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R.R.S. Newsletter No.7 — 15th November 1961

SINGAPORE - AN OPPORTUNITY

(by the Director)

I attended a conference in Japan last September and on my return journey I took the opportunity to visit Singapore. The visit started badly. I was more than 24 hours late because of aircraft delays and consequently missed a dinner party which Mrs. Clarke had kindly arranged for me, and failed to turn up to lecture to 'The Singapore/Malayan Joint Group of The Institution of Civil Engineers, Institution of Mechanical Engineers and Institution of Electrical Engineers'. Mrs. Clarke was too kind to tell me what happened to the dinner party but I do know that the audience arrived for the lecture and were shown some films instead.

Clarke took me first to the site for the interferometer on the Naval Air Field at Sembawang. The site is spacious, open, and flat, and I should think it is ideal for the purpose. There is space nearby for other aerials when we need them. The foundations of the small laboratory are laid, and an access road and power supplies are being worked on. I understand that the Navy will welcome our people as visitors to their mess.

Next we went to see the radio-noise equipment at the Cable and Wireless Station at Trafalgar. Our apparatus is in a small laboratory, just outside the main compound, and can be connected to rhombic aerials inside the compound, the most appropriate aerial being selected as required. The laboratory, though small, is very comfortable and contains an office in which they are about to put facilities for heating up a simple midday meal.

In the evening I gave a lecture at the University and attended a cocktail party at the house of the Dean of Science. There I met all our staff and their wives and several members of the University staff.

Next morning I went to the University to meet our staff at work and to see their accommodation. There is a field laboratory in the University grounds which houses the ionosonde and the equipments for observing satellite signals and measuring field-strengths. In the University building each member of staff has a separate desk in a large main office. Clarke has an office to himself with a side office where Mrs. Clarke works as his secretary. I talked to each of the staff, separately, about the work he was doing, and I was considerably impressed by their keenness and enthusiasm. I also talked to them collectively and told them that I thought there was an opportunity, in Singapore, for original research of a kind related particularly to its geographical location. I was able to tell them that some of their measurements of "Faraday fading" on the signal from a satellite had been analysed at Slough to give valuable information about the nature of ionosphere storms at Singapore. I told them that, to provide the best possible opportunity to do original work of the kind I had in mind, I was trying to arrange, in future, for two of the staff, in addition to the officer-in-charge, to be in the Scientific Class. I also said that I thought a Station of this importance, and with these opportunities for research, should no longer be called a sub-Station. It will, in future, be The Radio Research Station, Singapore.

I was particularly anxious to see the living accommodation so Clarke took me to Braddell Hostel, a large residential site provided for Government officials. Here I saw the kind of housing provided for junior married officers and for single officers. I thought it was of a high standard. The more senior married officers occupy flats or houses in other parts of Singapore.

The organisation at Singapore was set up as an outstation to make routine ionospheric measurements. During the I.G.Y. the staff was increased for the purpose of making observations required by the workers at Slough. It has now

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grown to the stage where it ought to be more than an "outstation" making observations required by the "home station". I hope the workers there will be able to show that they are an active team with ideas of their own and capable of producing new results. There are already signs that the radio-noise work, and the investigation of storm phenomena with the magnetometer, the satellite Faraday observations, and (soon) the topside sounder observations, will provide at least two such lines of independent research.

I was impressed by the work being done at Singapore, and by the keenness and enthusiasm of our staff there. I look forward to being able to send a regular stream of good people, with their own ideas for experiments, to work there.

In the future we shall replace half of the staff at Singapore each year, the normal tour of duty remaining, as now, two years. An attempt will be made to decide on the replacements before January 1st each year, so that those concerned can make all necessary arrangements in good time. Those members of the staff who feel they might like to spend two years there can find out more about the Station through Dr. Minnis, who acts as a scientific liaison officer, and through the Establishment Office (Mr. Oatley) who knows about the administrative arrangements. Mr. Oatley has a collection of photographs which I brought back with me.

