other scores of locations which must be manned and functioning before a Viking missile can be a complete success. One by one all these stations had made their reports back to the Project Officer, and exactly on time at the command to fire the missile lifted itself ponderously into the air and then launched itself suddenly into the sky. The smoothness of this operation with Viking No. 10 made the whole job seem simple, but Viking firings can be moments of heart-break too.

Viking No. 8 for example, the first of the new series, was never flight fired. During static test on 6 June 1952, the rocket broke loose from its firing stand and reached an altitude of better than 15,000 feet before tumbling back to the desert. This established the world's altitude record for static firings, an entry which Viking would prefer not to have put into its record books. Alert range personnel succeeded in obtaining Askania records of this static firing and telemetry records were achieved during part of the flight using as an antenna the trailing ends of wire left attached to No. 8 when it broke loose.

Viking No. 10, despite the success of the operation on 7 May 1954, seemed for a time to be headed for disaster even more complete than that experienced by Viking 8. The first time the count-down proceeded over the head of Viking 10 was on 30 June 1953. On this date when the command "Fire!" was given, the fuel in the motor chamber-instead of burning-exploded violently, leaving the Viking a mass of flames. The thousands of pounds of oxygen which dumped themselves onto this fire within a few seconds gave the fire an excellent start in spite of the heavy sprays of water from the fire nozzles ringing the launching platform. In the rocket, above the burning section, the alcohol tank still held thousands of pounds of fuel which dribbled slowly on the fire maintaining the flames within the control section. For many minutes fire fighting was limited to the fixed position nozzles which did not reach into the control section, because it was feared that the still vertical rocket would topple at any moment, or that the fire-weakened structure would collapse, releasing the entire supply of alcohol disasterously.

When after a few minutes the rocket still stood firm with the valuable instrument section in the nose entirely undamaged and with the fire reduced to small flames from the control section, it was determined to try to save the rocket. The fire fighters from the White Sands Proving Ground volunteered to move forward close to the burning rocket so that a hose could be applied directly on the control section. As these men started forward it was necessary to order them back almost immediately as the thin skin of the alcohol tank was seen to be dimpling dangerously as the alcohol drained slowly out, pulling a vacuum within the tank. It was feared that this tank might rupture at any moment. Lt. Pitts solved this problem through the aid of an Army carbine by placing a bullet hole in the top of the alcohol tank, which subsequently relieved the pressure and allowed the alcohol to drain out without causing collapse of the tank. When firemen had extinguished the blaze it was possible to drain the dangerous alcohol and save the missile. It was this same Viking 10 with a patch over the bullet hole and a new control section which was fired with such smooth skill nearly a year later in May of 1954. The flight of Viking 10 was completely successful. The missile obtained a peak altitude of just under 140 miles, matching the altitude records of Vikings 7 and 9.

Theoretically Vikings 9 and 10 should have been able to fly even higher; this theoretical altitude was achieved 17 days later when Viking No. 11 set a new single-stage high-altitude record of 158 miles. This altitude record still stands, although Viking No. 12, fired in February came second best with a peak of 144 miles. The primary importance, of course, is not the obtaining of records for altitude but the success of the vital instrumentation by which man is increasing his knowledge of the atmosphere around him. Without research of this nature he can hardly hope to see an orbital vehicle launched from earth.

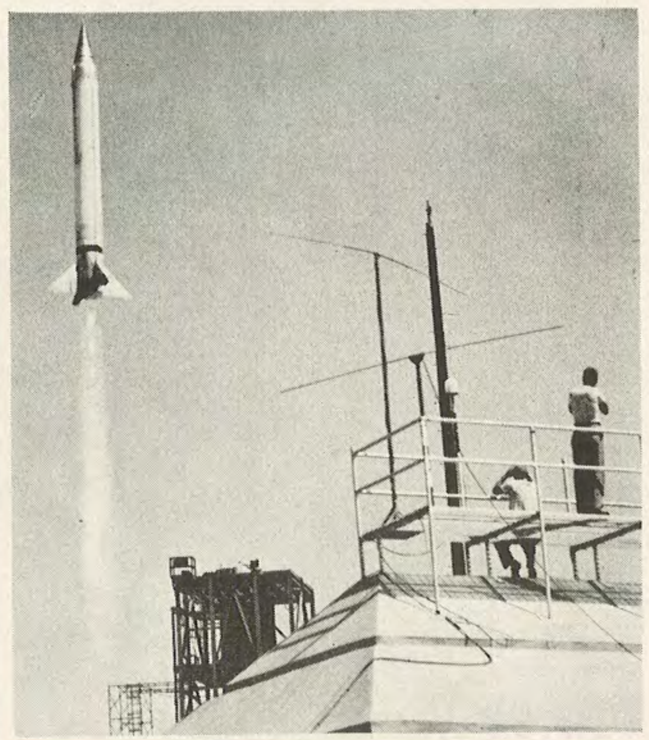
(Continued on next page)

FIRE! by F. M. Anderson

(Continued from page 11)

If all goes well, the next Viking of this series—Viking 13—will be fired from the Navy launching area in July of this year, according to still tentative plans. Like its predecessors, Viking 11 and Viking 12, the major weight of its instrumentation will be devoted to efforts to obtain additional information about the problems of re-entry into the earth's atmosphere at very high Mach numbers. To carry out this experiment, the heavy conical nose cone will be detached from the rocket near its peak altitude, and will hurtle back to the ground at tremendous velocity, carrying telemetry and other instrumentation. Determination of a stability of the cone as it reenters the atmosphere will be of great importance, as will heating effects and determination of drag.

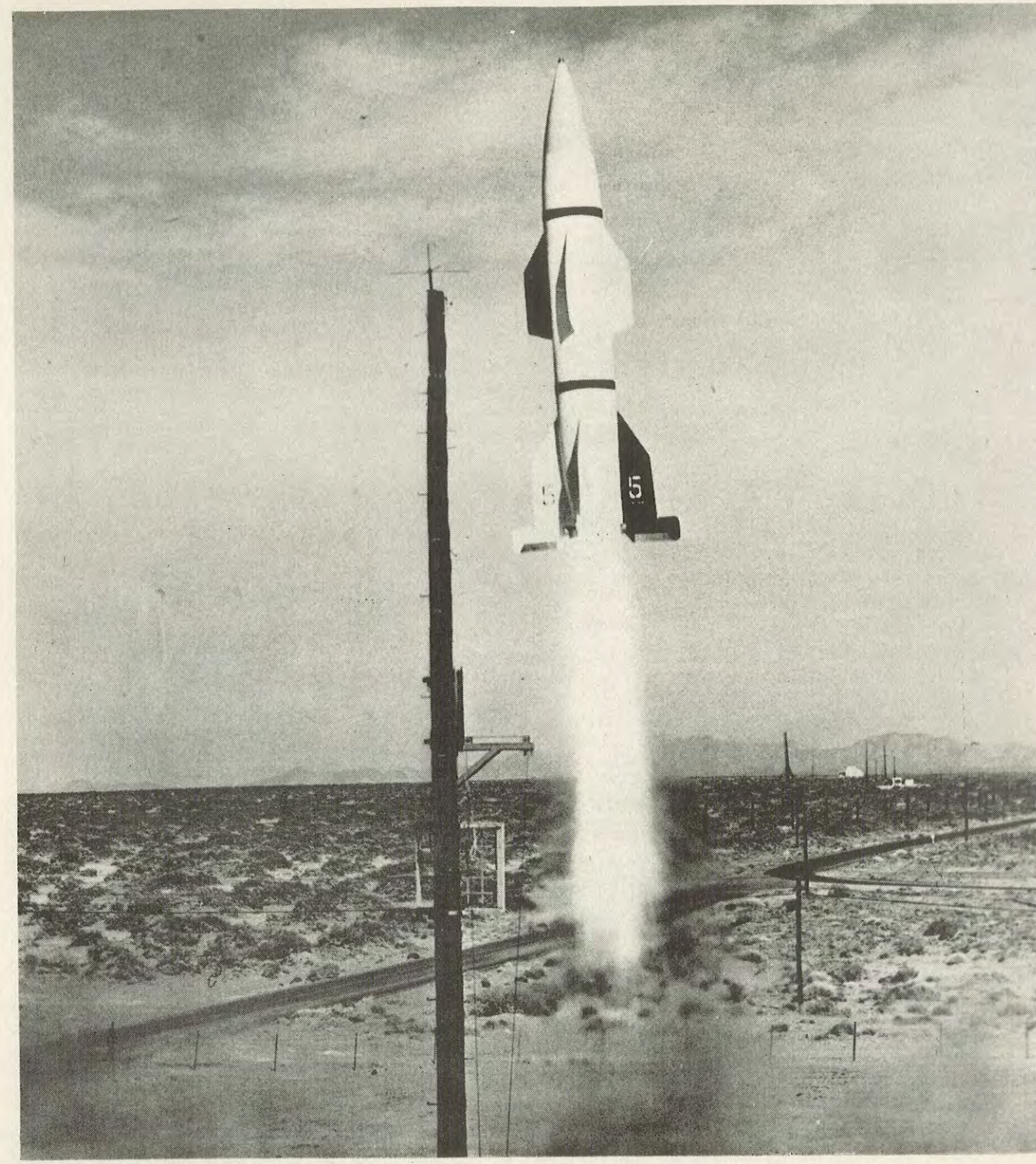
Research of this type, and of the type carried out in the earlier Vikings, is of immense importance. Without the information being slowly acquired from research of this nature, man can hardly hope to see an orbital space-vehicle launched from Earth • • •



Like the Phoenix which rises alive from the flames which seem to have destroyed it, Viking 10 is shown in this photograph a few seconds after the second, and successful, attempt to launch it. The instrumentation personnel on top of the Navy blockhouse seem unconcerned by thoughts of the earlier and nearly disastrous firing attempt. A photograph of the earlier attempt heads this article. (Glenn L. Martin Co. photo)

winged messenger . . .

