The OBSERVER

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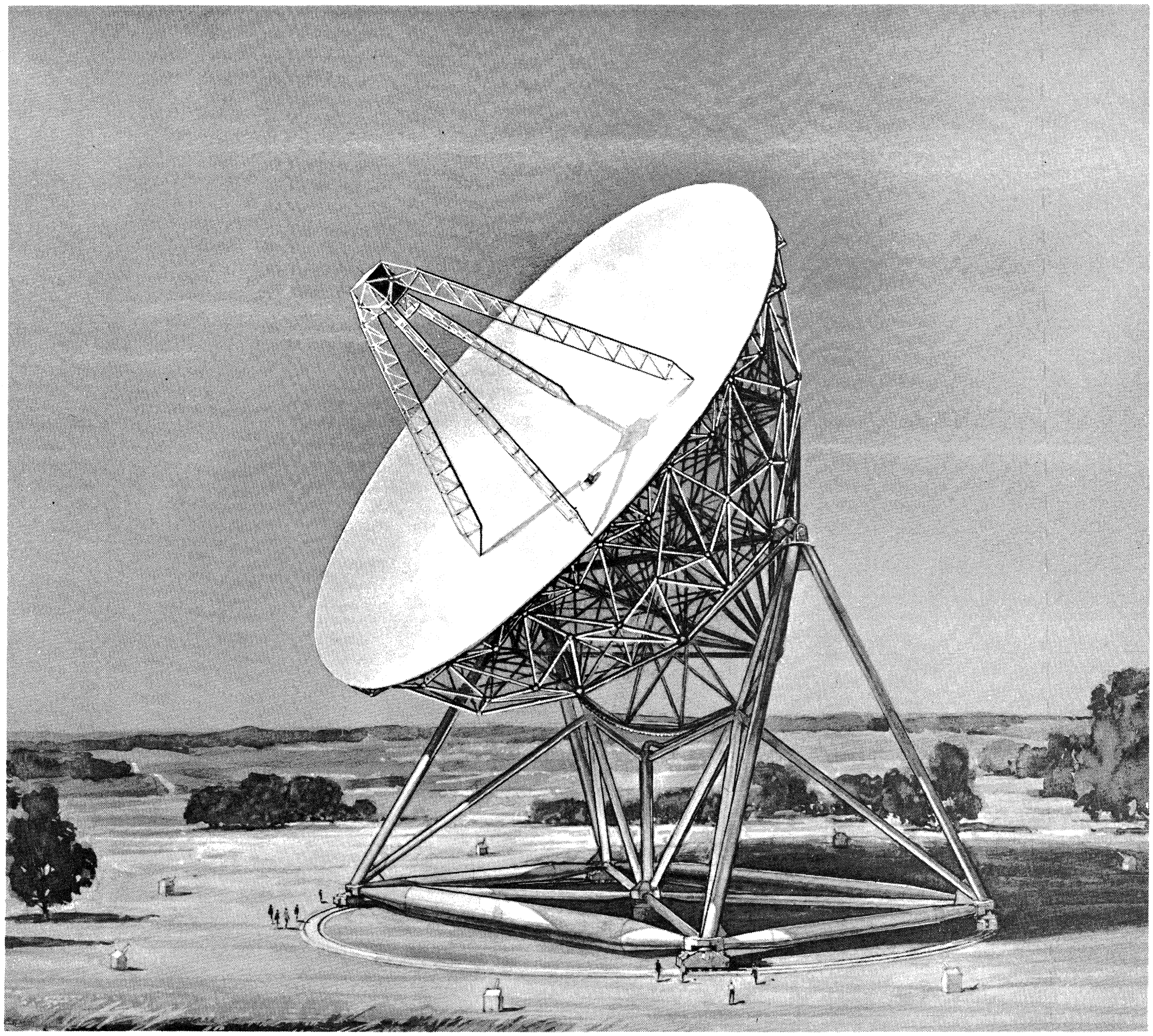

A 65-METER TELESCOPE FOR MILLIMETER WAVES

(Story on Page 3)

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A special thanks to all of those who helped assemble the OBSERVER.

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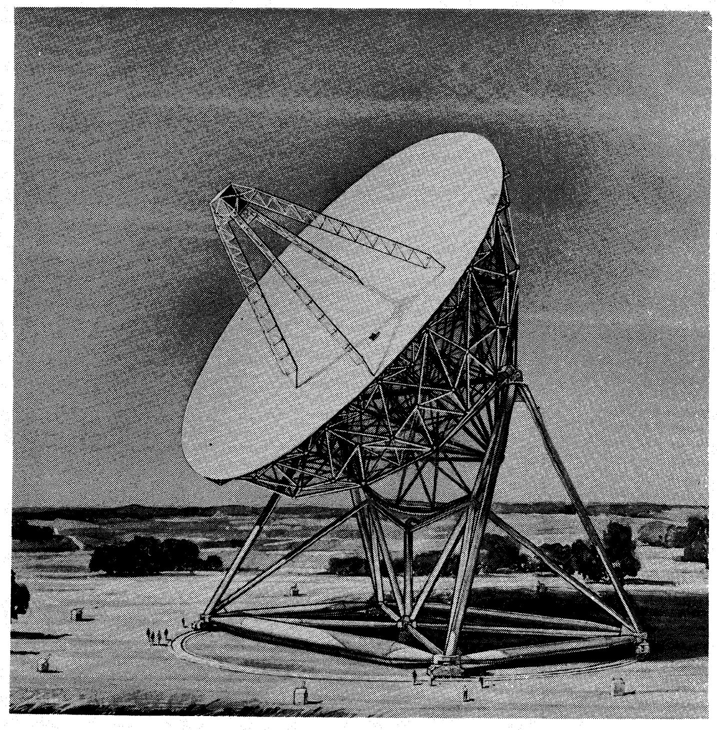
A 65-METER RADIO TELESCOPE FOR MILLIMETER WAVES

J. W. Findlay



We have recently finished the first stage of the design of a new, large, fully-steerable radio telescope. It is to be 65 m, 213 ft in diameter, and it is intended to work down to short millimeter wavelengths. By we I mean a design group from the Observatory; I will not list all the members, but the main work has been in the hands of Dr. von Hoerner, W. G. Horne, W. Y. Wong, C. Yang, and V. Herrero. Otto Heine from California has worked very closely with the group as a consultant. The last 2-1/2 years work has grown out of an earlier design study made for a 300-ft telescope. We realized that the success of the 36-ft telescope on Kitt Peak made it necessary for us to try to get a good instrument capable of working down to about 3.5 mm. We therefore set ourselves the task of designing the telescope to the following specifications:

Dish diameter	:	65 m (213 ft)
Mounting	:	Altitude - Azimuth
Sky Cover	:	Complete--but no tracking inside a small zone near zenith
*RMS surface accuracy	:	0.22 mm (0.009 inches)
*Short wavelength limit	:	3.5 mm (86 GHz)
*Tracking accuracy	:	3 arc seconds RMS
Slew rates (both axes)	:	20° per minute
Optics	:	Prime focus f/D = 0.43 Cassegrain--subreflector diameter 3.7 m (12 feet)
Instrument cabins	:	Behind prime focus; behind Cassegrain focus
Equipment room	:	Rotates in azimuth

*This performance is only possible under benign environmental conditions.