J. A. R.

U.R.S.I. SYMPOSIUM ON SPACE COMMUNICATIONS RESEARCH

A symposium on space communications research was held in Paris during one week last September. Although sponsored by U.R.S.I. the Conference actually dealt more with technology than with science. The reason for this became apparent during the proceedings and will be mentioned later. As can be imagined a wide range of studies is still needed to ensure the success of the expensive experiments involved in the development of various types of communication satellites. Sessions were devoted to the following subjects: launching, attitude control and tracking; frequency and propagation problems; modulation systems; ground equipment; satellite equipment; satellite communication systems; economics and miscellaneous topics.

The broadest conclusion that can be drawn is that no scientific problems stand in the way of the development of space communication satellites, and this is no doubt why most of the material of the conference related to technology. In particular, propagational disturbances are of second order importance at the frequencies chosen. Nevertheless many technological difficulties have yet to be mastered.

Descriptions of ground equipment included various large dishes-by now familiar sights, at any rate on paper - the Bell horn and low noise amplifiers. Nothing really new was reported in this field. Component reliability, environmental testing and solar cell power supplies occupied most of the discussions on satellite equipment. It was stated that there is no difficulty in providing solar cells with a lifetime of at least five years in orbit.

Several representatives felt that the deliberations on modulation systems were left incomplete. The tendency was towards wide-band frequency modulation with feedback at the receiver. The word "systems" in the context of the papers refers to the overall, basic operational plan such as the choice of reflecting signals from passive satellites or re-radiating them from active satellites, and whether the satellites are randomly distributed in orbit or synchronous. The choice of system depends on the application.

Economical considerations justifying the use of satellites for communications were produced but this was preaching to the converted. The need for a high traffic demand and large channel capacity, to make the systems pay, was emphasized.

The symposium was useful in bringing together both the scientists and the engineers, which helped to keep things in perspective.

R.D.

DATA PROCESSING

In the re-organization of the work of the Radio Research Station which occurred at the beginning of 1961, a new section was formed to build up and operate a data processing centre at Slough. This article briefly outlines the purpose of this section, the work that has been planned and the methods that will be used.

Scientists in the U.K. will in the near future be using satellites to carry out measurements in space. The Royal Society programme for launching British designed experiments in U.S. Scout vehicles and the Canadian and American ionosphere topside sounder satellite programme, in which R.R.S. is participating, are of particular interest. The telemetered information from these experiments will be recorded on magnetic tape at ground acquisition stations, such as Winkfield, Singapore and Port Stanley. Before the data for each experiment can be made available to the interested experimenter these tapes will have to be subject to a process to decode the telemetry signals into intelligible data. This is the function of the data processing section.

The first task that the section will undertake is handling data that will have been acquired from the topside sounder satellites at the three R.R.S. telemetry receiving stations. Plans for doing this are well advanced and processing equipment is being assembled.

The satellites will emit pulses down to the F-layer of the ionosphere and receive the reflected echoes after a time delay. The Canadian satellite uses a sweep-frequency method while the American one has six fixed frequencies emitted in sequence. In both cases the pulse and echo waveform will be telemetered to the ground on a VHF carrier together with synchronising pulses. Another VHF channel will carry cosmic noise data. All this information with time will be recorded in an encoded form on magnetic tapes at the ground stations.

When these tapes are replayed at the data processing centre the pulse and echo waveform will be used to give a brilliance modulated display on a cathode ray tube using the synchronizing pulses to initiate the time base sweep and the depth marks. Cameras, with continuously moving 35 mm. film will produce ionograms which can be projected and from which data can be read off in the usual way. The time information after decoding will be displayed on number tubes and photographed alongside the ionogram so that the position of the satellite can be deduced afterwards from tracking and orbital measurements.

The ionograms obtained from the Canadian satellite will show the variation of virtual depth with frequency and will enable the shape of the electron density profile above the maximum ionization of the F-layer to be obtained. The American satellite will give variation of virtual depth with position on six different frequencies and will show the fine scale variations of the F-layer ionization.

Another section of work which is being planned at present arose from a request by the Royal Society that R.R.S. should be responsible for processing data obtained from British Scout satellite experiments. For the first Scout, processing will be done by N.A.S.A. in the U.S.A. but it is proposed to set up a system, similar to that used by the Americans, at Slough for later satellites. The Goddard Space Flight Centre near Washington was visited earlier this year to obtain some details of the processing equipment required.

