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R.R.S. Newsletter No. 6 — 15th October 1961

# THE FIRST TOPSIDE SOUNDING

An event recently took place which has been awaited with keen interest by those at Slough who are preparing for the R.R.S. participation in the U.S./Canadian Topside Sounder Satellite programme. The event was the firing of a prototype ionosonde in a rocket to test the practicability of the proposed system for bouncing echoes off the topside of the ionosphere.

The N.A.S.A. Topside Sounder Working Group (on which R.R.S. is represented) recommended last year that a test pulsed sounding of the ionosphere from above should be made before the U.S. and Canadian satellites were launched, to find out whether the many uncertain factors in the experiment had been correctly estimated.

The Working Group chose the U.S. sounding system for the test. In this system a transmitter emits pulses in rapid succession on several frequencies, (six frequencies in the satellite, two in the rocket). In contrast the Canadian satellite is to use a sweep-frequency system, (familiar in ground-based 'bottom-side' sounding), in which a pulsed transmitter sweeps smoothly in frequency from 1.5-11.5 Mc/s in 15 seconds. The rapid climb of the rocket through the F-layer makes the slow-sweep method inappropriate, although the technique is quite applicable, and in many ways better, in a horizontally moving satellite.

The rocket-borne sounder was completely transistorized and emitted pulses alternately on two fixed frequencies, 4.07 and 5.97 Mc/s. The transmitted pulse length was 100 microseconds, the pulse repetition rate was 22 per second on each frequency and the peak pulse power radiated on each frequency from the aerial was estimated to be 2 to 3 watts. The received video echo waveform was telemetered to ground stations over a frequency-modulation system operating at 240 Mc/s, and recorded on magnetic tape.

After burnout of the rocket motor, the 32 foot telescopic dipole aerial was extended by an explosive squib, and 160 seconds after launch the sounder was turned on automatically. At this time the rocket was at a height of 350 Km and near the maximum of the F-layer where 4 and 6 Mc/s radio waves could not propagate because the surrounding ionized medium was opaque to these frequencies.

As the rocket emerged through the top of the F-layer, it reached in turn the levels above which 6 Mc/s radio waves could propagate by the 'Z', 'ordinary' and 'extraordinary' modes. As expected, above these 'reflection' levels echoes were seen which had travelled down from the rocket to the reflection level and back to the rocket. The 'depth' from which these echoes returned increased as the rocket climbed to the apex of its orbit, (1000 Km) and then decreased to zero again as the rocket fell back through the reflection levels. The same sequence of emergence through the Z, o and x reflection levels was seen at 4 Mc/s, but the heights at which this occurred, were somewhat higher than for 6 Mc/s, corresponding to a smaller density of ionization.

The success of the rocket sounding showed that a transmitter at 1,000 Km with a power of a few watts was sufficient to obtain echoes from a normal 'quiet' F-layer. Another rocket firing is planned when the F-layer is disturbed, to see whether the power is sufficient in the presence of irregularities which scatter radio waves instead of reflecting them specularly. This test has been particularly requested by the Canadian team who wish to know whether their sounder system will work and yield analyzable records in the disturbed auroral zone of the ionosphere in northern Canada.

Two unexpected phenomena were seen in this first test. Just as the rocket

/emerged

emerged through each reflection level, a ragged decaying echo was seen which extended from zero range up to 2-300 Km and had the appearance of ground-clutter on a ground-based radar. This may be due to some plasma resonance effect, an acoustical 'ringing' triggered by the transmitter pulse.

The other phenomenon, very marked at 4 Mc/s but barely noticeable at 6 Mc/s, was a scattered echo which appeared at 850-950 Km height on ascent and descent. This suggests that marked irregularities can exist in the F-layer even at this great height.

E. D. R. S.

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## VIBRATION TESTING

All rocket and satellite equipment has to undergo a rigorous vibration test before installation. For operation in Skylark, the R.A.E. designed rockets which will carry the early R.R.S. experiments a hundred miles up at Woomera, the equipment must withstand a vibrational acceleration of 4g in all directions. This vibration arises from the rocket motor and has a spectrum from 20 c/s to 2 kc/s.

No vibration testing facilities exist at Slough but fortunately R.A.E. Farnborough are well equipped with a range of vibrators from a midget model for testing components of a few ounces, to a gigantic bouncer which delivers a maximum of 20g to a load of one hundred pounds.

The vibration table is constructed in the same way as an energised loudspeaker but with the cone replaced by the specimen. A large power unit energises the magnet and a powerful audio amplifier feeds the moving coil. The input to this amplifier is a small audio sine wave generator for our tests. A piezo-electric transducer screwed to the vibration table is connected to a calibrated transistor voltmeter and records the acceleration. The vibrator, which creates a deafening din, is housed in a sound-proof room; ear protectors of a most elegant design are worn by all who respect their ear drums.