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These specifications, of course, are remarkable in that we are suggesting that a large telescope can be built to work in the open air at a wavelength of 3.5 mm. For reference one might remember that the original design specification for the 140-ft telescope was that it should work at 3 cm, though, of course, it has in fact been successfully used at wavelengths as short as about 1 cm. To go to this short wavelength limit requires that we understand the structural deflections of the telescope and that these are so managed that they do not impair the performance of the instrument. The principle of homology which Dr. von Hoerner first stated allows us to do this. What we have done is to design the structure that supports the reflector in such a way that as the dish is tilted, although the structure bends, the surface remains parabolic in shape. The focal length of the parabola may change somewhat and so may the direction of its axis. These two effects need not impair the performance of the instrument.

But in addition to the use of homology for managing the gravitational deflections of the telescope, it is essential that we understand how the instrument will be affected by the wind and temperature on the site where it will eventually work. This is more a matter of analysis and understanding than of design, although we have tried in the design to reduce as much as we can the effects of wind in destroying both the pointing accuracy and the surface accuracy of the telescope, and also the effects of temperature, and particularly temperature differences, in distorting the telescope structure. We believe that the telescope we have designed will operate at its short wavelength limit on clear nights when the wind is below about 18 mph. When the sun shines on the telescope, we expect the resulting temperature differences to degrade its performance so that it may only work at wavelengths longer than 1 cm. Thus, the telescope will always be a large, valuable radio telescope, but it will only do its best and most precise work under nighttime conditions when the wind is not blowing too hard.

The Scientific Uses of the Telescope

Despite the work done with the 36-ft, the wavelength region below 1 or 2 cm has been only studied in a very preliminary way. The main task of the new telescope would be to explore the properties of many radio sources in this region of the spectrum. Of course, one of the most obvious tasks that one can see at present is to extend the observations of spectral lines, particularly the spectral lines coming from more complicated molecules, to a large number of sources and almost certainly to a large number of new lines. Already about 40 spectral lines of many molecules have been observed between the frequency range of 20 GHz up to 115 GHz. Quite conservative estimates suggest that many more lines of those molecules already observed and many lines of new molecules will be found in this frequency range.

The astronomical interests in these lines are great. But so, also, is the hope of finding more complex organic molecules which are often popularly referred to as indicators of the way in which life has formed in our own galaxy. Of course, in addition to the line studies, all radio observations in the continuum need to be made in much greater depth and detail in this new spectral region. Quasars show their greatest variability at very short wavelengths. The new radio stars which have been detected with the Green Bank interferometer will be observed and others may be found in the millimeter-wave part of the spectrum. The study of the sun, the moon, and the planets is all a region where a large millimeter-wave telescope can be expected to make new discoveries. The telescope can also be thought of as one end of possible interferometer or VLB experiments. And, of course, by the time it is built, radio astronomy will have almost certainly turned up new problems, the details of which we cannot at present see.

The Design of the Telescope

We have already said that the telescope will incorporate the principles of homology in its structural design. Although this sounds as though it might lead to an unusual sort of structure, the two diagrams (Figures 1 and 2, page 5) show as outline drawings, that the 65-m telescope in concept does not appear to be very different to other large radio telescopes. It is a wheel and track

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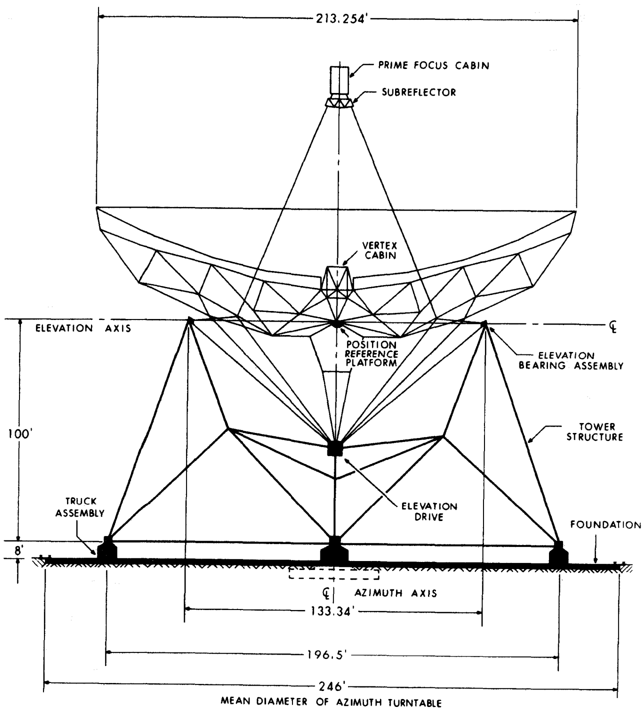

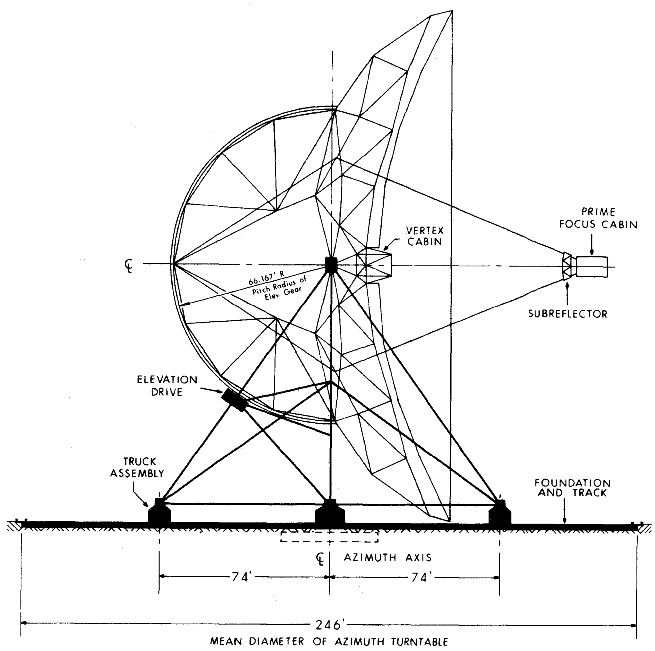

Figures 1 and 2 - Outline drawings of the telescope shown pointing to the zenith and to the horizon. (The trucks do run on the azimuth rails; it so happens that both these views look either end-on or side-on to the rectangular telescope base.)

design where the dish is supported on a tower which in turn rotates in azimuth on wheels rolling on railway track. This basic design is one where it is fairly easy to obtain the necessary stiffness and strength for the supporting structure at not too great a cost. Although it is obvious to emphasize the importance of the perfection of the reflector surface of a large telescope, it is also necessary to be sure that not only the telescope surface is good, but that the whole instrument can be pointed accurately enough to meet the demands placed on it.

The half-power beam width of this telescope at 3.5 mm wavelength will be about 15 seconds of arc. It is therefore necessary to be able to point the instrument so that we know where the radio beam is in the sky to an accuracy of about 3 seconds of arc. Many factors enter into the solution of this pointing problem, and here we will refer only to one which leads to a rather novel aspect of the new telescope. Normally, the direction in which radio telescopes are pointed is found by mounting precise encoders on the axes of rotation of the instrument. It is more desirable to measure where a telescope is pointing by making angular position measurements at the point where the azimuth and elevation axes intersect. In the present instrument we plan to mount a stable reference platform at this axis intersection and to measure the elevation and azimuth feed directions with respect to this platform. These measurements will be made with very precise but essentially conventional encoders. The trick is, of course, to maintain such a reference platform stable in position in space. This we plan to do by essentially locking the platform position onto the direction of light beams transmitted from a number of stable autocollimators mounted on the ground around the telescope. (See Figure 3, page 6.)