The **Hermes** A1 missile (U. S. Army Photo)



158

Miles Up!

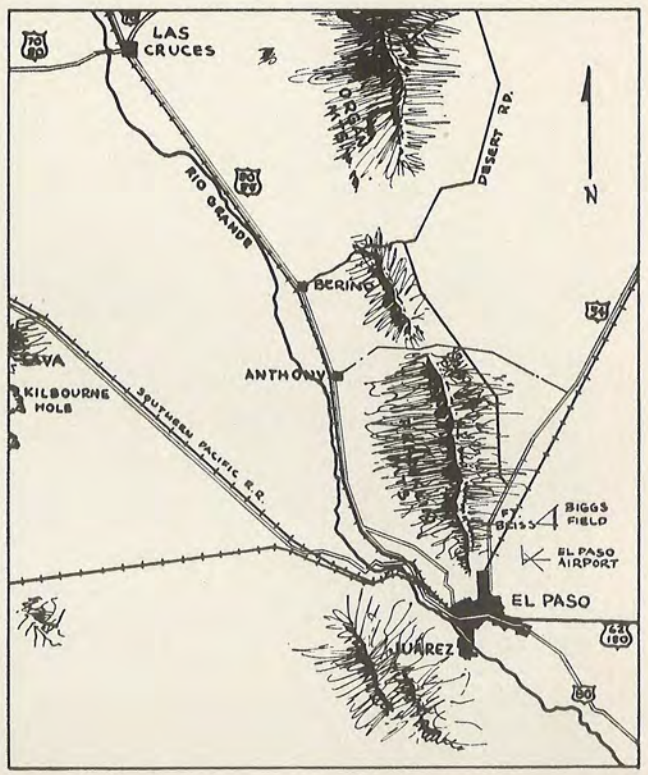
You are looking straight down from 158 miles altitude.

In one of the most remarkable photographs ever taken from a rocket, it is possible to see (by referring to the map) all of the towns to the west and south of White Sands Proving Ground. El Paso, Texas, is clearly visible, as are the railroad yards, the international airport, and Biggs Field. The Rio Grande River runs through the picture with the patchwork of farmlands along its fertile banks. Far in the upper left corner is Las Cruces; none of the streets are visible, and State College is covered with a cloudbank.

The photograph was taken on special infra-red film from Viking rocket No. 11 at or extremely near peak altitude on 24 May 1954 at about 11 A.M. in the morning. The U. S. Naval Research Laboratory and the Physical Science Laboratory of N. M. College of A.&M.A. used special cameras whose lens focal length had been corrected for vacuum conditions of refractive index. Hence the extreme clarity.

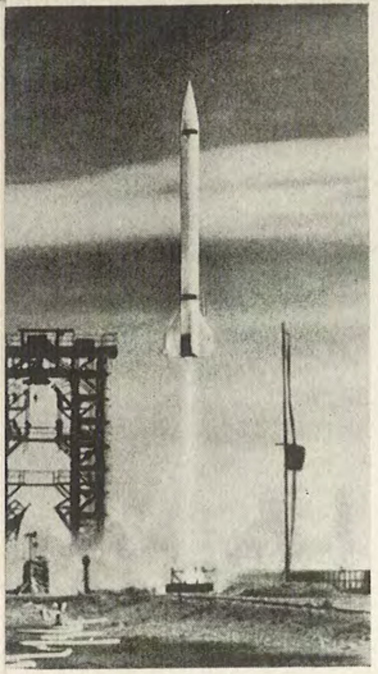
On the positive prints of the photograph, it is perfectly possible to pick out Montana Street in El Paso, Highway 80 where it leaves the valley near White Spur, and the Desert Road leading to WSPG.

This, then, is what some future space man may see on leaving White Sands. He will be heading out toward space, but already the works of Man are slowly blurring into obscurity against the vastness of the world from space.

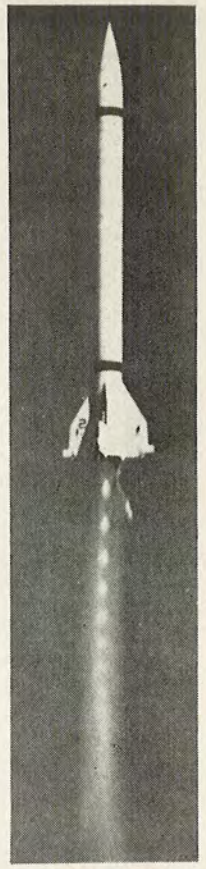


SKETCH AND LAYOUT: WAGONER

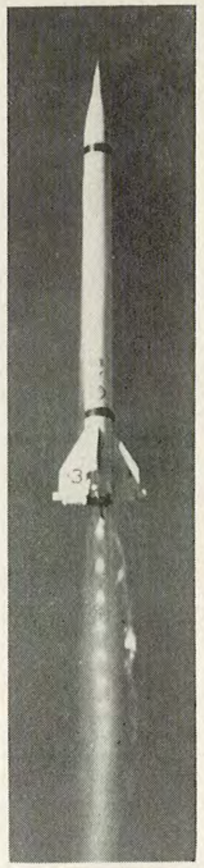
VIKINGS by the dozen



Viking I — 50.4 miles
(Glenn L. Martin Co. photo)

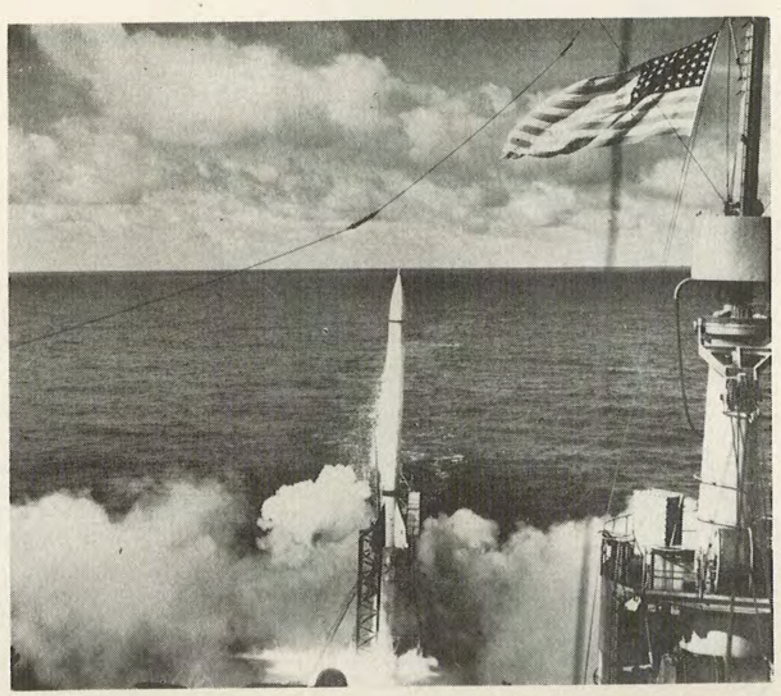


Viking II
32.3 miles
(U. S. Navy photo)

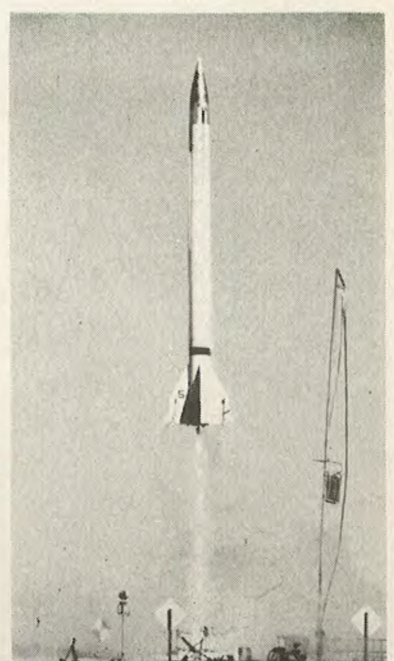


Viking III
50 miles
(U. S. Navy photo)

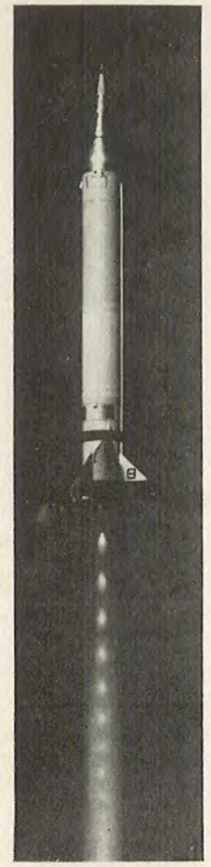
RTV-N-12 Viking sounding rocket, manufactured by Glenn L. Martin Co. and powered by a 20,000-lb. rocket engine developed by Reaction Motors, Inc., was conceived in 1945 as a high-altitude rocket for the purposes of investigating the earth's upper atmosphere. As of this date, twelve Viking rockets have poked their noses from the Martin factory. S/N 1 was launched on 3 May, 1949 at White Sands Proving Ground. Thereafter followed a succession of Vikings each a little different from the preceeding one S/N4 was the first big rocket to have been fired from the deck of a ship at sea; it took off from the fan-tail of the USS Norton Sound on 11 May 1950 in the vicinity of Christmas Island in the Pacific. Vikings climbed higher and higher until S/N 7 captured the single-stage altitude record from the V-2 on 7 August 1951. A new series of Vikings, fatter and bigger, followed with S/N 8 . . . which holds the altitude record for a static firing; S/N 8 broke loose during the regular static firing all Vikings undergo before being flight-fired. But S/N 9 went as scheduled. The story of S/N 10 is akin to the tale of the Phoenix; on the first attempt at firing, the motor exploded at X-minus zero, but the rocket was saved to be rebuilt and finally fly in May 1954 S/N 11, also fired in May 1954, established a new altitude record of 158 miles. Although Viking S/N 12, fired in February 1955, did not exceed the performance of S/N 11, it was completely successful.