A vibration test, conducted efficiently, requires three people; one to operate the sine wave generator, another to keep a watchful eye on the equipment under test for structural resonances or loosening of connections and the third to observe meters on the monitor panel. Operation of the generator is rather tricky and involves keeping the output at 4g whilst the frequency is gradually raised from 20 c/s to 2 kc/s in about 8 minutes. A complete check of the equipment is made both before and after the vibration run.

Our first attempt on a small vibrator concerned individual units - a receiver, calibration unit and converter - each of which withstood the test admirably. This encouraging result helped dispel our doubts over the receiver filter which contained four crystals not vibration proved.

In view of this initial result, we confidently expected success with our final model comprising three receivers, calibration unit, converter and distribution board all firmly bolted to a baseplate. However, flexing of this plate produced transverse effects considerably greater than 4g which broke two transformer windings and at a later date detached the crystal in the calibration unit.

Reinforcement of the individual units greatly reduced these effects and the transformer responded to treatment with silicone rubber.

On our fourth visit the equipment successfully withstood six complete vibration runs. We could then say with reasonable confidence that it would reach the D region and at the same time retain its pre-flight performance.

R. W. S.

A. J. H.

## SATELLITE TRACKING

The purposes for which information on the position of a satellite is required may be summarized as: (a) to follow the progress of its flight and to predict its future position, (b) to obtain its position at a given time for use in conjunction with radio propagation studies or measurements by instruments in the satellite, (c) to study irregularities in the motions of the satellite, (d) to make geodetic measurements.

The accuracy with which the position of the satellite should be known for these purposes varies approximately in the reverse order in which they are listed above. For example, for general purpose prediction a directional accuracy of 1 degree of arc is normally adequate, though for setting special instruments such as astronomical telescopes or very narrow beam aerials a higher accuracy is required. For correlation with propagation or atmospheric measurements a positional accuracy of certainly less than 10 km is desired. For certain types of study of orbital perturbations positional accuracies of 1 km are required, while for geodetic measurements, including intercontinental surveys, the highest precision is called for. The above figures are, of course, only intended as a rough indication of the requirements.

Optical tracking is undoubtedly the most precise tracking method, but observations are limited to about an hour or so after sunset or before sunrise when the satellite is in sunshine and the observer in darkness. Visual tracking is limited by the ability of the observer whereas photographic observations are limited by the ability of the camera to record very faint objects. Most satellites are of such a size that they can be photographed only by a Baker Nunn camera costing tens of thousands of pounds. Simple cameras such as those used at R.R.S. can record Sputniks and launching rockets but are too insensitive for most American satellites.

The only other ways of tracking satellites are by radio and radar. Radar requires a very high-powered transmitter and highly directive aerials, since a typical satellite may be only as big as a large toy balloon and may be as far away as Gibraltar is from Slough.

If the satellite has a working transmitter on board then it may be tracked either by direction finding or by a Doppler frequency change method.

The direction finding systems may be classed as:

(a) Ordinary moving direction finders having an accuracy of about $\frac{1}{2}^{o}$ in bearing and elevation and about $\frac{1}{2}$ second in time.

(b) Fixed, phase measuring, direction finders having an accuracy of about 1/10 to 1/100 of a degree in position and 1/10 to 1/100 of a second in time.

(c) Very large systems such as the Minitrack system having large aerials to reduce site errors and improve signal to noise ratio and employing the most refined phase measuring techniques. Although (b) and (c) are usually called interferometers, they do not work on the true interferometer principle.

At R.R.S. all these types have been used. The intermediate accuracy type is now awaiting dispatch to Singapore while the Minitrack is in regular use at Winkfield.

The Minitrack system is probably the most accurate that can be achieved on 136 Mc/s and any further improvements will use much higher frequencies and possibly combine radar and radio techniques.

Tracking by the Doppler frequency change technique has many advantages but, since it needs a transmitter with a frequency stability of a few parts in $10^{10}$, it is suitable only for satellites designed specifically for use as navigational beacons.

B. G. P.
G. E. A.

## SPACE RESEARCH CONFERENCE

A conference on "The Physics of Space Research" was held from 20th-22nd September at the Royal Military College of Science, Shrivenham, Berkshire. It was jointly organized by the Physical Society and the R.M.C.S. and scientists attended from industry, government establishments and the Services. Drs. Bain and Hall and Mr. Golton represented us.

The College buildings are pleasantly situated at the foot of the Marlborough Downs, below one of the famous White Horses on the borders of Wiltshire and Berkshire, about 7 miles from Swindon. We were excellently accommodated in the student officers' rooms. The catering too was first class.

The College is mainly used for teaching science to Army officers but a considerable amount of research work is also done. During our stay we were fortunate enough to tour some of the laboratories and found work in progress on plasma physics, a subject of great interest to R.R.S. We also noted a back-scatter transmitter.

