For the use of R.R.S. Staff only

R.R.S. Newsletter No.8 — 15th December 1961

Merry Christmas

I wish to take this opportunity of wishing all members of the Radio Research Station, both here and in the outstations, a very Happy Christmas and Prosperous New Year. We have recently welcomed a considerable number of new arrivals to the station whom we are rapidly getting to know. To them, particularly, I send, on behalf of all of you, our best wishes that in the New Year they will find good friends and congenial work amongst us.

For the Station as a whole the New Year presents a challenge and an opportunity. In it we hope to see the launching of the "topside ionosphere sounder", by the Canadians, and of our own rocket (R.1) from Woomera; several of the other recently started activities should begin to produce results; Singapore and Port Stanley will play a leading part in world-wide reception of satellite telemetry.

May all the new, and the old, work go well and happily.

J. A. Ratcliffe.

Director

INVESTIGATIONS IN RADIO METEOROLOGY

One of the most fascinating, and difficult, problems in radio research is the explanation of the propagation characteristics of radio waves at frequencies above about 30 Mc/s. It is now realized, for example, that the measured signal strength beyond the horizon, even in the absence of low-level super-refraction, is far greater than can be accounted for by diffraction theory. There is consequently great interest among radio engineers in studies of the refractive index variations in the lower atmosphere. This interest stems from the current importance attached to long-distance communication by V.H.F. and U.H.F., and the problem of mutual interference on common-channel broadcasting networks. Current studies at R.R.S. are closely related to these problems, and a review of some recent work in this field is given below.

The problem of tropospheric propagation is an extremely complex one. Several mechanisms require investigation, including (a) refraction, especially in the first few hundred metres above the surface, (b) partial reflection from elevated layers, and (c) scattering from turbulent irregularities in the refractive index structure. The relative importance of these effects is a function of the meteorological situation, frequency, path length, etc. Occasionally (e.g. over sea paths during hot summer weather) the refraction mechanism may be dominant, but in other situations a contribution from all three mechanisms is possible, with the scatter mode producing the residual signal on a long path in the absence of reflection or refraction.

In experimental studies at R.R.S. we are fortunate in having access to two aircraft in which, with the co-operation of the Meteorological Office, we have installed microwave refractometers for the direct measurement of fine structure. The latest equipment enables us to record changes in refractive index of 1 part in 10^6 at frequencies up to 40 c/s., corresponding to an eddy size of 1.5 metres at normal flying speed. These refractometers are being equipped with rapid-response thermometers, with a time-constant of the order of 50 milliseconds. R.R.S. staff operate these refractometers, and at the same time enjoy the privilege of seeing much of Southern England (and occasionally the English Channel) from the air. The investigations are also providing valuable data on humidity for the Meteorological Office. In addition, the station is using a 10 c.m.-band vertical pointing radar which also gives information on the refractive index structure (and on bird migration!) in the form of photographs of the return echo. During the summer and autumn, joint experiments were carried out with the refractometer and radar, the latter being located at Bramshill Park in Hampshire, with the aircraft flying from R.A.E., Farnborough. Spiral ascents and descents were made above the radar, with V.H.F. communication from air-to-ground, giving simultaneous soundings of the vertical structure. Parallel studies of the general meteorological situation have also been made.

These recent investigations, together with earlier experiments, confirm that the atmosphere is rarely, if ever, "well-mixed"; deviations from

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a smooth refractive index profile are the rule rather than the exception. Both techniques record the presence of major layers containing discontinuities, as measured by the refractometer, of the order of 1 part in 10^5 in a verticaldistance of 1-2 metres. Analysis shows that these features are most marked at heights of 1-2 km. on the western edge of anticyclones, in a region of widespread downward air motion (subsidence). It is difficult to account for the observed radar echo in terms of partial reflection from a single sharp discontinuity, and an explanation based on multiple reflection or scattering seems more likely. At grazing incidence, however, the layers are probably sufficiently smooth over a Fresnel zone to give rise to partial specular reflection, at least at V.H.F; calculations based on this assumption are certainly consistent with measured signal data.

As a result of the above studies, we have a better understanding of the nature of major inversion layers, but many problems remain. The true vertical gradients within the layer are still uncertain, and plans are being made to fly a refractometer with spaced cavities above the radar located at the mid-point of a tropospheric link. Low-level gradients over the seaalso require further study.