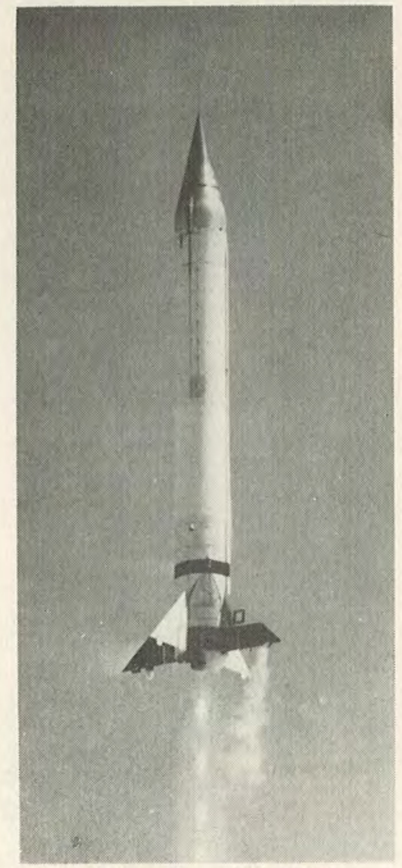
Viking IV — 106.4 miles
(Glenn L. Martin Co. photo)



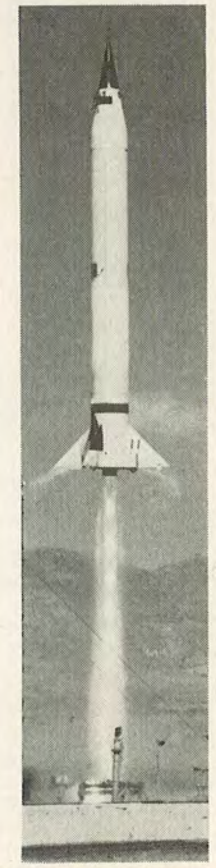
Viking V
107.5 miles
(Glenn L. Martin Co. photo)



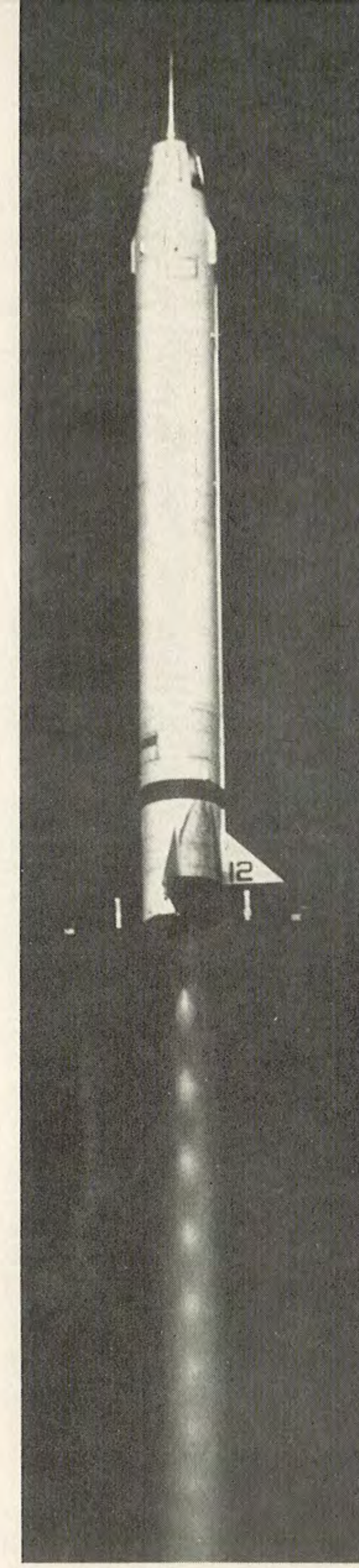
Viking IX
136 miles
(U. S. Navy photo)



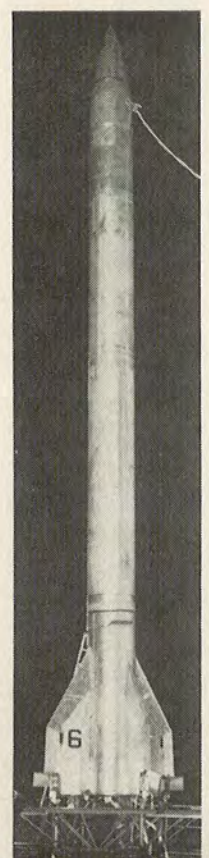
Viking X — 136 miles
(U. S. Navy photo)



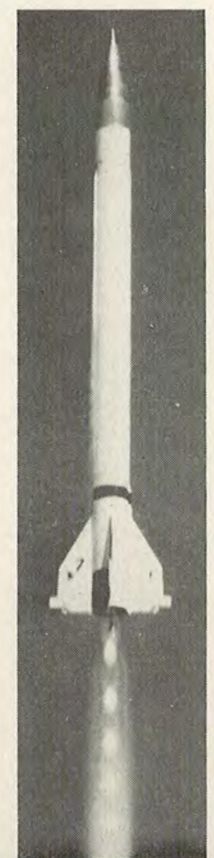
Viking XI — 158 miles
(Single stage altitude record)
(U. S. Navy photo)



Viking XII — 144 miles
(U. S. Navy photo)



Viking VI
40 miles
(U. S. Army photo)

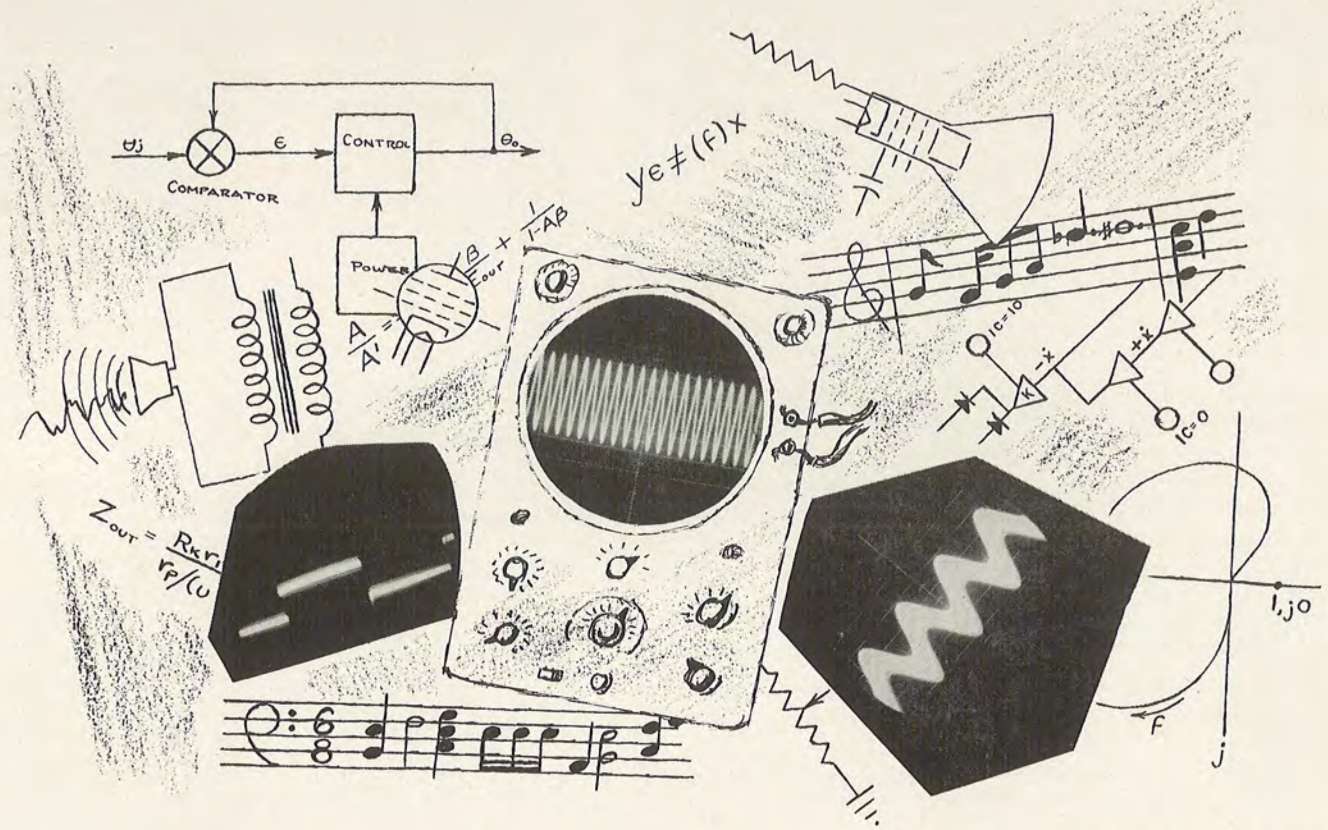


Viking VII
136 miles
(U. S. Navy photo)

Viking VIII
15,000 feet
(Shown in the air after breaking loose during static firing. (U. S. Navy photo)

LAYOUT by WAGONER

Information Theory



and Hi-Fi

By

JOHN W. CAMPBELL, JR.