Sir Graham Sutton, the Director-General of the Meteorological Office, opened the Conference at which Dr. Boyd (University College, London) and Dr. Butler (Royal Observatory, Edinburgh) gave the first lectures describing their proposed experiments for the British Scout satellites and some results of experiments with Skylark rockets. After dinner an evening session was held at which Dr. Wilson (U.K. Atomic Energy Authority) spoke on "Plasma Physics and Space Research".

The second day started with another excellent lecture by Dr. Quenby (Imperial College) on cosmic rays and particle physics. He was followed by Dr. Robinson (Meteorological Office) who explained how satellites could help in weather studies. During the discussion we learned that the Meteorological Office will be using an Atlas computer to help in sorting out its problems. The afternoon was devoted to Radio, Drs. Bain and Hall presenting papers on present and future rocket and satellite work at R.R.S.

On the third day, two papers were presented; one by Mr. Earl (Royal Aircraft Establishment) on the problems of satellite design, the other by Mr. Munday (Royal Military College of Science) on satellite orbit perturbations. The conference ended shortly afterwards and delegates returned home after lunch in the Officers' Mess. We all had an interesting and profitable time and made many useful contacts.

E. G.

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## LETTER TO THE OUTSTATIONS

Slough
15th October 1961

Dear Colleagues,

Apart from the changes in our environment which I wrote about last month (our bridge is now nearly finished) I feel I ought to tell you that the large white vehicle store is now a large green vehicle store and that, thanks to Tom Buckland, there is still a lot of colour in the flower beds around the Station. We are at present enjoying a series of sunny days, although the cold early morning mists of Autumn have started.

I have taken over Mr. Naismith's job since he retired and am faced with the task of rehousing the Ionosphere forecasting service in Spur C's small lab. The World Data Centre will then move into the Ionosphere Bureau so that its present accommodation can be converted into a laboratory.

Mr. Shearman has been transferred to rocket and satellite instrumentation work. His present team is Messrs. Ashwell, Appleton (a new S.O.), John Smith, and Curtis.

You will see from the S[illegible] NEWS that we have recently had a large increase

/of scientific

of scientific staff, so that we can expect a new impetus in our current projects.

On 22nd September, six of our Scientific Assistants took part in a protest meeting in the Caxton Hall about the "Pay Pause". Wearing lab. coats, they marched to the Treasury and back among banners and balloons.

I feel sure that the staff here and at the outstations would welcome a short "Letter from the Outstations" as often as you can manage it, monthly if possible. About 250 words would be an ideal length, and in order to catch a particular issue letters should be addressed to The Editor and reach me not later than 10th of the month.

Best wishes from us all.

Yours sincerely,

The Editor

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STAFF NEWS

Congratulations to: Miss S. Pye, who recently resigned her post as typist, on her marriage to Mr. J. Muir-Smith at Windsor Registrar's Office on 6th October.

Messrs. A. Baber and M. A. Tracey on promotion to Asistant Experimental Officer.

Recent Arrivals: Welcome to:
Dr. R. B. Cairns (S.S.O.)
Mr. E. J. Cox (Lab. Mech.)
Mr. D. Eccles (T/S.O.)
Mr. A. D. Johnstone (T/S.O.)
Dr. D. W. Mahaffey (S.S.O.)
Miss J. Scott (T/S.O.)
Mr. D. G. Thorpe (T/S.O.)
Mr. D. M. Willis (S.O.)

Departures:
Mr. D. L. Brown (T/Asst. (Sci.))
Mr. E. Collingwood (T/A.E.O.)
Mr. R. Naismith (S.E.O.)
Mrs. J. A. Svendsen (T/Typ. Singapore)
Miss J. Wallis (College based student)

Movements: Messrs. P. A. Bradley and J. Goodyer have now sailed for Singapore. Messrs. G. Hawkins, J. Juleff and J. E. Pearson sailed on the 'Uruguay Star' for Montevideo on 29th September. We hear that all three were ill during rough seas in the Bay of Biscay and may reach Montevideo after the Falkland Islands ship has sailed.

Mr. Dalziel attended the U.R.S.I. Symposium on Space Communication in Paris on 18th-22nd September.

Mr. Piggott has now returned from the U.S.A.

Visitors: Welcome to Dr. T. Yonezawa, a visiting Research Fellow, from the Radio Research Laboratories, Ministry of Posts and Telecommunications, Tokyo.

Substation changes status: Because of increased size and responsibilities the Singapore outstation will in future be called the D.S.I.R. Radio Research Station, Singapore.