We hope to investigate the structure and motion of the layer-type discontinuity with a refractometer on a captive balloon, by spaced receiver measurements, and by oblique soundings with the radar. The small fluctuations of refractive index, important in relation to spectral theories of turbulent scattering, will also be studied.

J. A. L.

A NOTABLE ANNIVERSARY

The Science Museum is currently celebrating the anniversary of an event which would probably have manifested itself late in the first quarter of this century. That it was deliberately sought after in the century's first year, and in the face of considerable theoretical opposition, supports the idea that one man's intuition can sometimes equal many years' application of more pedestrian methods.

On 12th December 1901, Guglielmo Marconi, then 27 years old, signalled across the Atlantic using electromagnetic waves. Since 1896 he had increased the efficiency of his system of telegraphy to such a degree that a range of 200 miles was possible. Lodge's principle of resonance had been successfully applied, and the coherer detector refined to a degree that made it a reliable telegraph instrument, instead of a capricious laboratory device. The time had come to attempt really long distance signalling.

Examination of the problems involved produced a body of opinion which maintained that, even after allowance for diffraction, the curvature of the earth was too great to permit any field to exist at a very distant receiver. This was

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correctly deduced from the knowledge of workers well versed in electromagnetic wave theory. Marconi, however, intuitively doubted their initial premiss; many years later he said 'From the time of my earliest experiments, I had always held the belief - almost amounting to an intuition - that radio signals would some day be regularly sent across the greatest distances on earth'.

The experiment required that the transmitter should be of such power that only engineering techniques would suffice, and to this end J. A. Fleming, Professor of Electrical Engineering at University College, London, was asked to help in the design of the plant. He had no precedent, for all previous work had used what might be termed 'laboratory scale apparatus'.

The sites chosen were Poldhu, in Cornwall and, at first, Cape Cod, Massachusetts. Enormous aerials were built at both places; they were in the form of a 'funnel' or cone of mines, suspended from a 200 ft. diameter ring of 20 masts 200 ft. high. From his considerable experience Fleming evolved a system in which a 2 Kv. alternator, powered by a 25 h.p. oil engine had its output transformed to 20 Kv. and applied to an ingenious circuit which suddenly discharged a massive condenser through a spark gap, producing powerful damped radio frequency oscillations in the aerial. The frequency was probably of the order of 100 Kc/s with a peak power of 20 to 25 Kw. though no measurements appear to have been made.

Work progressed during 1901 until September, when the Poldhu aerial was wrecked by a gale, and it was replaced by a simpler structure, a fan of 50 wires 160 ft. high, between two poles 200 ft. apart. Shortly after this a similar fate overtook the Cape Cod masts; but it was decided to carry on, using a balloon or kite to support the receiving aerial at a new site, St. Johns, Newfoundland.

It was realised that the fluctuating height of this aerial would make tuning difficult and an aperiodic receiver was decided upon. This was a circuit using a coherer, cell, and telephone wired in series, the coherer also being in series with the aerial and earth. In place of the more usual filings detector which changed from high to low resistance in a radio frequency field and was only restored to its initial state by mechanical shock, it was decided to experiment with so-called self-restoring types. These generally followed the form attributed to Castelli and used in the Italian Navy. The action appears to have been a mixture of coherence and, possibly, rectification, produced at the junction of a globule of mercury and carbon or iron rods. Such a device, though incapable of working a relay, would, when used with a telephone, form one of the most sensitive detectors at that time. The telephone itself was rewound to give maximum efficiency.

With this simple apparatus, and 400 ft. of aerial supported by a kite, Marconi listened at St. Johns. It was arranged that Poldhu should send a

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series of three dots, (the morse letter S) long signals might have overstrained the transmitter. On 12th December at about 12.30 p.m. a sequence of triple 'clicks' was heard, and continued to be heard during the next day.

The experiment had succeeded; the possibility of the rarified upper atmosphere being ionised, and forming a conducting shell to reflect energy to distant points, had been overlooked, although at intervals throughout the nineteenth century it had been considered for other reasons. Biot hinted at it to explain the aurora, and later Balfour Stewart proposed it in connection with magnetic phenomena. At its outset the 20th century was forced to reconsider an aspect of the earth's environment.

Suppose the experiment had not been performed. A system giving efficient communication over 200 or 300 miles was not likely to be abandoned, commercial interests would, doubtless, have clamoured for improvements in traffic handling capability, and there seems to be no reason to assume that, apart from long distance work, progress would not have continued in the manner, and at the speed at which it actually did.