The indications on these autocollimators, the light from each of which is reflected back from a seven-sided mirror on the refer-

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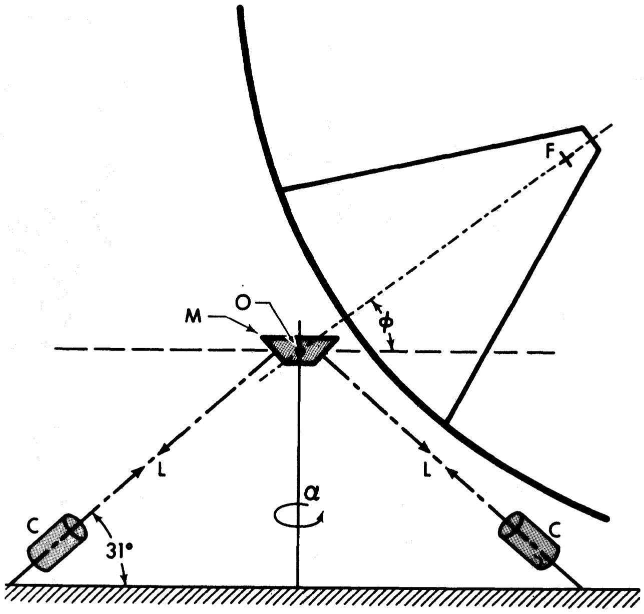
ence platform, will be used to control, by servo loops, the orientation of the platform to remain fixed in space. Tests of this system were run at Green Bank about a year ago by using a single autocollimator and a simulated mirror system mounted on the deck of the 140-foot telescope, and these measurements showed that the system would work to a precision of about 1 arc second.



The principle of the stable reference platform. The platform is at O, where elevation and azimuth axes intersect. M is a 7-sided mirror and CC are 2 of 7 autocollimators. M is locked onto the light beams LL, and the elevation and azimuth angles ϕ and α are measured with respect to M.

Now let us turn to the problems of the reflector surface itself. Two main difficulties have to be overcome. First, a method has to be found by which surface plates can be manufactured to a smoothness of about 2.5 thousandths of an inch. The second difficult task is to devise a means by which such surface plates can be mounted and adjusted on the surface of the final telescope so that the total surface error still lies at about 9 thousandths of an inch. These two problems are so important that two solutions have been found for each of the problems. Dr. von Hoerner developed at Green Bank the first method by which the plates could be made to the required accuracy. The photographs (Figure 4a and 4b, next column)

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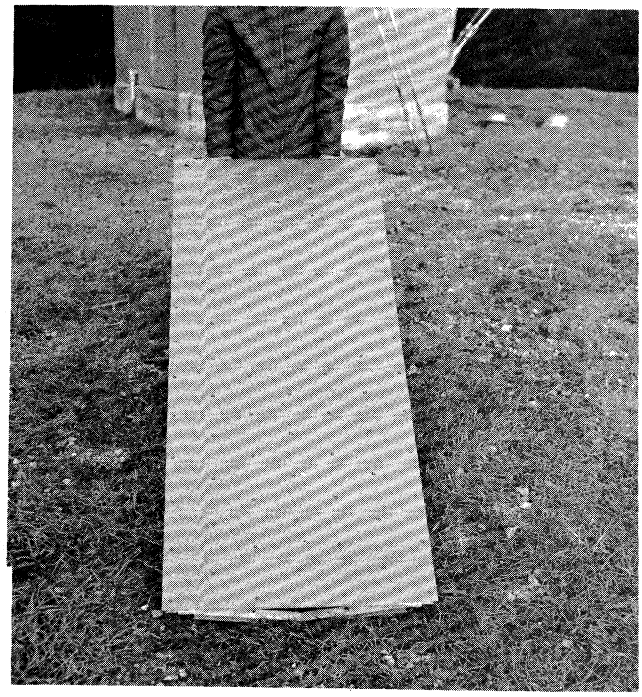

Figure 4a.

Figure 4b.

Two photographs of the von Hoerner surface plate, designed, built, and tested at Green Bank. (The arms in one picture belong to S. Smith.)

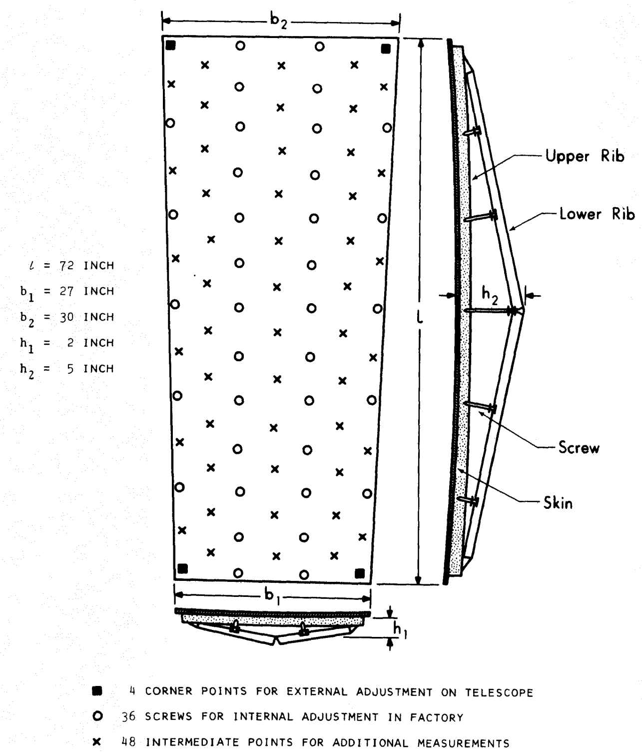

Figure 5 - The von Hoerner surface plate. The sheet aluminum skin, originally flat, is pulled against the rib structure by 36 adjustment screws which are finally cemented to lock them.

and diagram (Figure 5, above) maintain it even after a man has walked backwards and forwards over the reflector surface. The second method by which the plates might be made has been developed by the Philco-Ford Corporation and essentially makes each plate first by making an aluminum casting which produces in rough form both the surface plate and its supporting backup structure. Next, this casting is machined on a numerically controlled machine to the required surface accuracy. We believe both these methods will work, and the one finally to be used will be chosen when the final design of the telescope is complete.

To measure the surface plates on the telescope, the use is suggested first of a high-quality steel tape to measure the distance to a target point on the surface and then, second, to measure the angular position of this target using the known angle by which a quartz pentaprism reflects a ray of light. This method is different in detail from the one presently used for the 140-ft telescope but in principle it is essentailly the same.

A second possible method for measuring the surface is to rely entirely on range measurements. To prove that such a method would work, a distance measuring equipment has been developed at Green Bank which can measure distances up to 60 meters to an accuracy of better than 0.1 millimeters. This instrument has been the work of John Payne and, in a prototype form, it has been quite extensively tested. Such an instrument could be used to set the surface of the 65-m telescope by making two range measurements, both starting from the dish vertex; one going directly to a target and the other going to the target position via a reflector placed near the telescope focal point. This technique is very attractive because it is capable of being completely automated. The reading time for a single target could be only a few seconds and very many targets could be measured and the measurements recorded in digital form in a relatively short time.

Estimates of Cost

There are, of course, two main reasons for carrying out a quite detailed design study of this kind. The first is to determine that the instrument that is being designed can be built and will in fact perform as well as the design suggests. The second, and very important result of such a study, is to say what it would cost to build the telescope. Therefore, in making cost estimates we have used a variety of sources of information and have done our best to check one against the other and all against our own estimates. We will not give the details of the cost estimate here, but only the final result. We believe that the cost of the telescope complete on a reasonable site, but not including the costs of radiometers and electronics used for observation, would be in 1972 dollars about $9.4 million.