In the Winter issue, there appeared an article on Information Theory, which may some day solve or help to solve some of the knotty problems of science. But, as with any new thing, people have asked, "How do you apply it?" Here is one example. Take a few principles from analogue computer methods, sprinkle them with some servo engineering, and stir gently with audio engineering . . . and you have a new hi-fidelity amplifier which you can build and try out.

As a boy of 10, I had great interest in mechanical gadgets; I liked to analyze how they worked. On one occasion which I have not been permitted to forget, I successfully analyzed my grandmother's washing machine, found out how all the parts were fitted together, and discovered the principles involved. My uncle was called on the next morning to resynthesize the machine, since my interest had been purely analytical.

I have a strong feeling that Science has a certain aspect of that same tendency—it's doing a magnificent job of analysis, but it might be even more useful if someone would call for Uncle to put it back together. There are some perfectly wonderful techniques being used in one branch of a science which are completely unknown and unused in an immediately adjacent branch of the same science; there are some exceedingly competent specialists, but their achievements could many times be immensely aided by a few generalists—a type of thinking not adequately appreciated today.

Now Information Theory is a highly complex mathematical discipline, and I'm no mathematician—but the **type of thinking** that the Information Theory men have worked out isn't highly complex mathematics; it's a generalized philosophy, a way of looking at problems. They're trying hard to take the next great step, and achieve a Meaning Theory. They don't have it yet, but they do have ideas that help understand how to use information in a much broader and more generalized sense.

One specific example will show how it can be used to supply the cross-over concepts whereby the walls between two adjacent branches of a single science—electronics—can be usefully penetrated.

In information theory thinking, "noise" is any signal that is not message—and message is precisely and only what you want to transmit. Thus static, electron-frying, thermal agitation of electrons, harmonic distortion, faulty tubes, burned-out fuses, everything and anything that adds to, subtracts from, or alters the message in any way is "noise".

Now I like hi-fi music, and I like building my own hi-fi systems. What I want, evidently, is a noise-free amplifier—in Information Theory terms! One that has zero distortion, zero pop, crackle and snap, and zero failure. The last may be a bit harder to achieve, but we can make a try on the others from the information theory end.

An amplifier is a transmission system; in information theory terms, it is actually "noisy" in one respect—it distorts the **magnitude** of the input. But this we want. (You wouldn't, however, if you were trying to measure the magnitude of the input signal, for instance.)

What I'm then trying to do in building a hi-fi amplifier is precisely what the electronic computer men have been working on for years: to achieve an accurate analog device, having little or no noise. And by "noise" they include change of characteristics due to tube aging, voltage variations, resistor aging, etc., etc., **ad** practically **infinitum.** When you're trying to build an analog computer that's accurate to ½% using tubes that are only 30% predictable, you start really scratching to get noise-eliminating systems.

One approach, of course, has been the digital computer; it uses an all-or-nothing system, and pretty well eliminates the "noise" effects, save for tube failures. (If the average life of a tube is 1000 hours, and you have a machine with 5000 tubes in its circuits, how long can you expect it to run without failures? Answer: 12 minutes at a time.)

The digital computer approach won't help us get a hi-fi amplifier conveniently. But the analog computer approach will; The analog computer is simply a device for taking information in at one end, combining and interacting it, and expressing the resultant in some chosen manner at the other.

All right—I choose to have my analog computer express the resultant in terms of movement of a loud speaker diaphragm, instead of movement of a graphing pen. The information theory men have been studying problems of encoding information for a long while now—computermen have done a lot of work on it. And that concept of encoding is a useful one; the phonetic alphabet you're using right now is one way of encoding sound for transmittal. A magnetic tape is another way. To the information theory people, they're essentially two ways of doing the same thing.

My proposed hi-fi amplifier then is to take in information encoded as voltage variations, compute an analog roughly 33,000,000 times as energetic and transduce this voltage-variation code to a mechanical displacement code.

That's what any audio amplifier does, of course—but put in these terms, it becomes obvious that analog computer circuits, specially developed for extreme accuracy—orders of accuracy far exceeding any hi-fi-audio techniques—are precisely what we want. So let's take a look at some of the simpler analog computer circuits.

Computermen don't trust vacuum tubes; they know from experience that no two are alike, and no one is like itself two hours running. Furthermore, they're non-linear; double the applied signal, and you do **not** get twice the voltage change at the output, even with the best of tubes.

Back around 1940, when some of the first hi-fi systems were being built, the audio engineers found that pentode and beam-power tubes gave considerable distortion—up to 17% or so. Triodes, particularly big, heavy-current, low-gain triodes, were much cleaner. So, by 1940, everybody who knew anything about real hi-fidelity knew that you **had** to use triodes for quality.

But they weren't using negative feedback circuits then. And they insisted on using Class AB_2 or, grudgingly, AB_1 operation.

(Continued on next page)

Information Theory and Hi-Fi (con't.)

Triodes are out of the field now; everybody's using beam-power tubes, running them in Class A, and using plenty of negative feedback. Beam-power tubes do fine, if you don't try to treat them like triodes, or use the techniques you have been using on the Good Old Reliable triode.

But because pentodes have high plate resistance, they don't handle high frequencies well in audio amplifiers, so everybody who knows anything about real high fidelity knows you have to use the good old reliable triode for the voltage amplifiers.

But the computermen don't; they like pentodes — because they don't like any tube very much. For their purposes, **no** tube is even approximately linear—they all distort, and generate "noise," which means wrong answers in a computer.

A lot of people who've studied the distortion produced by power amplifier tubes most carefully have operated in the happy idea that "voltage amplifiers don't distort appreciably." Ask a computerman! Or, for that matter, look it up in the Sylvania tube handbook under the Resistance Coupled Amplifier charts. The "good old reliable triode" 6C4, asked to deliver a modest 23 volts—just enough to drive a 6L6, for example—has 4.9% distortion. At 14 volts output, it's not so bad—only 3.8% distortion. But the demeaned pentode, the 6SJ7, will give 11.5 volts output with only 0.8% distortion, and 47 volts output with only 4.2%, and at that gives a gain of nearly 100 times.

Those percentage distortion figures make it abundantly clear why the computermen don't like tubes to have any notable effect in determining the output they get. If you're trying to determine something to plus-or-minus 2%, one 6C4 in the circuit means you're out of bounds.

So they developed a null-bridge type circuit, the electronic great-grandson of the bridge circuits physicists were using back in the 19th century. A Wheatstone bridge, for example, depends on balancing one set of resistors against another with a student acting as a servo-corrector mechanism triggered by a galvanometer. Given a reasonably sensitive galvanometer, and a student that wouldn't go to sleep on the job, whether the student was left-handed, stupid and cross-eyed, or not didn't matter much. The **student's** characteristics didn't count, if he'd just keep the galvanometer reading down at zero.

The vacuum tube is simply used to replace the galvanometer and the student. The more sensitive the tube is, the more nearly it will approach keeping the circuit at balance; its distortion characteristics aren't important any more!

So the highly sensitive pentode is preferred. The circuit is simple enough:—

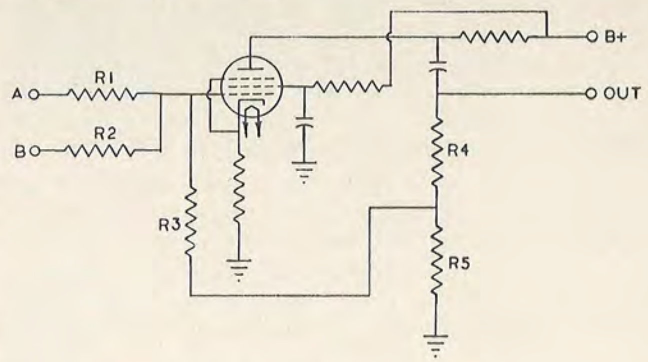


FIG I: THE NULL-BRIDGE CIRCUIT

The computermen developed the circuit as an adding device; two inputs, A and B are shown for simplicity; as many as five can be used; and in computers added complexities to provide lower output impedance are required, but the basic principles are here.

A signal fed in through A will, we'll say, start the grid going positive; if a 6SJ7 is used, the plate will go negative 100 times as much, and this negating signal will be fed back through R4-R5 to R3, and thence to the grid, cancelling the input signal almost completely.

The null-bridge is, essentially, R1 and R3, with the grid-cathode-ground system the galvanometer, while the plate, and the R4-R5 system are the equivalent of the student who alters settings to restore balance.