The experiments proposed for the Scout programme have come mainly from groups working at Universities but some are from Government Departments including R.R.S. Various types of measurement such as electron density and temperature, cosmic radiation, atmospheric ozone analysis and micrometeorite activity are included in the programme.

Several experiments will be flown in each Scout and each experiment may have several parameters that require transmitting to the ground. Each parameter is

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sampled in turn by an encoder in the satellite in accordance with a pre-arranged time sequence and is converted into a tone, the frequency of which depends on the value of the parameter. These tones will either be stored on a recorder in the satellite, for rapid play-back when commanded later, or they will modulate the telemetry transmitter direct and will be sent to the ground stations at the rate of 50 per second. A magnetic tape record will be made and will contain coded timing information and replay speed control signals in addition to the telemetered data.

As many as 20 or 30 of these raw telemetry tapes containing a total of half a million data points may be made each day for one satellite and these will be sent to the processing centre. They will first be edited to discover which parts are worth processing and will then be fed into the main equipment to convert the information into digital form.

A novel feature of the equipment, for separating the rather weak telemetry signals from the noise background, will be a comb-filter consisting of a bank of 100 filters each connected to its own binary number generator. When a telemetry tone falls within a filter pass-band the binary number corresponding to that filter will be passed to the output. The digital readings of the various parameters will be assembled in a ferrite core store together with digitized time readings at appropriate intervals. The store will be emptied periodically onto magnetic tape in a format suitable for input to digital computers such as Pegasus.

From here onwards normal computer methods apply. The data can be sorted and separated out into the various experiments, calibration curves can be applied and calculations can be performed as required by the different experimental groups. Ideally the final output should represent in consolidated form the result of each experiment, for example, checking a hypothesis. If this procedure is followed the data remain "untouched by hand" from satellite sensor to final result.

It is not always possible to proceed to these last stages without a preliminary idea of what measurements the experiment is producing. For this type of "quick-look" sampling, an output from the processing equipment will operate a chart recorder on which any selected parameter can be traced. Another method of inspecting the information before computation is to print out the contents of the digital magnetic tapes on a high speed printer in a tabulated form. Both these methods are useful for sampling purposes but not for the main output of an experiment as the experimenter is liable to be rapidly buried under a load of paper.

To avoid situations of this sort arising consideration should be given, in the early planning of a satellite experiment, to ways of minimizing the amount of data that has finally to be analyzed after processing has been completed. It may be possible to "sign-post" those parts of the telemetered information that are useful, in such a way that they can be identified by a computer while the rest is ignored. Although modern data processing methods using digital computer and logic techniques are powerful and fast, the final outcome of any experiment is limited to the amount of information that can be analyzed and absorbed by the experimenter.

G. W. L.

PLASMA PHYSICS AND RADIO RESEARCH

Before discussing the work of the Plasma Physics group at the R.R.S., there are a few questions which must be answered.

Firstly, what is a Plasma?

Various people give different definitions, but they all seem to agree that a plasma is a gas consisting of a collection of particles which includes electrons and positive or negative ions, but which, on average, is electrically neutral.

Why do we study Plasma Physics at the Radio Research Station?

A simple answer is that the ionosphere is a plasma. This means that we can learn about the processes in the ionosphere, and about the behaviour of possible experiments in the ionosphere, from laboratory experiments with Plasmas.

What sort of Plasma is the ionosphere?

By laboratory standards it is a very anaemic one. The electron densities are rarely greater than 10^6 per cc, whereas labroatory plasmas rarely have electron densities less than 10^8 per cc. Also the electron temperatures expected (and sometimes found!) in the ionosphere are only about 300 to 2,000°K depending upon altitude, whereas in continuous discharges in the laboratory electron temperatures of 10,000°K or more are normal. In really high temperature plasmas, such as those in Zeta, ion temperatures are of the order of millions of degrees.

Ions and electrons in the ionosphere are being simultaneously produced and destroyed, so that the electron density is determined by the balance between the various production and loss processes. If we are to understand the behaviour of the ionosphere, we must know which processes are important in controlling the equilibrium. In other words the various rates of reaction for these processes must be found. Now these depend on the composition of the atmosphere and upon the probabilities of the processes which might take place.