We have also estimated that such a new telescope would need a staff associated with it of about 26 people, and that if it came into use in the Observatory it would require about half a million dollars more in operating funds per year to keep it going. It might be worth noting that when we say "operating funds" we do not include the additional cost which would be required to provide it with the up-to-date electronics

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through the years and that this sum might be as high as a further quarter of a million dollars annually. We have also estimated that from the time at which we knew we were going to be funded for such a telescope to the time when it first started observations would be about three years.

Telescope Sites

The site on which such a telescope would be built has not been decided. However, it does seem clear, although perhaps unfortunate, that such a telescope should not be built on the Green Bank site. This fact arises almost entirely from the need for a clear atmosphere, as free from clouds as possible, for as large a part of the year as possible. Green Bank has on the average, measured over many years, about 80 cloud-free days per year. Good sites in the southwest of the United States can run as high as 260 cloud-free days per year. This shows that such a telescope, to be free from clouds, should be located somewhere in the southwest. A second important atmospheric factor is that for millimeter-wave observations the atmosphere should be as dry as possible. Again, although there are some very dry and very cold nights in Green Bank, on the average low water vapor in the atmosphere can be found for a much larger part of the year if one searches for high sites in the arid southwest.

Many sites have been surveyed and studies made of them for this telescope. And although no decisions have been arrived at, a very possible location would be to associate it with the Very Large Array on the site near Socorro in New Mexico.

Conclusion

The work of this design group has now been written into a report, and this report is going for its final printing. We hope that it will be possible fairly soon, to get the necessary funding for a telescope of this kind, but we can even now look ahead already far enough into the way in which funds can come from the Federal Government via the Science Foundation, and it seems clear that there must be a waiting period of at least two years before we could make the first move in building this telescope.

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POCAHONTAS COUNTY - SOME PLACES TO VISIT*

Cranberry Glades and Cranberry Visitor Center - On Route 39, south of Marlinton

Hills Creek Falls - off Route 39, a few miles south of Cranberry Visitors Center

Droop Mountain Battlefield State Park - Route 219, south of Hillsboro

Gaudineer Scenic Area - off Route 250 on Cheat Mountain

Bear Town - off Route 219 on Droop Mountain

Watoga State Park - 10 miles from Huntersville. West Virginia's largest state park

Seneca State Forest - 5 miles south of Dunmore, on Route 28.

Pearl Buck's Homeplace - on Route 219 at Hillsboro

Edray Fish Hatchery - near Marlinton on Route 29

Cass Scenic Railroad - 2-1/2 miles south of the Observatory on Route 28--turn right and follow the signs

Recreational sites for camping and picnicing - Bird Run - east of Frost on Route 28; Old House Run - east of Bartow on Route 250 Pocahontas - east of Minnehaha Springs on Route 92

*Adapted from 1970 article by Jane Chestnut

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POCAHONTAS 'ROOMY'

Pocahontas County, third largest in West Virginia in area, is the least crowded. Only 9.4 people inhabit every square mile of Pocahontas County. Pendleton County is second with 10 people per square mile.

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SAVE YOUR STALE BEER

The Ole Dirt Dobber

For years I have been plagued by the garden slug whose ravishing appetite for garden plants is incredible. He looks like a snail without a shell and feeds at night on foliage and fruit. He moves slowly and leaves a trail of slimy-like material. He is a real pest--no...I mean a real menace in the garden.

In the spring he eats tiny plants as soon as they emerge from the ground. One may wonder why his lettuce or kale didn't come up. It's probably because Mr. Slug did away with them. Plant leaves of all sizes are chewed by him. Telltale evidence of Mr. Slug are chewed leaf ends, holes in the leaves, and his slimy-like trail. He is a lovely sight gourging himself on a tomato or a ripe apple that has fallen from the tree. The truth is he is sickening. He soon becomes a challenge to eradicate. But that's where the fun begins. Trying to find something effective to use that will do away with him. Special slug baits containing poison have been formulated and sold. They work to a degree if you hide it under rocks, wood, dead leaves, etc. (slugs hide under these things during daylight). This takes a lot of effort and the slug bait loses its effectiveness when wet. Wood ashes, sawdust, lime, and sharp sand placed in rings around plants are supposed to stop him. They do until they are rained on or become damp. Salt is effective--sprinkle some salt on him and he immediately begins to dissolve. But who wants to run around with a salt shaker sprinkling salt on slugs? A water solution of salt works too, except it burns the leaves of plants like lettuce. Too much salt will kill the plant. So over a period of years I was trying everything and anything that was suggested to rid slugs. One day I read that a fellow used stale beer to rid his garden of slugs. He placed shallow dishes of stale beer throughout the garden. Apparently slugs are lushes and are drowned while consuming the beer. I was real skeptical. I had grabbed at straws before, but I tried it. And I'll be damned if it didn't work. I put out one dish of stale beer and the next morning there were a dozen dead slugs in it. Now where do I get that supply of stale beer. Beer around our place never gets stale. What a decision! Give the beer to the slugs or drink it myself. There _must_ be a better way out.

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BROOKHAVEN'S "TUNE IN" PROGRAM

Brookhaven Lab has a program called "Tune In" that is able to provide Lab employees with answers to a large variety of questions, gripes, suggestions, and comments. Questions, gripes, suggestions, and comments are submitted on "Tune In" forms available at many locations throughout the lab.

When "Tune In" receives a letter the writer's signature and letter are numbered similiarly. The signature stub is filed in a safe place and the numbered letter is retyped and sent to someone to answer. The person answering the letter has no way of knowing who wrote the letter. It could be a department chairman or it might be someone in his own office. When the reply is received, both reply and signature stub are mailed to the writer's home address. Anonymous letters go through the same numbering process except copies go to people who might be interested--for information only.

Copies of all letters are sent to the Lab Director and Personnel Manager. All letters sent to these two people are without identification. Each letter and answer is filed in the official "Tune In" book. Once a reply is sent, there is no record kept of the identification of the writer.

While many letters and answers of general interest have been published in the "Brookhaven Bulletin" many more letters of a personal nature have been received and answered. Subjects of letters range from:

The price of on-site gas
Food prices in the cafeteria
The height of the reactor stock
Work schedules
Lab budget
Raises
Layoffs
Litter.

We think it's a great idea. How about a "Tune In" program for NRAO?

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1972 SUMMER STUDENTS

NAME	SCHOOL	YEAR	MAJOR	ASSIGNED
Thomas M. Bania	University of Virginia	1 G	Astronomy	Burton
Dennis J. Bechis	Harvard College	3 U	Astronomy	Westerhout
Mary P. Bonnell	Dartmouth	3 U	Astronomy	Verschuur
Peter C. Camana	Ohio State University	1 G	Elec. Eng.	Shalloway
John F. Chandler	M. I. T.	3 U	E & P Sci.	Buhl
Michael L. Cherry	University of Chicago	1 G	Physics	Brown
Duncan M. Chesley	Dartmouth	3 U	Physics	Fisher
Francis Chin	University of Toronto	4 U	Eng. Sci.	Backer
Vicky Diadiuk	M. I. T.	4 U	Physics	Baker
Susan Edward	Wellesley	1 U	Physics/Asty.	Rather
Vernon Fisher	West Virginia University	4 U	Elec. Eng.	Craig Moore
Thomas Gandet	Kansas University	3 U	Astronomy	Wade
David Gibson	University of Virginia	2 G	Astronomy	Wade
Daniel Grayson	University of Chicago	4 U	Mathematics	Braun
Stanley Hansen	University of Massachusetts	2 G	Astronomy	Cram
Gary Jorgensen	Seton Hall University	4 U	Physics	Fomalont
Rosemary Kennett	Nottingham University	3 U	Mathematics	Balick
Alan Lapedes	University of Virginia	3 U	Physics	Rather
Jay Lockman	University of Massachusetts	2 G	Astronomy	Mark Gordon
Linda Lucagnaui	Wellesley	4 U	Astronomy	Sramek
Stephen Maas	University of Pennsylvania	1 G	Elec. Eng.	Fleming/Brundage
Steven Peterson	Cornell University	1 G	Astronomy	Sramek
Lars Pettersson	Chalmers University	3 U	Elec. Eng.	Weinreb
Philip Stickney	University of Arizona	1 G	Astronomy	Gammon