If electrons start flowing in through R1, electrons must be pulled out through R3, or the grid will accumulate a charge. The electrons must be pulled out just as fast as they are fed in, so if R1 and R3 are equal, the voltage appearing at the junction of R4-R5-R3 must be equal and opposite to that imposed at A, minus a slight percentage (since the gain of the tube is not infinite.) If the value of R4 is properly selected, the voltage at the Out terminal will equal exactly that at A.

Now if a signal is also applied to B, more electrons flow in, and now R3 must drain out the electrons coming in through A **and** those coming in through B. For the computermen, the critical word there is **"and"** —because that's the meaning of the addition sign in mathematics. The voltage at R5 will now rise to a point representing A + B. It will, of course, add algebraically.

Now for hi-fi use, the important trick is that the **tube** has practically nothing to do with the performance; it's characteristics aren't important. What happens is determined by the electron-flows through the resistors, not by the gain of the tube.

The computermen wanted an adder; I have a use for an adder in my hi-fi system, but I want an amplifier even more. One slight modificatoin of this adder, and I've got it.

If R4 is made 4 times the value of R5, then the voltage at the Out terminal will have to rise to 5 times that at A or B before the circuit balances. And now we have a circuit that gives a gain of 5 times—and is still dependent almost solely on the electron-flows in the resistors, not on the tube!

In practical terms, R1, R2, and R3 can all be 0.5 megohms, while R4 is 0.2 megohms, and R5 is 0.05 megs. The plate resistor is 0.1 megs., and a 6SJ7, because of its inherently good characteristics, works beautifully. However, even a highly non-linear tube designed to be non-linear, such as the 6SK7, would work too!

For a simple, amplifier stage, operating at an output level of 10 volts or so, for audio hi-fi work a gain of 10 in the circuit is perfectly satisfactory—the distortion is then down somewhere below 0.05%! But if the output is to be of the order of 50 volts, the gain should be held down to about 4 times; the tube can't be entirely eliminated, and its distortions do creep in to some extent.

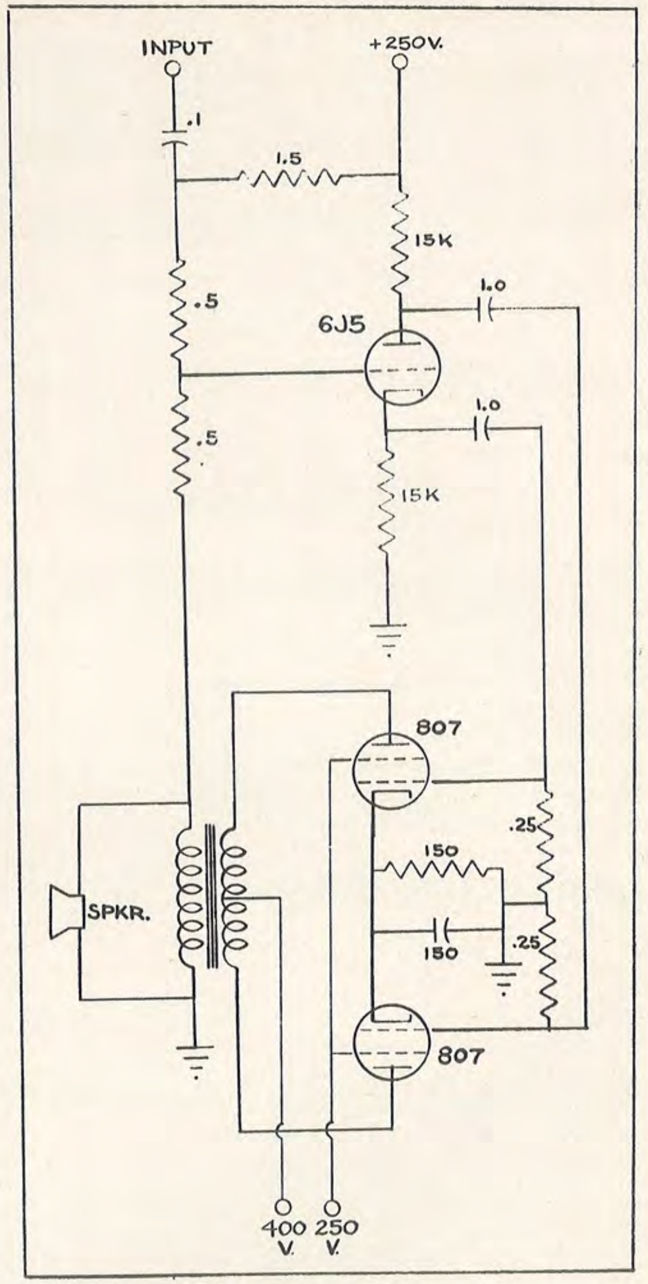
And for a straight ampilfier, of course, input B is left out.

However, there's something called an "input mixer" in many audio amplifiers, where two or more inputs can be simultaneously entered. The usual tone-control circuits frequently use separate-channel amplification, and recombination of the signals—and we hope that that which is called "a mixer" doesn't mix. Mixers, properly speaking, are heterodyne modulation systems; they don't simply add two signals together; they interact them.

Now **any** non-linear circuit element will act as a true heterodyne mixer. An overage and overweakened tube starts distorting, and you not only hear all the music that went in, but a lot of new notes that are strictly home-grown—the heterodyne beat-frequencies produced by interacting the original frequencies. This cross-modulation is in addition to, and distinct from, harmonic distortion, and inevitably occurs in any circuit element which is not strictly linear. In true hi-fidelity work, this cross-modulation is what forces us to seek extremely low levels of distortion, which is non-linearity. You can't hear 1% distortion of a pure sine wave, perhaps—but you'll hear the cross-modulation when two sine waves undergo heterodyne modulation in that non-linear circuit.

The computer type added circuit really adds two channel inputs, and does **not** mix them. Furthermore, because the circuit acts to maintain the grid terminal at an almost exactly constant voltage, the two inputs cannot interact on each other.

Finally, taking off with these computer-type electronic circuits, and crossing the boundary from Computer Engineering to Audio Engineering, the voltage amplifier section of the new hi-fi system was set up. One more side excursion, to the Servo Controls Systems Engineering department was made to get a useful concept for the power stage—the idea of the homeostatic device.



The Power Stage

It's essentially a variation of the null-bridge circuit; any system that tends to maintain its condition, and to restore itself if pushed off balance ,is a homeostatic device. This includes the flush-tank in a toilet, the thermostat-and-furnace system in your home, and a lion out looking for dinner in an effort to restore the homeostasis of a comfortably filled belly.

Note that for each of these devices, the **predetermined state of balance** is what's important—not the method or process of achieving it. The thermostat-furnace system may have to run on an 85% duty cycle when the temperature's down to —20, and a

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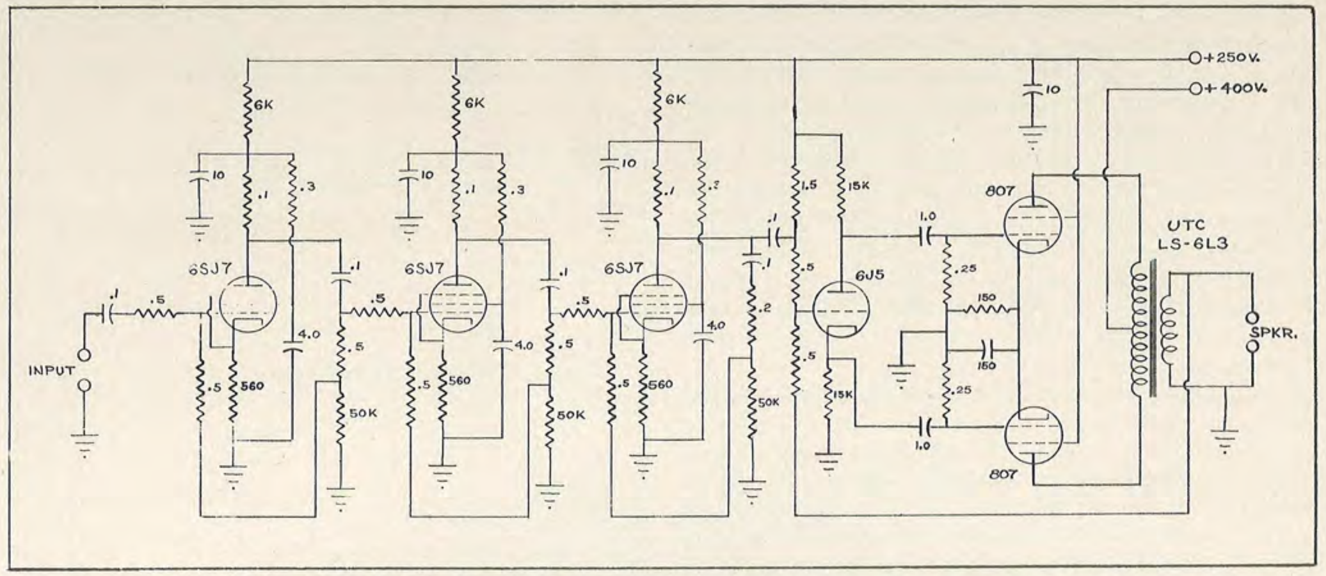


The Circuit of the Campbell Amplifier. This amplifier consists of two 807 power output tubes, a 6J5 cathode-follower phase inverter, and three voltage amplifier stages using 6SJ7 pentode tubes. With an input of 1.0 v. from a preamplifier, it will deliver 30 watts to an 8-ohm loudspeaker. The output transformer should be of the highest quality; plate-to-plate impedance for Class-A 807's is 6000 ohms, but a UTC LS-6L3 (9000-ohms p-p) works. All resistors are in megohms unless followed by a K (X 1000), and cathode resistors, which are in ohms. Condenser values are given in microfarads; the 10 mfd. units can be a quad unit can. Vector-type turret sockets greatly simplify the construction of the circuits. Power requirements are 400 volts· D. C. at 150 ma., resistors, ½-watt except 807 cathode resistor, which is10 watts. All condensers 450-600 wvdc except 807 cathode bypass, which is 50 wvdc.