## R.R.S. SPORTS AND SOCIAL CLUB

### TENNIS

Six couples took part in an enjoyable tennis tournament, organised by Mr. P. A. Smith, on the hard and grass courts on Saturday, September 16th. The first prize (Boots gift tokens) went to Mr. & Mrs. F. Horner.

### BONFIRE NIGHT - NOVEMBER 4TH

We are preparing for a Bonfire Party on Saturday, November 4th. Mr. Weston would appreciate some lunch-time labour to help collect wood for the bonfire. Will volunteers please contact him as soon as possible. Both parents and children are welcome at this event, which includes a firework display and snacks.

### CHRISTMAS PARTY - DECEMBER 16TH

This year's Christmas Party will comprise a pantomine and dance and will be held on the evening of Saturday, December 16th. Please come along and make the evening a success.

### BADMINTON CLUB

Badminton is on Thursdays from 7.0-10 p.m. at the Austen Leigh and Baldwin Institute, Eton. Please contact Miss M. Peart (Spur C).

### BRIDGE CLUB

Unless otherwise notified Bridge will be played in the staff restaurant on Tuesday, 17th October starting at 7.0 p.m. Will anyone interested in playing please sign the list on the Sports and Social Club Notice Board in the main corridor.

E. M. A.

### CHRISTMAS PANTOMINE

Rehearsals have now started for "Jack and the Beanstalk" to be produced by Mr. Douglas in the Staff Restaurant on 16th December. All those interested should contact Mr. Waller (Spur D).

## R.R.S. AMATEUR RADIO SOCIETY

New Members - We welcome Barry Jones, our twenty-second member.

Departures - Miss Pye who has left to get married, promised to continue her morse lessons (at which she showed great skill) as the wife of G3OHW.

Messrs. Bradley, Pearson, Juleff and Goodyer have gone to outstations, where we hope they will spread the word and eventually contact us over the air.

Appointments - Mr. Weeden, who has always been most helpful to the Society, has replaced Mr. Juleff on the Committee.

Mr. Clough has become Librarian; we still require an Equipment Secretary.

Acknowledgements - We thank Messrs. Froome and Golton for gifts of equipment and Mr. Stocker for magazines and for his excellent performance on October 9th when he described and demonstrated his Hi-fi equipment.

Forthcoming Meetings - In future, every Monday will be Club Night. Full details of meetings appear regularly on the Social Club Notice Board. There is to be a film show on October 30th.

Morse Classes - These will begin during the week ending October 21st, on the two lunchtimes best suited to members. A knowledge of morse is necessary for obtaining an Amateur Licence. Don't wait until you are posted overseas! Start learning now!

R. F.

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## THE CAMERA CLUB

The Camera Club September show started as a 'Newman Baker' effort, one with seven prints and the other six. But on the third day, John Juleff not to be outdone by Mr. Newman's 'CAT', entered his 'Stone Age Pet'. Mr. Bates then produced a very fair portrait of a 'COW', which apparently had got very interested in his camera and lost its ears.

We thank our colleagues for again helping us. We got more votes this time, and the results were as follows:-

(1) W. Newman - 'I knew we'd win'
(2) S. Baker - Horse and Foal
(3) N. Bates - Cow
(4) S. Baker - Highland Cattle

The subject for October is 'Summer Prints'.

S. J. B.

BRUSCH UP JÖR CHERMANN

GERMAN PHRASES FOR GUIDED WEAPON EXPERTS

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|---|---|
| Guided Missile | Das Skientifiker Gessenwerker Firenkrakker |
| Rocket Engine | Firenschpitter mit Smoken und Schnorten |
| Liquid Rocket | Das Skwirten Jucenkind Firenschpitter |
| Guidance System | Das Schteerenwerke |
| Celestial Guidance | Das Scheinenballische Schtargasen Peepenglasser mit Komputentracen Schteerenwerke |
| Pre-Set Guidance | Das senden Offen mit ein Pattenbacker und Fingeren gekrossen Schteerenwerke |
| Control System | Das Pullen-und-schoven Werke |
| Warhead | Das Laudenboomer |
| Nuclear Warhead | Das Earengeschplitten Laudenboomer |
| Hydrogen Warhead | Das Earengeschplitten Laudenboomer mit ein gross Holengraund und alles Kaput |
| Direct Hit | Das Bullzei mit Laudscheer |
| Near Miss | Das Scheerbadlucken |
| Misfire | Das Schweeren |
| Infra-red Homing | Das Schteerenwerke von homensenden mit warmen Echschorsten |
| Radar Homing | Das Schteerenwerke von homensenden mit Blipblipecholisten |
| Missile Engineer | Ein Kristolgazen und Hittenmissen-gessenwerke Mann |
| Launcher | Das Firenkrakker Upflingermaschine |
| Catapult | Das Firenkrakker Pusspussupflingermaschine |

From RRE to RRS

Happy Launchings at Woomera

15th October 1961
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