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Michael True	Indiana University	4 U	Astrophysics	Burton
Changlin A. Wey	University of Michigan	1 G	Astronomy	Wright
Patrick Yeung	Princeton University	4 U	Physics	Brown
Alma Zook	Pomona College	4 U	Physics/Asty.	Turner

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36' RADIO TELESCOPE

Gene Wetmore

This spring our 36' dish has been very busy searching and probing our galaxy and others for those molecules we're all so uptight about. Our team was made up of various radiometers ranging in frequency from 33 GHz to 160 GHz, many wide and narrow filter banks and associated equipment, and a Honeywell 316 processor and CRT terminal to manipulate and present the data in a convenient form.

Another quite important advancement has been observations made at 11 mm. (Did you hear someone say something about 400 microns?) I'm sure Dr. John Rather and Mr. P. A. R. Ade would be tickled pink to fill you in on the particulars.

We have also been doing quite a bit of testing on our site, so far, this year. A lot of software testing and improvements have been made. Because of this, more science is being done on-line that ever before. Mr. Chuck Moore and Mrs. Elizabeth Rather have been very busy perfecting this unique and efficient on-line program.

We also have tested the dish to see if our present concept of a Cassegrain receiver on the 36' antenna is feasible. The results of these tests look very good. If Wally will let me, I'll give you a full report in our next issue on the Cassegrain system.

Thanks for listening.

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WANTED TO BUY

Used Oil Stove. 25-50 B.T.U. with thermostat and fan. Wally Oref: 456-4647 or Ext. 270.

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NRAO TO BE ON TV

In June WSWP-TV, Channel 9, Beckley, West Virginia will begin video TV taping of a program centered around the National Radio Astronomy Observatory. Camera crews are expected to be on site June 12 and remain here for the rest of that week. Unless interference problems forbid its use, WSWP-TV will use a 15-ton, 35-foot long van with full color capabilities to produce the video tape program.

No time has been set for showing this program on WSWP-TV. The program will be offered to two other West Virginia educational television stations: WMUL, Channel 13, Huntington, and WWVU, Channel 24, Morgantown. The program will also be offered to Eastern Educational Network (EEN) and WSWP-TV is considering making this program available to the Public Broadcasting Service (PBS) for inclusion on national network.

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1972 SCIENCE YOUTH CAMP

Tentative arrangements have been made for the almost 100 members of the National Youth Science Camp to visit the NRAO on July 9 for a three hour tour from 9:00 AM - 12 noon. NRAO will also provide three staff scientists to give lectures before the campers come to the NRAO.

The National Youth Science Camp is sponsored annually by the state of West Virginia for the nation's top science students - two young men from each state. The NYSC presents a unique educational and recreational program led by representatives from the academic fields, industry and government.

NRAO employees are welcome to attend lectures given at the camp.

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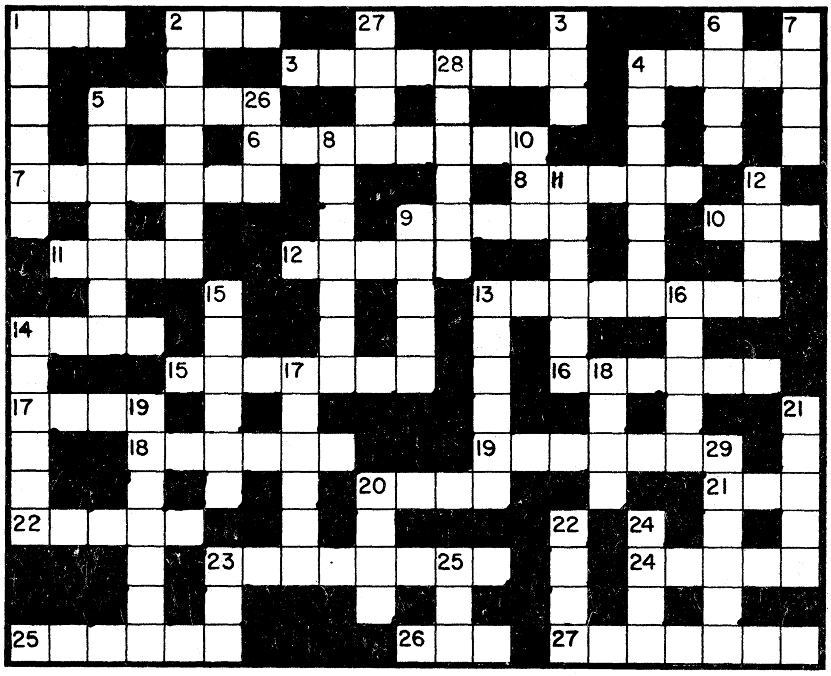
EMPLOYEE CROSSWORD



Fill in the above blanks with first names of employees or members of their families from the clues given below.

DOWN

1. what a match does
2. Mrs. mechanic
3. opposite of "play woman"
4. end of a ham
5. her dad works in the warehouse
6. Beechnut and Wrigleys
7. school teacher
8. painter's daughter
9. lives in a monastery
10. add an "e" to what a trumpet is
11. vegetable planter
12. works in the shop
13. builds things
14. may be used after the word "lock"
15. sounds the same but spelled different
16. mother of one; wife of another
17. her husband and Carol's husband have the same name
18. his wife is a "flower"
19. bus driver's wife
20. Different sex of a famous Navy movie
21. brand name of a pen
22. next to retire
23. her daughter and husband work here
24. Abe Lincoln's look-alike
25. works for Engineering Division
26. "J" fan
27. Wendell's son
28. same last name as a fictitious space hero
29. mother of Lisa, David, and Richard

ACROSS

1. short form of 28 down
2. Charlie's oldest daughter
3. Tom Carpenter's mother-in-law
4. part of a room plus a scream
5. part of your face plus associated with thumb
6. also a beach
7. guard's wife
8. he is on the road a lot
9. Herman's youngest son
10. usually associate ice with the last syllable of his name
11. opposite of less
12. two with a PhD
13. these letters unscrambled: DMNTOUHR
14. part of a window mispelled
15. opposite of "corridor woman"
16. Don's daughter
17. Queen of England
18. floor finisher
19. these letters unscrambled: AEAANMN
20. Mr. Clean
21. part of eye glasses (without s)
22. upper regions of space (according to Webster's dictionary)
23. financed Columbus but spelled with an "e"
24. etiquette authority
25. woman doctor
26. his dad has a snowmobile
27. his dad built a new home

THE SECOND SOVIET - AMERICAN
VLB EXPERIMENT - Continued

K. I. Kellermann

Summary of Previous Episodes - In the last two issues, Barry Clark described his travels with Charlie through Holland, Germany, and the U.S.S.R. During this time John Broderick and I had the much easier task of running the Green Bank end of the experiment. Following the first observing session, the plan was for Barry Clark to return to NRAO with the tapes, and John and I to go to Russia for the second part of the experiment. In the November '71 issue I described our adventures in Poland enroute to Russia.