Information Theory and Hi-Fi

30 MPH wind is blowing; the duty cycle may drop to 5% on an early spring day. It may be that you set the thermostat to 85°, or down to 55°; no matter, the system simply maintains the condition of balance-as-indicated.

The lion may walk half a mile; he may spend 12 hours hunting. The amount of effort invested isn't the point; satisfying the demands of his appetite-homeostat is very definitely the point.

Now this concept would be useful in a hi-fi amplifier; we want the speaker to move the way the encoded voltage variations require—and we're quite willing to have the power stage work itself into a panting frenzy if it has to do it. **How** it achieves the result is its business; we just insist that it achieve it.

Since the output is the only thing we're interested in, we'll let everything be determined by the comparison between the input signal, and the output.

How can we do that? Simply use another adaptation of the null-bridge circuit such that when the output is exactly what it should be there will be no demands placed on the power stage—but a departure from balance stimulates the power stage to do something about it.

Let's do it this way:—

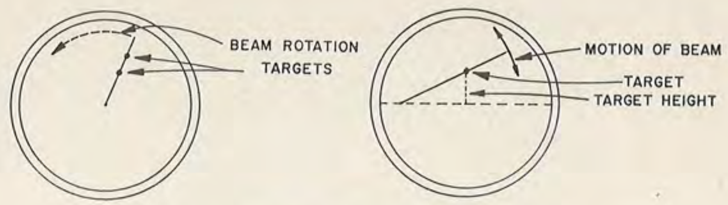
Our null-bridge is the system R1-R2 and the output winding of the transformer with the speaker voice-coil. If the voltage across the output winding is equal to and opposite to the input voltage, there will be no signal at the grid of the phase-splitter. If the loud speaker diaphragm chooses to oscillate at its own natural free-wheeling frequency, it will generate a voltage across the voice-coil and the output winding; the balance at the grid will be disturbed, and the power tubes urged to Do Something Qiuck. I'm using a pair of 807's; if someone shot off a pistol in front of the speaker, violently driving the speaker diaphragm, the 807's might be driven clear out of the Class A region, and into the Class B region· Their job is simply to make that R1-R2 bridge balance, and stay balanced; if they have to go frantic doing it—let' em! The homeostatic circuit demands one, and only one thing—that that bridge be kept balanced.

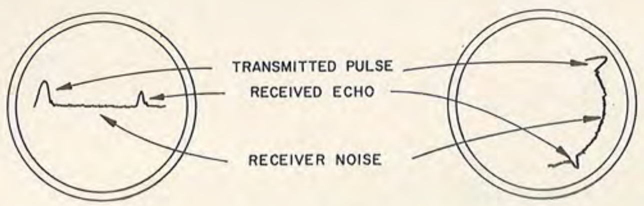
Of course, in doing that job, they will necessarily be driving the speaker diaphragm to follow exactly the variations of voltage applied to the input. The output will, then, be a faithful mechanical analog of the voltage-variation code put in at the input of our analog computer! • • •

(Note: Being audiophiles ourselves, we have conducted some experiments with the Campbell amplifier and have carried on some additional correspondence with Mr. Campbell. Our rig utilized a UTC LS-63—because it was on hand. At this point, both Mr. Campbell and ourselves discovered some interesting things. Proper impedance match for a pair of 807 tubes in Class A push-pull is 6000 ohms. With this impedance, you get maximum power transfer. But the Campbell amplifier utilizes power feedback, not voltage feedback . . . and the optimum conditions don't hold. When you go all-out for stability and control, you must sacrifice power to some extent. So we found the optimum transformer primary impedance for this circuit should be 9000 ohms or greater! Sure, we lost power, but we gained in stability!)

ED. NOTE: John W. Campbell, Jr. is probably known to some of you as the thought-provoking editor of "A s t o u n d i n g Science-fiction." Mr. Campbell was, by profession, a nuclear physicist and a graduate of MIT before he became editor of ASF. He is the author of a well-known book on atomic energy and has been responsible for much of the growth of modern science-fiction. High-fidelity audio is one of his hobbies.

RADAR and GUIDED MISSILES





by W. F. HILTZ
White Sands Proving Ground

Radar, the mysterious gadget that can probe through fog to help an airliner land or guide a missile . . . In earlier issues, we have been treated to a basic explanation of the principles of radar. How is it used with guided missiles?

The purpose of this paper will be to give a general resumé of the principles involved and the techniques used in radar and the relationship of radar to guided missile systems. In general, radars are primarily an information link in any guided missile system. This can take several forms. One, it can give continuous position information concerning the position of the target or position of the missile or both. It can also serve as a communications link between a missile in flight and a ground control system. There are several different types of radar used in guided missiles or rockets. One is the ground base radar where all the major portions of the radar are on the ground. Another is the ground-air link which is provided by a beacon located in the missile. A third is a completely missile-contained radar control system. A fourth system would be radar fuses— that is, warhead detonations that are controlled by radar devices.

In considering the development of radar to its present state, it would perhaps be important to go back to beginnings and define radar. Originally this meant radio detection and ranging. The word itself is made up of the first letters of these words. The earliest radar systems were just that—a method of detection and ranging of a target. The development of radar was based on the reflection of radio waves by objects located in the beam of the transmitting antenna. The only measurement that the first radars were capable of was a range measurement. This was accomplished by a timing system that consisted of sending out short pulses of energy at a given time rate, and starting a timed sweep on an oscilloscope at the same instant that the pulse was transmitted. Then, the received echo pulses—that is, pulses that were reflected from an object in space — were presented on this sweep as signals, and the distance in time from the start of the sweep to the presence of this return signal was then directly readable in range.

The early radar scopes had just a single sweep as would normally be seen on a standard laboratory oscilloscope with a calibrated range measurement in terms of sweep length. This, however, would only give range information and would not give any information of angular position. Therefore, the early search radars were those that had a fixed azimuth or a fixed angular position with respect to the radar over which surveillance could be accomplished. The technique of rotating an antenna and developing an oscilloscope presentation that would have a rotating sweep that would correspond to the angular position of the antenna was the next natural step. This was accomplished by rotating a magnetic deflection coil around the neck of a magnetic type oscilloscope tube, thus fixing the position of a sweep on the scope with the sweep starting from the center and extending to the edge of a circular tube to agree with the position of the antenna at this time. The agreement of the antenna position and the oscilloscope sweep was accomplished by a system of servo motors which allowed the antenna axis to position the sweep. This type of presentation is known as the PPI,

or plan position indicator. With such a device it is possible to plot the presence of echoes in the general area around the recording radar in such a way that the attack on aircraft targets can be planned by a battery control officer. Since in most tactical operations, it is desirable to look more critically at one sector of the area around the battery, it soon became feasible to use what is called a sector scan where a pie-shaped sector of the PPI scope is scanned more frequently and this sector is carefully considered. This is accomplished by using an oscillating type of motor drive which causes the antenna to oscillate over a selected sector. In many cases, this sector can be selected as any part of the circular area around the battery. A further development was the B-scope or a selected sector scan of the area under scan by the radar. This was accomplished by time gating such that a sector corresponding to a certain range could be selected and enlarged on a separate scope through a gating system that was synchronized with the transmitted pulse.

The angular accuracy that was obtainable was a direct result of high frequency radio waves that approached closely enough to the optical spectrum for the application of optical principles. This allowed the development of parabolic antennae which used directly the principles of focusing that had already been developed for optical sources. In these systems the electrical energy was introduced at the focal point of the parabolic section and focused by the parabolic section into a shape that was desired. These shapes took many forms to accomplish several purposes. For example, a search radar that was searching for enemy aircraft would most logically utilize a very narrow beam in azimuth so that angular direction could be determined to a high order of accuracy, but with a large beam in evaluation so that aircraft approaching at various altitudes could be detected, without changing the elevation position of the antenna. Of course, the development of associated components to make it possible to use these high frequency radio waves also contributed greatly to this development. This included the development of radar detection crystals, the klystron and magnetron development, development of TR gas switching tubes, waveguide and waveguide transmission techniques. A whole new set of components were necessary for operation at these very high frequencies that had never been explored previously.