The need for continuous wave generation had long been remarked; Duddell, Poulsen, Goldschmit and others were making efforts in this direction. Some of these workers, together with Ruhmer and Fessenden, were considering wireless telephony and by 1906 this was achieved over a distance of 200 miles. At the same time detectors were not neglected; the magnetic receiver, based on early work of Rutherford, was much in use; the crystal rectifier of Dunwoody and Pickard, Fleming's thermionic diode, and, most significant of all, De Forest's triode, were also used. By 1912 simultaneous work on this device by Meissner, Armstrong and De Forest himself, had caused it to fulfil the function of a continuous wave generator, amplifier, and later, a regenerative detector of unprecedented sensitivity. None of these steps would have been affected had Marconi not carried out his experiment.

Surely it is not too much to suppose that by 1920 or so anomalous propagation far beyond the theoretical limit would have been noted, and the need for a revised geophysical model forced upon science. The success of 1901 brought this about 15 to 20 years earlier.

Pure and applied science should be mutually stimulating; ideally the two merge to form a continuous range of activity; and this early work of Marconi's exemplifies such a union. His success in the applied science of wireless signalling posed questions about the basic physics of the upper atmosphere and provided a field of pure research which, 60 years later, is still not exhausted. Might it not be claimed that the positive result of this 'applied' research has helped almost as much as the negative result of the 'pure' studies of Michelson and Morley in the increased understanding of the true nature of things.

G. W. G.

THE JOYS OF TRAVELLING

Time to spare?
Go by air!
More time yet?
Go by jet!

Modern air travel is fast and, on the whole, comfortable - if you are not too tall or fat - but it still has a few unavoidable snags. Statistically these turn up on less than 10% of the journeys but statistically highly improbable sequences can and do occur. This was my experience in the U.S.A. and Japan. Over three-quarters of my air journeys were subject to delay, diversion to another airport, misconnections and similar perturbations! This was particularly inconvenient on the jet flights. These are so fast that it often takes longer to get from the town to the airport and through the checking-in formalities than actually to fly to your destination. Thus if the plane breaks down or is grounded for weather it is seldom possible to leave the airport: 'Another announcement will be made in 30 minutes'. It is surprising how long 10 successive 30 minute periods can seem at the average airport!

Most U.S. Airports are liberally provided with shops, restaurants and chairs but it is usually necessary to stay within range of the public address system (not HiFi). This gets distracting after a time even apart from the difficulties of translation into English which usually prevents any attempt to work while waiting! I found it possible to collect much material for a thesis on 'The American Novel and its use in Geophysics' but it was usually more interesting to chat with other passengers. There are also usually Motels or even Hotels within easy distance. They are needed as it is not unusual for 1000 passengers to be stuck at the same time. The overnight bag is then an essential as the checked baggage is often unreachable.

The different airlines are in competition and dislike transferring passengers to each other, or to surface transport, unless it is clearly impossible to complete the journey by the planned route or at least by their planes. It is possible to insist - if you know the timetables accurately-but even then the change is complicated and difficult. However if time does not matter it is certain that you will eventually arrive at your destination by just leaving it all to the airline agent. The route may, however, be curious.

On one trip East I arrived at a small airport some 60 miles from my destination to find that my connection did not fly. 'Why not go by road??' Oh no, we cannot arrange that but we can fly you to Boston and then back on your ticket. The result, a 150 mile flight to Boston, five hours to wait (the plane of course missed the connection), then a 100 mile flight back. A small typhoon blew up as we approached my destination. It was very dark and bumpy and the plane was thrown about severely. The air conditioning broke down and we

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overheated. Finally we dropped some 500 feet with everyone straining their seat belts and the pilot decided to fly on to the next airport on his route - near the Canadian border. We finally returned by car, an exciting ride of some 150 miles through floods and fallen trees reaching my destination just 12 hours late. Still it was a cheap trip at under £3 for the 60 (nominal) miles. And so it went on: Baltimore 8 hours (hydraulics), Chicago 8 hours (thunderstorms and engines), Boston 6 hours (burnt out wiring), Seattle 14 hours (fog) and 12 hours (engines), Anchorage 4 hours (plane never arrived), San Francisco (fog), Salt Lake City (forced landing - engines), Tokio (typhoon), Honolulu (engines and hydraulics).....! Honolulu was a wonderful place to be stuck in. We stayed overnight in luxury which was well worth the memory of an exciting take off which we only just made, a flight to jettison fuel and a landing with fire engines chasing us down the runway!