On to Russia

In spite of not having a valid visa for the U.S.S.R., the Brodericks elected to fly with me to Moscow. Upon arriving at the Moscow airport I was quickly passed by the immigration authorities. As expected, John and Diane were asked to step aside until the rest of the passengers were cleared. Three full plane loads (and one hour) later, the immigration officer finally was free and gave John a long lecture followed by many questions. Unfortunately, this all took place in Russian, so not much was understood. Finally realizing that John's Russian was minimal, he called on his chief to intervene. The "Chief" spoke a few words of English and explained to John that his visa would not be valid for several days - a fact of which we were well aware. The "Chief" explained he was not able to do anything, but he would call his chief (we will call him "Big Chief"). Big Chief spoke a little better English and indicated to John that the situation was very grave indeed.

Meanwhile, a representative from our Astronomy colleagues arrived to greet us. His name was George, and he only spoke one word of English, "Yes". Big Chief and George disappeared into a back room for about an hour to discuss the situation of the American astronomer trying to illegally enter the country. About every 15 minutes George would come out of the room looking very concerned and indicating that things were not going well at all.

Apparently the Big Chief could not help and he finally called his chief (we will call him "Super Chief"). Now Super Chief, who was very friendly and spoke fluent English, indicated that he would allow John to illegally enter since he was such an important visitor, but added that "of course John would be in trouble if anyone asked to see his visa", which is required every time one checks into a Russian hotel. John seemed a bit concerned about this, and asked, "What will happen to me then?"

"Oh," replied Super Chief, with a sly grin, "Nothing too terrible!"

And so we were in the U.S.S.R. After taking us to our hotel, George still seemed worried about what he seemed to describe as a military invasion. Needless to say, not being able to read any Russian newspapers or understand radio or TV, we were a bit worried.

The next day the situation was explained to us in more detail, and indeed we had grounds to be worried. Apparently the Soviet Army was holding its annual war games in Crimea, and Crimea was temporarily "Off Limits" to all foreigners. When we asked if the "games" would be over in time for us to go for our scheduled experiment, we were told "Maybe yes, maybe no!"

Since most of the Soviet colleagues were already in Crimea preparing for the experiment, and those who were in Moscow were engaged full time in negotiating with the government to allow us passage to Crimea, we were left to manage on our own.

About the only serious problem we had was when trying to eat in Moscow's only Chinese restaurant, the "Peking". After standing in line for about half an hour, we were asked if we were part of a "Delegation". Knowing that delegations get preferred treatment in Russian restaurants, I said "Yes" (sometimes non-delegations get no treatment, i.e., no food), and we were immediately ushered to a large table.

Apparently Russian-Chinese restaurants are similar to American-Chinese restaurants, i.e., neither the waiters nor the food is Chinese and you must order 2 from Column A, 3 from Column B, etc.--the only difference being that the menu was in Russian. (Of

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course it could have been worse.) Our handy tourist guide gave translations for reasonable food like steak, roast beef, and even hot dogs. But try to translate WAR SHU APP into Russian! However, with the aid of a dictionary we did manage to pick out a few vaguely familiar foods and secretly made a little pencil mark on the menu beside the desired dishes. So when the waiter finally arrived to take our order we were able to quickly and impressively order our dinner. The many questions asked by the waiter were simply answered Da (Yes) or Nyet (No) at random. (A technique of proven value in Polish restaurants.)

After a wait of about 45 minutes the head waiter noticed that we had not yet received our meal and tried to assist. After chewing out our waiter for about 5 minutes she came over to our table, apoligized for the delay, and indicated that if we sat elsewhere we would be "immèdiately" served. At the new table she brought over a new waiter and new menus (without the important pencil marks) and stood by to see that our order was properly taken. We tried to explain that we had already given our order, but she made it clear that we must do it again. So we ordered at random.

One other interesting experience that describes the frustrations of a visitor to the U.S.S.R. was our encounter with a man from India near the Kremlin. In the course of conversation, we learned that he had just arrived the day before. Wondering what Indians were doing in Moscow, John asked him if he were a Communist. "I was," he replied, "until yesterday."

On to Crimea

In spite of the usual Soviet bureaucracy, it is usually the case that if you know the right people, any rule can be broken or changed. And so, in spite of the secret military activities going on, we were given permission to travel through Crimea.

On the way from the Crimean Airport to our hotel at Yalta, we had the unique opportunity to review the troops in "action". We found that nearly all of the cafes and restaurants, particularly the outdoor ones, were "occupied" by soldiers drinking beer and wine. Many of the soldiers were accompanied by one or more natives (usually female, ages 18-25).

At the Observatory we found all of the VLB equipment apparently in working order just as Barry Clark had left it. I use the word "apparently" because everything was surrounded by a rats nest of wires and cables that can best be described as the electrical equivalent of Barry's desk in CV. Nevertheless, everything seemed to work satisfactorily except for "Charlie", whom you have probably gathered from the two previous issues, was the key to the experiment. Charlie was a bit ill, or at least his power supply was, and unless one was very careful, Charlie would deliver a nasty shock. At one point Charlie actually died after a power failure. Due to the way in which Charlie's power supply was constructed, and to the way Charlie had been "fixed" so as not to electrocute people, it turned out that a momentary power interrupt of only a second or so switched Charlie permanently over to his batteries, and so when the batteries ran down, Charlie died. Fortunately we were still monitoring the Loran time signals from Turkey and also Charlie's friend from MIT was still operating, so there was no serious problem.

In contrast to the first experiment, the observations were made without any excessive difficulties other than the usual semi-intelligible phone calls to the U.S.A. Remembering the "ill health" of the American participants at the 1969 closing party, the 1971 party started out a bit more restrained with only about 6 bottles of vodka for about 30 people. But as the evening wore on, a steady flow of vodka and coñac appeared and a good time was had by all, especially John Broderick!

Return to the U.S.A.

One of our tasks at the end of the experiment was to arrange to get a crystal oscillator back to Caltech without interrupting its power, so it could not travel by usual freight, and had to be hand carried. Now this oscillator was much smaller than Charlie and much lighter. Also its battery was good for 20 hours. So no real difficulty was expected. Traveling back to Moscow, we

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stopped along the way in Kharkov for one day. Both in Moscow and Kharkov the maids kept unplugging the oscillator from the wall socket, apparently afraid that it would blow up. But fortunately, the internal batteries kept it going.

Our main task in Moscow was to arrange for all of the VLB equipment, which had come to Moscow by truck from Crimea, to be shipped to the U.S.A. After our previous experiment, all the equipment was lost in a Pan Am warehouse in New York, and there was some embarrassment when NRAO sent several telegrams to Moscow inquiring about its location. This time, to avoid further incident, John and I were told by the Russians to accompany everything out to the airfield while it was being loaded on to a IL62 jet. Having witnessed the loading and the plane's departure for the 12 hour flight to New York, there was no question that the Russians had kept their part of the deal to promptly return the equipment.

To get ahead of the story, when we returned to NRAO two weeks later the equipment was not yet there; and more nasty telegrams had been sent to Russia. This time it was located in a warehouse in New Jersey.

But to get back to Moscow. We still had to hand carry the oscillator back to the U.S. The next leg of the journey was Amsterdam, where my wife was to meet us. Recalling Barry's difficulties with the Dutch customs, I mistakenly decided to register the oscillator with customs in order to prove that I had properly brought it into Holland and so there would be no difficulty on departure.