Once it was possible to obtain the information about the location of targets from search type radar, it became desirable to develop a system that would continuously indicate the position of a single target in such a way that a weapon could be directed against this particular target. This type of radar became known as the fire control radar. This was made possible by using a parabolic dish antenna with a feed that would rotate around the focal point of this parabolic dish in such a way that it would describe a small circle. This would result then in a circular pattern in space performed by each rotation of the antenna feed. Then, if the power of this antenna beam varied from a maximum to a given point below maximum, the position of the target in the center of this circle could be detected by an equal amplitude of return signal from all positions of antenna feed. If there were differences at 180° points, the information would be unequal and an error signal could then be fed into a servo mechanism which would drive the antenna in the direction indicated by the error signal. In such a fire control system, one of the basic principles indicates that one and only, one target must be measured for position information. Otherwise the radar would be confused by several different error signals of several different directions. To accomplish this, the area in which the target was positioned would be gated by a time gating arrangement called range gating. This system would gate out all other signals and allow only those signals in the area being tracked to be fed through the receiving system of the radar. Several systems of gating were developed, some included wide gates and subsequent narrow gates, and even in some cases, narrow, narrow gates which are known as N-square gates. In the transmission portion of a radar, high voltage modulators were required to supply high voltage pulses in the order of thousands of volts for short time durations. To accomplish this, a spark-gap technique was used in early radars whereby the duration of a short-time spark gap would determine the length of a pulse that would be utilized. To replace the spark gap, high voltage hydrogen thyratrons were developed that were capable of delivering short-time duration pulses of several thousand volts. These thyratrons had the characteristic of being capable of firing when the proper trigger pulse of low voltage was impressed upon the grid causing a breakdown or ionization of the gas between cathode and plate of the high voltage and returning in a short-time duration to this steady condition. This high voltage pulse thus produced either from the spark gap or from a hydrogen thyratron was impressed upon a magneteron in such a way as to cause high frequency oscillations in the specially constructed iris of these tubes. This high frequency oscillation was then transmitted as a short burst of energy at high frequencies to the antenna feed and on out as energy transmitted into space.

Since the energy reflected from a target in space is necessarily of very low power, the receivers used in radars had to be of a very sensitive nature. Because of this, it was necessary to protect the receiver from the transmitted pulse if a common antenna system must be used for both transmitter and receiver. This was accomplished by the use of gas switching tubes which would break down and provide a short circuit across the input of the receiver when the transmitted pulse was impressed across it. It would recover shortly after this time and the short circuit would be removed from the receiver at all other times. This resulted then in the possibility of the use of a common antenna for both transmitter and receiver and reduction of a great deal of mechanical equipment. To provide a super-

RADAR and GUIDED MISSILES

(Continued from page 25)

hetrodyne type of receiver for radar equipments, klystron tubes were developed that would oscillate at the frequencies used in various radar equipments. The incoming signal was impressed across a detector crystal and mixed at this point with the local oscillator frequency supplied by the klystron and the resultant frequency usually in the order of 30 to 60 megacycles was taken as the IF frequency and amplified with conventional type amplifier circuits, and eventually brought down to video frequencies by a second detector device and impressed as a signal on the display scope previously discussed. To maintain a proper IF frequency, it was necessary in many cases to have AFC or automatic frequency control. This type of circuitry is usually of the type that samples a small amount of the transmitter frequency through a directional coupler and compares this with the frequency of the local oscillator. When the difference between the transmitted frequency and the local oscillator is greater or less than the desired IF frequency, a servo mechanism is given an error signal to correct the tuning of the local oscillator. This results in a constant IF frequency and a more convenient setting of gains and other components of the circuitry in the IF circuit. To maintain a constant signal level, so that various types of measurements can be properly controlled, AGC (automatic gain control) circuits are used. These circuits are similar in nature to the automatic volume control used in a normal house receiver and simply monitored the amplitude of the signal at some given point and fed a bias voltage to the grids of several tubes that was proportional to the signal level of the input.

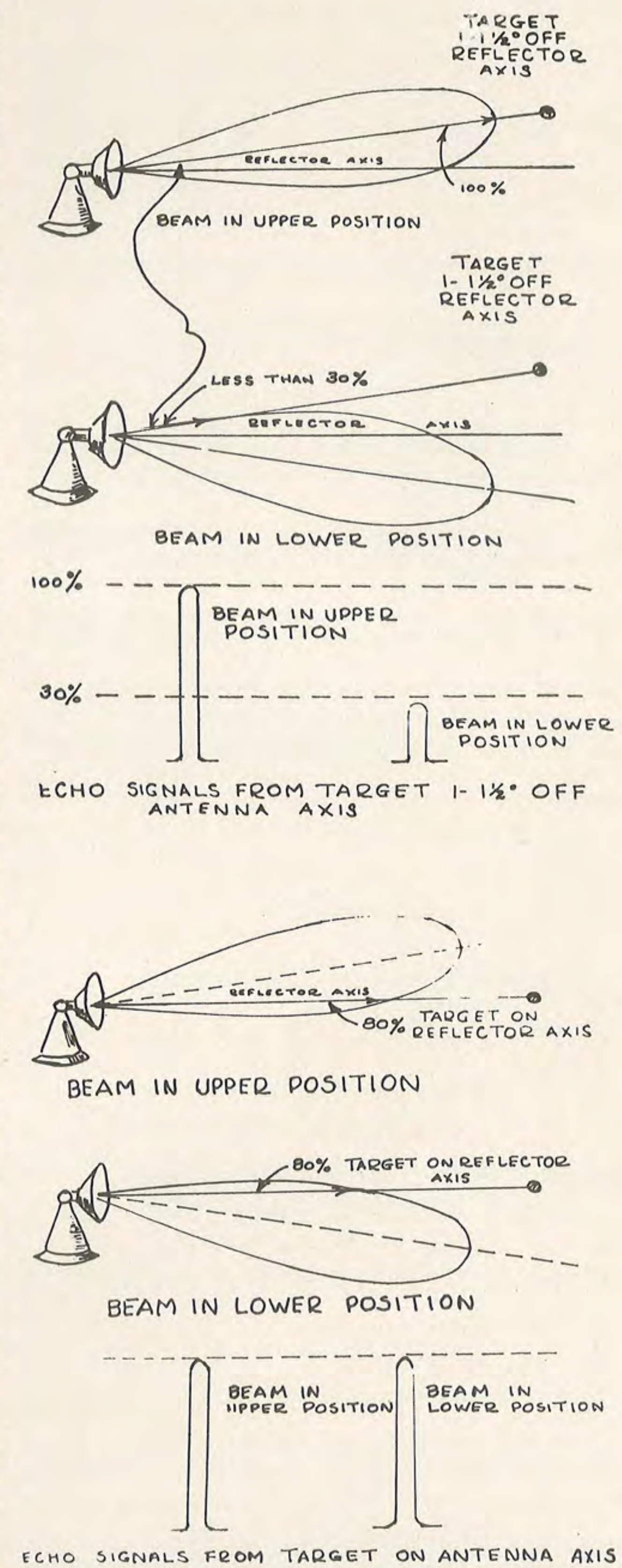
A common term in radar is signal to noise ratio. This is similar to the same use of the term in other cases where noise is a factor. As used in radar, the signal to noise ratio means the ratio between the height of a signal as compared to the height of the background noise level.

Several types of tracking were developed for use with fire control radars. One was manual tracking where the operator detected the position differences or the errors in pointing of the radar as shown by the return signal and fed corrections into a servo drive mechanism to correct the position of the antenna. Another was aided manual tracking in which a rate generator was used to generate a rate that compared to the rate of target movement and as long as the target continued to move at this rate, servo mechanism would be driven at the proper rate and the errors would be kept at a minimum, and the third was automatic tracking in which the errors were detected by automatic circuitry and fed in as errors to a servo mechanism which would automatically position the target. The accuracy of tracking with a fire control radar of this type is subject to errors from many sources. One, of course, is the size of the beam and the accuracy of the positioning information available to the radar. Another is the amount of change in the reflecting surface of the target being tracked. Thus, an aircraft that is constantly varying position with respect to the radar would present a constantly varying position with respect to the radar, would present a constantly varying target that would result in an amplitude fluctuation of the return signal and therefore an erroneous indication of the true position.

The primary use of position information as obtained from fire control radars is, of course, as its name implies, to position a gun or weapon launching device so that the weapon will intercept the target at some optimum point. This is done by the utilization of data transmission system which provides position information to a computer which in turn computes the intercept point and positions the gun or launching device for the proper intercept point. In most systems, the information obtained from the radar is in the form of range information, angles of elevation and azimuth. These bits of information are fed to sine and cosine potentiometers which are positioned by the shafts of the antenna and yield rectangular coordinate data in three dimensions (x, y and h) to the computer. The fire control computers mostly operate on this rectangular coordinate information and transmit orders to gun or launchers in this form. This rectanuglar information can also be transmitted by various means to other locations where a total picture of an entire area can be plotted on the plotting boards. Several special data transmission systems have been developed that transform the analog data of the data transmission outputs into digital form and transmit these in the form of digits represented by bursts of frequencies to another location. This provides central command information. Another use for this type of information is to transmit the position indicated from one radar to another at a remote site, and, with the introduction of paralex to compensate for the difference in position of these radars, the second radar can then be positioned on the same target. A still further use of this information would be the tracking of a designated target which is carrying a beacon for the purpose of indicating its position definitely to a radar. In this case, the transmission from the radar would be in the form of a code which can be accomplished by a series of pulses or by several other means which corresponds to a gate system in the beacon, such that the beacon will only accept signals that are properly coded, and the return from this is then plotted on a plotting board at the radar site and the position of the selected target can be followed.