One can have too much excitement and I decided to try some train journeys. My first, from Fairbanks to Anchorage looked ominous. The timetable stated 'Main Line: No responsibility for delays due to Moose on the right of way'. In fact the train was on time, the only delays en route occurred when it stopped to sell cups of coffee to fishermen in the wilds. However we had wonderful views of Moose, Grizzly Bears, Mountain sheep and the country. I stayed the night near Mount McKinley, the tallest hill in the U.S.A., and toured the National Park, recatching the train the next day. All my train trips were equally successful, from Denver to San Francisco across the Rockies and the great desert, San Francisco to Los Angeles, Kyoto to Tokio and even the much despised line from Washington to New York. It was good to relax on the Queen Mary (also on time) but I shall be quite glad to stay at home this Xmas - if the plane from Nice actually manages to get me home in time!

W. R. P.

STAFF NEWS

(2nd November - 1st December 1961)

Congratulations on their engagement to: Paul Dickinson and Margaret Williams

Congratulations on their Promotions to:

Mr. J. E. Pearson (Falkland Islands) who becomes a Scientific Officer as from 18th September 1961

Mr. M. A. Hammond, who changes from Temp.A.E.O. to A.E.O. from 16.11.61

Congratulations to: David Croom on his Ph.D.

Recent Arrivals - Welcome to: Miss K. Sumner (Clerical Officer Secretary)
Mr. S. J. Watford (Mechanic)
Mrs. M. Wetton (Supt. of Typists)
Mrs. Y. M. H. Wood (Temp. Typist I, part-time)

Movements: Mr. Luscombe has recently returned from a short visit to Ottawa and Boulder in connection with the topside sounder project.
Mr. Wilkins, Mr. Piggott, Dr. Minnis and Dr. King are now attending the URSI conference in Nice.

SPORTS AND SOCIAL CLUB

The last newsletter of the year gives us an opportunity to review the present state of the Sports and Social Club activities.

We have an excellent membership; out of the 189 people employed by the Radio Research Station (of whom 15 are at outstations), there are only 33 who have not yet joined the club, and 5 of these are at outstations. These figures should be obsolete by the time the newsletter is circulated, because of the rapid recruiting rate!

For those 33 nonmembers, and for any others who may not already have the information, here is a list of some of the Sports Club activities, showing the subscription rates (if any), the number of people who already subscribe to the section concerned, and the people to contact if you are interested in taking part.

Section	Contact	Subscription	Paying Members
Amateur Radio	Ray Flavell	5/- per yr. 6d. per month	20
Badminton	Margaret Peart	3/- per evening	16
Bridge	Drs. Bain or Bramley		
Camera Club	Stan Baker	7/6 per yr. 9d. per month	9
Concerts & Ballet	Jeanette Biggs		
Cricket	Vic Owen		
Table Tennis	John Reed		
Tennis	Richard Smith or Paul Dickinson	Summer £2 - Winter 10/-	25
Theatre Trips	John Reed		

A resumé of the major events of the year is given below:

March: Spring Dance

June: Car rally organized by Miss Williams and Mr. Juleff. Amateur Radio Society formed with Mr. Froome as Chairman.
Cricket Match May's XI v. Owen's XI
Camera Club monthly exhibitions started

July: Lawn Tennis Match - R.R.S. v. R.R.L. at Harmondsworth
Hard court construction started by Contractors

Aug: Hard court opened by Director. Tournament followed by Tennis Dance

Sept: Lawn Tennis Match - R.R.S. v. R.R.L. at Harmondsworth
Doubles tournament at R.R.S.
Thursday evening Badminton started

Oct: Bridge season began

Nov: Bonfire night party followed by informal dancing

Dec: 1st Bridge Match - R.R.S. v. N.P.L.II - Lost by 400 points
16th. Pantomime and Christmas Dance - Tickets (inc.) 5/-.

SPORTS AND SOCIAL CLUB (cont.)

Bridge

A pairs competition was held at R.R.S. on 17th November. Twelve players were present. The winning N-S pair was Mr. and Mrs. Gordon-Smith and the winning E-W pair was Mr. Nicolson and Mrs. M. Smith.