I had to show all the usual papers--proof of purchase, proof of ownership, etc. After considerable discussion, we were told that the oscillator could enter Holland if I posted a $4,000 bond. Not having this kind of money with me, we argued that it was U.S. government property, part of the big U.S. - U.S.S.R. scientific space program, etc., but he wasn't impressed, and insisted that unless we could post $4,000 bond we had to leave the oscillator in the storage room, where we could plug it in. But the keeper of the storage room refused to let us use his electricity. Finally my wife was called upon to act as interpreter and witness to our good character, and after considerable further discussion the bond was decreased to 500 Dutch guilders (about $150). So I exchanged enough American money to post the bond, and the next round of paper work began. Finally, when everything was in order we found the 500 guilders had somehow disappeared. A thorough search of the room revealed nothing. The door was then closed, and it was announced that no one must leave the room. And of course the Dutch customs agent and I immediately suspected foul play on the part of the other. After a further search, my wife suggested that I try my shirt pocket, where somehow the money turned up, and we made a quick and silent departure with our precious oscillator.

The next day was spent in trying to arrange with Pan Am to fly our oscillator back to the U.S. But the usual problems of no power, etc., were encountered. (It turns out that 707's have 110 volts power in the freight compartment, but not 747's, and Pan Am flys only 747's between Amsterdam and New York.) So John had to carry it in the cabin on his return flight.

After reaching New York, John somehow arranged for the oscillator to be placed in the cockpit of a flight going to Los Angeles. There it was finally collected by a Caltech graduate student, who would take it the last 200 miles to the Caltech Observatory, after we had successfully kept it operating the entire trip from Yalta - Kharkov - Moscow - Amsterdam - Rotterdam - Amsterdam - New York - Los Angeles.

That night a fuse blew, and the already tired batteries lasted only a short while and the oscillator died!

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When we hear news we should always wait for the sacrament of confirmation. --Voltaire

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Automation is a process that gets all the work done while you just sit there. When you were younger, this process was called Mother.

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SAFETY AT HOME

Mowing Know-How

Fill the fuel tank before starting and never refuel a hot or running engine.

Clear the area of children, adults, and pets.

Pick up foreign objects that might be thrown by the blade.

Start the mower only where your footing is firm and the machine will be stable while you're adjusting its speed.

Keep your feet clear at all times. Push the mower ahead of you as you walk--never stop and pull it back towards your feet.

Stay away from the discharge side of the mower and never "aim" the discharge in the direction of people or pets.

Stop engine or disengage blade clutch before pushing mower across walks, roads, curbs, gas or water valves, or any object that might be above ground level.

Never leave the mower, even for a moment, without first stopping the engine.

With a walk-behind mower, always traverse an incline horizontally--never up and down.

Use extreme caution with riding-type machines on slopes or uneven terrain. With a rider you mow up and down to prevent tipping.

Don't allow children to operate the mower or be in its vicinity anytime it is running.

Never tip the mower for an inspection without first stopping the engine and disconnecting the spark plug.

If you must work on the underside of a mower, first remove the spark plug after disconnecting it. So long as the spark plug remains installed, an engine can always fire one more time.

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Figures prove it. The National Safety Council says that seat belts in every car, used at all times, by driver and passengers, could save at least 5,000 lives a year, reduce serious auto injuries 1/3.

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THE WONDERFUL WORLD OF COMICS

Virginia Van Brunt

Children of all ages still thrive on the heroic exploits and superhuman fantasies portrayed in comic books and comic strips. Comic books are becoming hot collector's items, and there seems to be a resurgence of interest in this popular media which had its heyday in the 1940's.

One hears bits and pieces of news items about people who have painstakingly assembled complete collections of comic book series, or collections of comic strips. Whether you are following crime-busting Dick Tracy, self-reliant Little Orphan Annie, or the daring exploits of Captain Marvel, Captain America, or Red Ryder, there are books being published to go right with your hobby. The comics, once considered too "pop" in an age of Pop Culture, have come into their own as a serious hobby.

Calkins, Dic. The Collected Works of Buck Rogers in the 25th Century. Chelsea House, 1969. $12.50.

Couperie, Pierre. A History of the Comic Strip. Crown, 1968. $5.95. Translated from the French, yet the best work published on the comic strip.

Gould, Chester. The Celebrated Cases of Dick Tracy, 1931-1951. Arlington House, 1970. $15.00.

Gray, Harold. Arf! The Life and Times of Little Orphan Annie, 1934-1945. Arlington House, 1970. $15.95.

Raymond, Alex. Flash Gordon. Nostalgia Press, 1967. $12.95.

Bails, Jerry G. The Collector's Guide of the First Heroic Age. POB 7411, Northend Station, Detroit, Michigan 48202. $5.00.

Overstreet, Robert M. The Comic Book Price Guide. 2905 Vista Dr., N.W., Cleveland, Tennessee 37311. $5.00.

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A POOR MAN'S ROAD RACE

Rick Fisher

More often than not when a guy buys a sports car he's got an interest in road racing. At least, I do. Since it is about all most of us can do to convince the bank that it should sponsor us to a street machine, the chances of ever seriously competing in a race-worthy version of our favorite make are slim indeed. Sports car types, being what they are, have come up with several forms of driver competition which can be run for only a few dollars per race to buy the better drivers a trophy. One of these events is autocrossing.

An autocross is best described as a timed run through a twisty course laid out in a parking lot. The course is marked with soft rubber pilons (they bounce when you hit 'em), and it generally takes about a minute to run through it. In principle there is only one car on each part of the course at a time, but I did see a near fender-bender when somebody made a wrong turn. In fact, one of the toughest parts of autocrossing is remembering where the prescribed route is in the sea of pilons in front of you. I spent a whole morning memorizing my first one. An autocross is open to anything from a Bug-eyed Sprite to a snorting Mustang or Corvette. Similar performance cars are grouped in classes.

Now, you ask, how have I and my yellow 240Z done? Well....let's say I'm just starting. My first crack at it was a moral victory in that I stayed on course on both runs. That put me about a tenth of the way up the list of finishers - ahead of all those who couldn't do the same on either run. Since then, I have run five more autocrosses this spring with gradual improvement. One was a big sweeping job laid out by a Corvette Club (wouldn't ya know it) where I actually got into 2nd gear. That one was run in the rain with more time spent sideways than anything else. Whee! Another was so tight that the bigger cars were slipping their clutches to keep from stalling out. A classic example of battered elbows from about 15 turns lock-to-lock in a minute. I just got the results of the last autocross back today, and I beat two MGB's, an Alfa, and three other Datsuns in my class. Three of them even stayed on course.

To date, I've collected five pilons and worn about 10,000 miles off my tires. The "Z" has sustained more damage by being parked next to jokers with strong door springs than in six autocrosses.

Oh yes, I forgot to mention why I haven't made FTD (fastest time of day). I've run everything so far on snow tires. Too bad it never snowed.

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1972 TOUR PROGRAM

Wally Oref

Twelve years ago NRAO began a modest tourist program. The first tour season in 1960 was eight weeks long and 2490 visitors were counted who took tours. In 1971 this 1960 total was easily surpassed by the largest one week's registration. While our program and facilities have remained relatively modest, the number of visitors to NRAO has increased every year. In 1971, 19 per cent more people visited NRAO than in 1970. If the same general increase occurs this year, we may tour as many as 35,000 people.

The 1972 public tour season will begin on June 10 with daily tours through Labor Day, September 4. Weekend tours will start on September 9 and end on October 29. Weekday tours will start from Green Bank Grade School and weekend tours will start from the warehouse auditorium. Tours will be scheduled on the hour from 9:00 A. M. to 4:00 P. M.