Unfortunately the theoretician can only predict in detail the probabilities for reactions which are of little or no interest in the ionosphere! This means that the probabilities for interesting reactions have to be found experimentally, and this is one of the objectives of the work which is being started here.

One of the main processes producing electrons in the ionosphere is photoionization of the gases by solar ultra-violet radiation. The practicability of setting up an experiment at this station to measure photoionization cross-sections by vacuum ultra-violet radiation is now being actively considered.

We cannot measure electron loss rates in a normal continuous discharge because, as in the ionosphere, the ionization is being simultaneously produced and destroyed. However if we interrupt the discharge no further electron production occurs and the ionization then decays, usually in a few tenths of a millisecond. During this brief afterglow period we can observe the electron density decay rate and hence derive the recombination coefficient. This is similar to the process of finding recombination coefficients by observing the ionosphere during a total eclipse of the sun.

If we can analyze the ions present in the laboratory afterglow with a mass-spectrometer, and measure their decay rates, we can find reaction rates and probabilities of processes not directly involving electrons, such as the charge exchange between ions and neutral molecules - an important process in the F2 region.

For these reasons we are starting to build a system which will produce pulsed gas discharges, with a miniature mass-spectrometer built into it, to "look at" the behaviour of the ions in the afterglows.

These are just two of the projects in which the plasma physics group is interested. Resonance probes, electromagnetic wave propagation in plasmas, and the provision of a vacuum test chamber for rocket and satellite experiments must be left for discussion at some later date.

P. H. G. D.

STAFF NEWS

(to 1st November)

Congratulations to: Mr. A. J. Stocker on his marriage on 4th November at Highgate.

Recent arrivals: Welcome to:
Mr. M. D. James (T/A.E.O)
Miss A. J. Jones (T/Sci.Asst.)
Mrs. A. I. Newman (Temp. Appt. Part-time)
Mr. D. E. Page (Sen. Res. Fellow)
Dr. M. L. V. Pitteway (Sen. Res. Fellow)

Staff changes: Mrs. E. R. Clarke from Temporary Typist I to Temporary C.O. at Singapore.

Mr. I. R. N. Eyre becomes established as a Storeman A.

Mr. I. C. Fletcher becomes established as an A.E.O.

Movements: Messrs. Pearson, Juleff and Hawkins arrived in Port Stanley on 23rd October. They caught their ship at Montevideo and did not have a prolonged stay there as was once thought probable.

Mr. Bradley arrived in Singapore on 19th October, followed by Mr. & Mrs. Goodyer on 27th October.

We regret to have to report the death of Mr. E. J. Cox on 28th October. Mr. Cox had only recently joined the Workshop staff from Road Research Laboratory.

Mr. Shearman, whose resignation was recently announced is to be Senior Lecturer in Electro-magnetism in the Electrical Engineering Department of the University of Birmingham. For the first 9 months he will be entirely on research work. He is due to start on 1st January 1962.

LETTER TO THE OUTSTATIONS

Slough
15th November 1961

Dear Colleagues,

We hope to send out to you, before our Christmas issue, a set of photographs showing our changed surroundings and the state of the new road. I think you will agree that these photographs were well worth taking.

Activity in preparing for the Christmas Pantomime is becoming intense, and help is currently needed from an amateur composer to write an overture. There are **rumours** that Maureen Armstrong may fill the bill; your editor has regretfully declined.

I think a letter from Singapore and, if there is time, from Port Stanley, describing Christmas in those parts would make very interesting reading in our Christmas issue. Can you help?

Best wishes from all of us. And a Happy Summer Christmas to those of you in the Falkland Islands.

Yours sincerely,

The Editor

SPORTS AND SOCIAL CLUB NEWS

Bonfire Night

Despite the notices scattered around the station, 'Fire! Prevent it', nearly 140 people came to see a large bonfire surmounted by two 'Guys' on the evening of November 4th. A display of fireworks accompanied the crackle of the blazing bonfire. Judging by the expressions on the faces of most of the children, they seemed to be thoroughly enjoying themselves.

When the fireworks were finished, the audience took advantage of a supply of hot dogs and cups of hot coffee. About 30 people stayed for dancing to records in the hall for the rest of the evening. We thank all those who helped to make the evening such a success.