By the proper utilization of these techniques then, it is possible to transmit commands to a missile to correct the trajectory path of the missile while in flight. This could be accomplished by putting a beacon in the missile and tracking this with a fire control radar, which would constantly monitor the position of this missile and compute corrections which should be made in its trajectory, transmit these in a pre-

(Continued on next page)



RADAR and GUIDED MISSILES

(Continued from page 27)

determined code such that the information can be carried from the ground and resulting in correction of the missile's position or direction. There are several basic guidance systems that can be used utilizing radar —to mention a few, there is the command system, the beam rider system, the active seeker system, the semi-active seeker system, plotted trajectory system, or the crossed beam system. An attempt will be made to explain briefly the fundamentals of each of these systems. In a command system, two fire control radars are utilized. These are usually designated as target tracking radar and missile tracking radar. The target tracking radar tracks the target constantly indicating the target position. The missile tracking radar tracks the beacon in the missile and constantly indicates its position, also to a fire control computer. The fire control computer then computes the correction in trajectory of the missile required for a proper intercept with the target. This is a constantly changing trajectory, constantly corrected to position the missile for a proper intercept as the target maneuvers or other factors affect the tactical situation. This requires a code device that will be transmitted from the missile tracking radar to the beacon in the airborne missile. The beacon circuitry then detects the orders transmitted from the missile tracking radar and translates these into terms of servo commands which position the directing fin surfaces to properly correct the trajectory.

In a beam rider system, a fire control radar tracks the target and the missile is launched in such a way that it will be in a position, at some point in its trajectory, within the beam of the radar. The beam is coded in such a way that it will provide an orientation for the missile in space, and radar receiving equipment carried in the missile detects its position and directs the missile toward the center of the beam, causing the missile to ride the beam directly to the target.

An active seeker type of missile system utilizing radar would have mounted in the missile a target tracking radar which would detect and constantly monitor the position of the target with respect to the missile and direct the missile, through servo mechanism devices, toward the target.

In the semi-active seeker type of missile, a ground-based target tracking radar tracks the target. The missile has radar receiving equipment mounted within it, and this receiving equipment detects the reflected signal provided by the target tracking radar tracking the target, and the missile is directed by this radar receiving equipment in the direction of the energy that it is detecting.

In a plotted trajectory type of guided missile system, the trajectory to a fixed target is plotted before launching time, and the desirable ballistic characteristics are calculated. The missile has mounted in it a radar tracking beacon which indicates the position of the missile to a fire control radar on the ground and receives from this fire control radar corrections which will keep the missile close to the pre-determined trajectory. This system also utilizes some sort of device to cut off propulsion at a desirable point such that if the missile continues from that point in free flight it will intercept the target point.

In a crossed beam (or hyperbolic) guidance system, two radars or other radiating devices transmit from predetermined points such that their beams will intersect along the desired flight path. This point of intersection is then detected by a radar detecting device or receiving device in the missile and the missile is positioned to arrive at the selected target point.

All of the systems described here have advantages and disadvantages. The accuracy requirements in some cases are severe; in other cases, the amount of equipment expended by the missile on each firing is expensive and a definite limit to the precision and type of equipment that can be used. In other cases, the systems are susceptible to various types of countermeasures. All of these things must be carefully considered in the selection and design of a guided missile guidance system. However, in practically all cases of present guided missile systems, radar has been, and seems to continue to be, the basic guidance tool that is available. Therefore, it is of interest and importance to all people who are definitely interested in guided missiles and the future of jet propulsion.

It is expected, however, that the limitations that are presently apparent in radar systems will soon limit the feasibility of the utilization of radar as a guiding device and that other systems must supplement or replace the present radar guidance systems that are being used. It is quite possible that astronavigation or completely inertial guidance systems can be developed that will replace the radar systems that are presently in use, and will not have the severe limitations that are presently limiting the guidance of missiles with the use of radar.

The systems described here are all of the pulse type radar systems. However, a great deal of development has been accomplished on CW or Doppler type radars. These radars operate on the Doppler principle which results in a frequency difference between transmitted and received signal which can be measured directly as velocity with respect to the transmitting and reception points which is a measure of type of position. This type of radar has some distinct advantages over pulse type radars and a great deal of development work is being conducted in this direction. Such types of radars have been used successfully to determine velocities of moving objects and have had a definite place in the instrumentation of guided missiles at various proving grounds. • • •

MISfires . . .

Contest Winner—

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Rare Birds of the American Southwest

Compiled by
R. K. AUDOBURNE

AMERICAN LOON: **Perpetueis Buzza.**

Field Marks Over 25 feet from nose to tail with a maximum body diameter of 33 inches. The low wings extend out about 10 feet on each side of the body. This bird does not use an ordinary method of flight but propels itself through the air by a pipe-like arrangement mounted on its back near the tail. Coloring patterns are varied but a bright yellow body with red-white stripes on the wings and tail is frequently seen.

Similar Species: The American Loon is a direct descendant of the European Loon, (common name Vee-Wun) that appeared in great numbers along the Atlantic coast of France and England during the middle 1940's. U. S. and British fighting birds made quite a sport of flying along beside these European birds and disturbing their flight by brushing wings with them. This and the wanton destruction of these birds led to the disappearance of this species from the European Atlantic coast. A more distant relative is Schmidt's Jet Piper, a central European bird.

Range: The American Loon appeared in the U. S. soon after a number of the European species were captured in England. The bird has been observed over a wide area, even far out at sea. For some time there was a large nesting place near Ft. Bliss, Texas and there the antics of these birds provided many of our soldiers with hours of entertainment.

Comments: As with most members of the Loon family this bird is awkward on the ground and has difficulty getting into the air. The European Loon used a catapult device to assist it during the take-off period whereas the American Loon gets the help of a smaller bird called "Booster". However once in the air the bird is capable of flying over distances greater than 150 miles. It flies at the low altitude of 4,000 ft. and at a speed less than mach one. In recent years the species became more and more rare until today an observer is extremely fortunate to see one in the air.

Other Names: Vee-Wun, Buzz Bomb.

POST-SHOOT CONFERENCE

With this issue, we are saying goodbye to a lot of our old friends and fellow members of the NM-WT Section. Many of them were on the staff of "Missile Away!" or had contributed to the growth of the publication. There are many reasons why we hate to see these persons go, aside from the loss to the NM-WT Section. The Rocket Capitol of the World is losing some of the best men in the United States.

Both of our past presidents are now gone, Ed Francisco to Los Angeles to set up Potter Aeronautics there, and Frank Koen to the technical staff of the Ramo-Woldridge Corporation. Charley Little is now with RCA, R. R. Powell with Bendix, and Charley McKinster with Chrysler in California. And, of course, the General Electric boys have been gone since December.

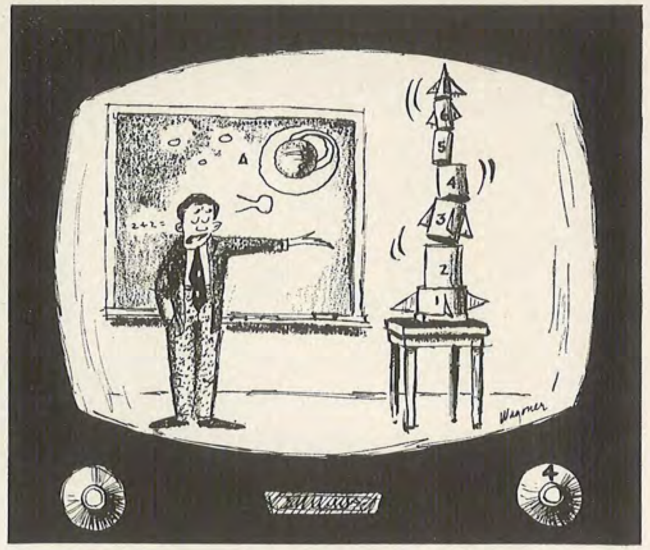
It does not seem enough to say that we will sorely miss all these men, including some we didn't mention. It leaves a big, deep vacuum everywhere. But we can say with all sincerity, "Good luck, boys! We'll never forget you, and we hope you won't forget the days you spent in the Rocket Capitol of the World!"

Program Chairman Lou Stecher has lined up an enticing series of monthly Section meetings for the near future. At the closed meeting of 31 March, we heard Herbert L. Karsch tell us about the uncovering of German missile projects on the special ordnance task force into Germany in 1945 and then discuss the first firings of the V-2's at White Sands Proving Ground back in the "early days".

Coming up on 28 April at a closed meeting for members and guests will be a talk on the White Sands integrated rocket and missile range. Following that in May will be another closed meeting during which "Missile Away!" will be the theme; many of you receive this magazine not knowing of the policies, goals, and methods we use to get it out, so this meeting should turn out to be one of interest to all.

A tentative dinner meeting has been scheduled in El Paso for June with no speaker announced as yet. The rest of the schedule, according to Lou Stecher, runs something like this: July, open meeting in Las Cruces; August, closed meeting in Las Cruces; September, closed meeting in Las Cruces; October, dinner meeting in El Paso; November, open meeting, place not scheduled; December, final dinner meeting in Las Cruces.

It looks like a fine schedule thus far.



"Und here ve haf mine latest design . . . "

The Holloman-Alamogordo Region of the Section has been hearing some interesting speakers at its meetings. Dr. Eber of Holloman Air Development Center has talked on atmospheric re-entry problems of an orbital vehicle, and Dr. Hubertus Strughold of the Air Force's School of Aviation Medicine at Randolph Field lectured on the ecosphere of the sun.

When asked about the possible guidance systems that might be used in an intercontinental missile, a missile engineer was rumored to have replied, "Use the simplest, most reliable guidance system we've got—a man."

The Air Force has now officially released photographs and a description of the air-to-air missile, the "Falcon", built by Hughes Aircraft. There were also announcements concerning the air-to-surface missile, the Rascal, and the intercontinental missiles Snark, Navajo, and Atlas.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