The tour program will include a 15-minute movie on radio astronomy, a narrated bus tour of the site and telescopes, and a demonstration of how a radio telescope works using a 2-foot radio telescope that observes the sun. The tape narration provides technical, scientific, and general information about the site, NRAO, our telescopes, and current research. The information on the tape is supplemented by information panels located at the Tour Center and at the 2-foot, 140-foot, and 300-foot telescopes. These panels give technical information about the telescopes and research. The tour takes about an hour and, of course, it is free.

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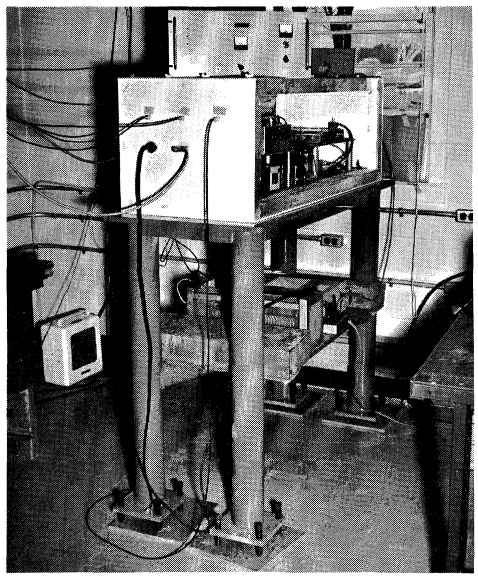
LASER DISTANCE MEASURER

John Payne

People may have been wondering about the rash of little white huts breaking out over the site in the past couple of years: first, one behind the lab, bearing the legend "John's Privy" - lovingly stencilled on by some joker; next, one behind the 140-ft, which moved about 100 feet after a couple of weeks, apparently having given birth to a concrete column about 2 feet square which it left behind. Now of recent months, this long-suffering hut has appeared about 200 feet away from the Reber dish building. All this hut moving and building of concrete pillars has enabled us to do experiments on instruments that will be used on the 15 meter telescope (if we ever get the money!).



Laser Distance Measurer

The latest experiments, at the Reber dish building, have been concerned with trying to measure distance very accurately using a laser beam. The reason we want an accurate instrument of this nature is to enable us to set the panels on the new telescope very accurately and quickly. The instrument we have all been working on will let us do this by measuring distance from the vertex and focal point of the telescope to little reflectors on the surface of the dish. By deflecting the laser beam from one reflector to another with an accurately controlled mirror, we will be able to measure the dish surface very accurately and quickly.

Lots of instruments like this are made by different companies but the best ones only give an accuracy of about ± 40 thousandths of an inch. For our purpose we need an accuracy of ± 4 thousandths for ranges up to 200 feet, so we decided to build our own.

The instrument works by measuring the time it takes a beam of light to travel there and back over the distance to be measured. When you think that light travels about 186,000 miles in one second, it may seem silly to think you can measure the time it takes it to go 4 thousandths of an inch! It turns out though, using modern electronics, that it is not very hard to do and we all recently celebrated beating our goal of ± 4 thousandths of an inch in 200 feet. The instrument in its present form measures ranges up to 200 feet with an accuracy of better than 3 thousandths and only takes 2.5 seconds to make one measurement.

Marvin Wimer in the Central Shop was the first one to work on the instrument last fall. Martin Barkley, Ed Gardner, "Coonie" Wright, Wendell Monk, and Lake Sipe have all done great work on the project and have been very patient in the face of at least one thousand changes. Basil Gum and Bedford Taylor built the mount for the instrument.

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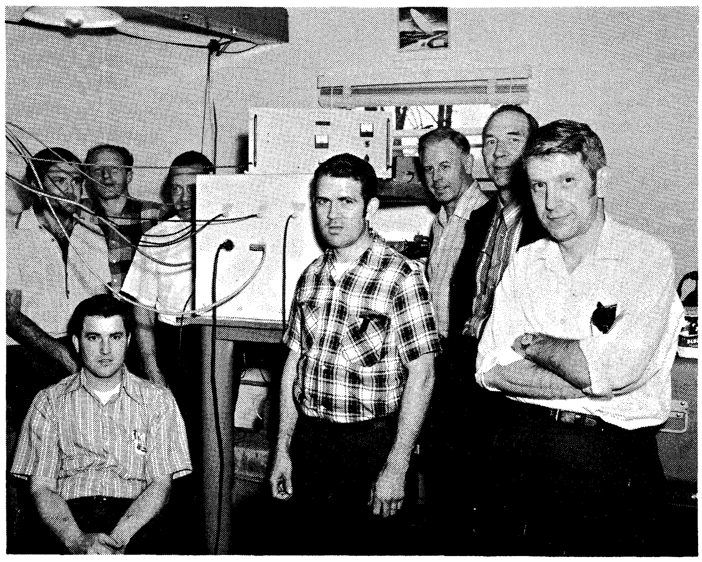

Steve Mayor, John Payne, Martin Barkley, John Findlay, "Coonie" Wright, Ed Gardner, Marvin Wimer, and Ralph Becker.

Ralph Becker and Steve Mayor worked hard on the construction of the electronics and testing of the complete instrument. Special thanks goes to Charlie Pace in CV who designed and built all the digital electronics. Sid Smith looked after building the very stable foundation for the optical reflector and helped a lot with layout of the test range.

Later this year we may start an engineered version of the instrument suitable for putting on a telescope.

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COMPUTER FOR 140-FT

Bob Vance

On May 8, 1972, observing with the 140' telescope was halted for about six weeks. During this period of time, many tasks will be completed by various groups of NRAO personnel. Among the work being accomplished is:

1) Install new console
2) Oil Change
3) Adjust surface
4) Test new 21 cm cooled receiver
5) Overhaul Sterling Mount
6) Overhaul Inductosyns (Read-out system)
7) Overhaul Oil Chiller
8) Restroke Hydraulic Motors
9) Change Polar Master Brake cylinder
10) Install H316 Computer.

The remainder of this article will pertain to Item 10 above--H316 Computer. An H316 (8K memory) computer has been purchased from Honeywell. This computer will replace the present Pilot Drive for telescope positioning and control. The Pilot Drive was located in the old console and through the interaction of the many gears sent a signal to the drive motors that moved the telescope at the correct rate commanded by the telescope operator through the selector switches.

The H316 computer will now send the signals to the drive motors to position the telescope as commanded by the operator. Through a new control panel, the operator will still have the capability of manually positioning the telescope through the computer to the desires of the Observer. This mode of control is essentially the same as the previous Pilot Drive mode, except the control knobs have been changed and relocated.

Many new features will also be included. Automatic positioning by the computer through the control panel will be available in both axes of the telescope. This allows the operator to select the desired position in digi-switches for each co-ordinate, press an update button, and the computer drives the telescope to the commanded position, using built-in acceleration and deceleration routines.

Another mode of operation which will be included later in the software is Card Control. This mode of operation will allow the observer to punch the desired positions on cards along with other information about the observation, feed them into the computer through the card reader, and the observation will be carried out automatically.

The new console includes a CRT (Cathode Ray Tube) for display of telescope positions and other information pertinent to the operator for monitoring purposes.

The DDP116 computer will still be used for data collection. In essence, the H316 computer replaces the Pilot Drive system but gives the operator an automatic system of positioning the telescope.

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CALENDAR OF NATURE EVENTS

Sponsored or Co-Sponsored
by
West Virginia Department of Natural Resources

June 17	Family Trails Day Kanawha State Forest
July 18	DNR Cranberry Tour (Blooming Orchids) Richwood

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An obstinate man does not hold opinions, but they hold him. --Pope

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