Bridge

The next bridge evening at the R.R.S. will be held on Friday, 17th November. All players (especially new members) will be welcome. A high standard is not expected. Further details will be on the notice board in the main corridor.

Messrs. Bain and Bramley won the last contest, on 17th October, by 3070 points.

Christmas Party

Please remember December 16th is the date for the Grand Christmas Pantomime and dance.

E. M. A.

AMATEUR RADIO SOCIETY

Owing to falling attendance at recent meetings it has been decided that, as an experiment, we shall have meetings of more general interest once a month, beginning after work instead of at 7.0 p.m. as at present. The plan to build and operate a Club Station has received almost negligible support and has been postponed.

Appointments - We are grateful to Mr. Wilkins for having consented to become a Vice-President of the Society.

New Members - We welcome Mr. Fooks, who capably played the part of Operator at our recent film show.

Acknowledgements - To Mr. Golton, for his excellent talk on "Earth Satellites and Radio Propagation", given to the Society on 23rd October.

To Mr. Hammond for the donation of magazines, and to Messrs. Hall, Trotman and A. Smith for donations of valves and equipment.

To Mr. Clough, our Librarian, for having marked and catalogued our quite extensive collection of magazines, which are available to members on loan.

November Meeting - Mr. E. D. R. Shearman is to give a talk entitled "Short Waves and how to use them" on the 20th, to which our President, Mr. Ratcliffe, has said he will try to come. We hope all our members will make an effort to make this meeting a success, and any visitors will be welcome.

R. F.

CAMERA CLUB

The October show of Summer prints was of a higher standard than in previous months but, even so, there was no outstanding print.

Mr. H. Rishbeth produced a very pleasing picture, reminding one of the Japanese style, while that of Bathing Machines submitted by Mr. P. Dickinson took some members of the staff back a few years.

We could still do with a few more prints for showing each month, to ease the burden on the usual four or five club members.

The week following the Club show Mr. J. Reed let us have five very nice large prints for exhibition, which were shown with four other prints from a Club member.

S. J. B.

HISTORIC PHOTOGRAPHS: SERIES '... DURING ...'

Eight new photographs illustrating the progress in the road works outside the main entrance are now on sale; profits to benefit the Sports Club Fund. They provide a direct comparison with pictures in the Series 'Before ...'.

A CAT is shown in action, as well as the THING in the 'magnificent hole' mentioned by the Editor in his letter of 15th September 1961. Mr. Hargreaves' cottage - which for a few days before its end became the 'Radio Research Station' with the official signboard propped against its wall - is shown with senior members of the staff gracing its entrance, and as a sad ruin a few days later.

We invite orders for these and the six earlier photographs (Series 'Before..') now on display on the Notice Board. Closing date: 24th November 1961. A final set '... and after' will be published when the by-pass is finished.

W. S. N.

LETTERS

To the Editor of the Newsletter,

Dear Sir,

At a time when the Governments of the World are concerning themselves with the dangers of fall-out, perhaps you could spare a few inches of space for an appeal regarding a form of radioactivity nearer home. I refer to the Amateur Radio Society, which has fall-out problems of its own.

Although twenty-four people have joined our ranks in the past six months, attendance at meetings has fallen to almost microscopic proportions. One of our visiting lecturers found himself addressing a packed audience of four people, while other meetings have fared even worse. Even our film show failed to attract more than a handful of members.

Clearly this state of affairs cannot continue. If we are to have an Amateur Radio Society at all, it must provide an incentive for a good attendance at each meeting and attract people willing to lend a hand at construction and development. If we cannot do that, then we may as well disband the Society and put the time to better use.

As the Society's news this month will show, we are instituting one or two changes which we hope will improve the situation. We would welcome suggestions from anyone, whether a member or not, which will help us to get the support we must have if we are to keep going.

We would appeal to anyone who thinks the Society is a good idea to make this their personal problem and to give us the benefit of their views. A note in the "out-tray" will only take a moment to write, but it will give us a valuable insight into public opinion.

To your readers then, Sir, may we say 'Please think about it and do something, now!

Yours sincerely,

[illegible] Flavell (Secretary)