On Friday, 1st December an R.R.S. team played the N.P.L. 2nd team at bridge at Teddington. Our team lost by 400 aggregate points. The team was composed of Drs. E. N. Bramley and J. Harwood; Mr. C. Nicolson and Mrs. M. Smith; Dr. W. C. Bain and Mr. A. C. Gordon-Smith; Messrs. A. J. Legg and V. Owen.

W. C. B.

N.B. Our apologies are due to Mr. Nicolson and Mrs. Molly Smith for having omitted them from the winning Bridge team in our last Newsletter.

Editor

Camera Club

The Camera Club had the usual show of Prints during November: the subject being 'Architecture'. As members will be busy with Christmas activities during December, we do not intend to hold an exhibition of Prints this month. To make up for it, we hope to have an exceptionally good show in the New Year.

The subject for January is 'Table Top Photography'.

We should like to wish all members a very Happy Christmas and a Prosperous New Year.

S. J. B.

Amateur Radio Society

We were very pleased to welcome our President, Mr. Ratcliffe, and our Vice President, Mr. Wilkins, to Mr. Shearman's talk on the Ionosphere, held in the Canteen on November 20th. Together with two visiting amateurs from the A.C.O. introduced by Mr. Wilkins and a fair representation of our regular members we saw an interesting film of back-scatter observations and heard a very useful account of what the radio amateur ought to know about radio propagation.

Since many of our members do not seem very enthusiastic about the construction of equipment for the Society, this is being taken over by a Sub-committee consisting of Messrs. Golton, Weeden, Clough and Flavell who have begun work on our first venture, the top-band transmitter.

As pantomime rehearsals and other Christmas activities are keeping many of our members busy in the evenings there will be no December meeting, but we hope to get off to a flying start in the New Year with a Hi-Fi meeting. Please watch the notice board for details.

In the meantime we are investigating the extent to which the Society could co-operate in Project Oscar, the American Satellite with a transmitter in the 2m Amateur Band.

Best Wishes for Christmas to all our friends.

R. G. F.

HISTORIC PHOTOGRAPHS

The Slough by-pass is making giant strides: 'our' bridge is finished, the new ditch is full of water (and ice), everywhere are heaps of sand, mud and pipes, and menacing machines smooth the vast road-surfaces-to-be, even after dark. The scene is changing all the time - and Mr. Hargreaves' cottage is just a memory except to those farsighted enough to purchase some of the fourteen photographs published so far.

Over 270 copies have now been sold and the total amount of £3 3s. 6d. has helped the Sports Club Fund and also paid for two sets of recent photographs sent to our colleagues overseas in time for Christmas, with our best wishes. Nostalgic memories of Ditton Park may well be revived by these pictures of devastation. 1962 should see the end of the transformation, which will be marked by the publication of a final series '... and after'.

W. S. N.

DEFINITION OF A RADIO ENGINEER

"A person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude an infinite series of incomprehensible formulas calculated with micrometric precision from vague assumptions based on debatable figures taken from inconclusive experiments carried on with instruments of problematical accuracy by persons of dubious reliability and questionable mentality for the avowed purpose of confounding and annoying a hopelessly chimerical group of esoteric fanatics referred to all too frequently as practical radio men."

(from "The Monthly Median" 1949)

LETTER TO THE OUTSTATIONS

Dear Colleagues,

I expect you will all be sorry that you can't be here to say goodbye to Ramsay Shearman and to wish him well in his new job. As you know, he has helped very many people here with their problems and we all greatly respect his clear mind and graphic approach. I personally have worked with him for many years, but I have never once known him to be "too busy" to help anyone immediately with their difficulties. I think you will all agree that Birmingham University are very lucky to have him on their staff.

This seems a fitting time to tell you about some of our proposals for the 1962 Newsletters. In the January issue the Director will be summarizing current projects, and we will also bring you up-to-date on who is working on them. Geoff Gardiner has kindly agreed to write a "history" of the Radio Research Station since its earliest days, probably in six instalments, which should interest all readers and is a task for which, as you will see from pages 3, 4, and 5, he is well qualified.

The photographs of the Station's new outlook should have reached at least some of you by now, but they don't show the gravel which has now been laid or the final appearance of the bridge. We now only have occasional bogged-down lorries to interest us during the lunch hour.

May we expect a New Year letter from any of you, saying how you find the Newsletter and bringing us news of your activities?

Yours sincerely,
The Editor