R.R.S. Newsletter

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COMMUNICATIONS IN UNUSUAL MEDIA

by

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Part I

Several papers were presented at the North East Electronics Research and Engineering Meeting in November 1964, in Boston, Mass., which describe some unusual methods of communication. Possible modes of transmission between underground points are considered. Much of the work in this field is classified but this report summarises three general unclassified papers on this subject.

1. SEISMIC COMMUNICATIONS

Seismics have been used for short distance communication in the past to some extent by oil companies and geophysical prospectors. Seismics offer a possibility of long distance communication and although a seismic communication system would be expensive, and the data rate would be very low it might be a useful method for survival communications between hardened sites in time of war.

Consideration of the propagation of compression waves through the earth shows that at distances up to about 500 km, the amplitude of the received signal is inversely proportional to the distance between the transmitter and the receiver. Between 500 and 1000 km there is a shadow zone in which the received signals are very weak, but the amplitude is high again at distances between 1500 and 4000 km. Furthermore, the attenuation is quite low in this latter zone. This phenomena may be accounted for by a channel or wave guide mode of propagation. These characteristics have been confirmed by practical tests which have been made on the propagation of seismic waves from nuclear underground explosions.

For communication purposes signals would have to be provided by some type of waveform generators rather than by an explosion. Such a generator would have a rather low efficiency of production of compression waves but its output could be increased by using phased arrays

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It would be advantageous to bury the transmitter and the receiver as deeply as possible in the earth, for example in abandoned mine shafts in order to avoid transmission through the crustal layer in which multipath propagation and high attenuation occurs. Deep placing would also provide a closer coupling to the earth's mantle, and would reduce both the generation of surface waves and the microseism noise at the receiving end.

Much has still to be learnt about the propagation of seismic waves through the earth and little is known about their use for communication purposes. However, it does seem feasible to use such a means of communication between deep holes as far apart as the east and west coasts of the U.S.A., although the data rate would be extremely low.

2. RADIO PROPAGATION THROUGH ROCK STRATA

Recently there has been an interest in the use of radio propagation in the earth's crust for application to communications between hardened sites. Propagation between antennas immersed in the rock strata, may take place either directly through the rock, or via an "up over and down" mode between the two stations, or it may also have multipath modes in which waves are reflected from layers.

Early work was carried out on Cape Cod, with linear antennas in holes in the rock about 1000 ft deep. The conductivity in the vicinity of each hole varied rather irregularly with depth from 0.4 to 10 mmhos/m, and the value was almost independent of frequency in the ELF-VLF spectrum. The bulk conductivity between antennas separated by about a mile, was obtained by independent measurements made on the surface and was between 1.1 and 1.6 mmhos/m.

Owing to the high value of the conductivity over the path, the useful frequencies for communication over a distance of 1 mile were limited to less than 7 kc/s. With these high conductivities, the range attainable for a practical communication system using the "direct through" mode is small.

In order to obtain more data, work was transferred to sites in the Adirondacks in N.E. New York State, where it was believed that lower conductivities would be found and where, in addition, some holes 4000 ft deep already existed. The conductivity of the media surrounding the drill holes was deduced by measuring the resonant frequency of insulated monopole antennas in the holes, and from the input impedances of short dipoles. The latter were also used to explore the variation of conductivity with depth by measuring impedance as a function of depth. The conductivity of the intervening medium between the transmitter and receiver was determined by measuring the magnitude and phase of the mutual impedance between separated antennas.

The local conductivities in the various drill holes were not found to vary significantly from a frequency of 20 kc/s down to D.C. In some locations the conductivity was as low as 0.1 mmhos/m and was quite uniform with depth. In other areas large discontinuities were found attributable to known faults or fractures in the underground strata. Transmission tests were conducted between the various holes at frequencies up to 50 kc/s and path lengths up to 6000 ft.

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It was also observed that when an antenna was lowered below the overburden the signal strength would be maximum at a certain depth. In one case, for example, the amplitude of the received signal was maximum at a depth of 350 ft. The strength of the received signal also increased with the frequency. The longest range of transmission was over a 3 mile path and in this case there was evidence of both "through the rock" and "up over and down" modes of propagation. It was found that the noise level in the rock, below the overburden was some 40 or 50 db below that measured above the surface at 50 kc/s. The early tests at Cape Code used a power of only about 100 W but in the New York State tests the input power to the transmitter was 10 kW.

From these tests it was concluded that the usefulness of "through the rock" mode of propagation is limited in frequency rage and in distance owing to the low bulk conductivity over the intervening path. The possibilities of communicating between any two points can be predicted approximately by making full use of the geological information of the area together with some site tests. Measurements and site investigations have been made by the Air Force Cambridge Research Laboratory in different parts of the country.

To be continued

LASING AT WINKFIELD

No, there is nothing wrong with the above spelling. I cannot, of course, speak for the Minitrackers, our kind hosts, but we, the Laser Group, have certainly been very active. Some of you may have seen that splendid photograph which appeared in one of our better Sunday papers showing four of us in, to quote, 'a precise pose for precise work' in front of a searchlight mirror. What, precisely, are we up to?

Ever since its launch on 9th October 1964, U.S. Satellite Explorer XXII (alias S-66 or BE-B) has been the unenviable target of blinding bursts of monochromatic, coherent light from ruby rods aimed at it by various 'Goldfingers' in the U.S.A., France and Berkshire. For the underlying principles of physics I would refer you to Dr. Bain's note in R.R.S. Newsletter No. 22 of February 1963 but suffice it to say that the beam emitted is very narrow and represents a well-defined burst of energy microseconds in duration. Explorer XXII is not quite defenceless - it has been equipped with an array of mirrors designed so as to reflect in the direction whence it came any light that hits it.

Our laser is mounted near the top edge of the searchlight mirror which can be turned and tilted in any direction by the two trackers seated on either side of it and peering intently through telescopes. On a fine, clear winter night (so rare and, Oh so cold), with no moon to speak of, they might spot S-66 on its predicted path gleaming in reflected sunlight. Instantly they will be galvanized into action - frozen limbs permitting. The safety officer near at hand scrutinizes the sky for aircraft - London Airport has already been alerted and is holding all traffic - the camera-cum-electronics

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operator in his little hut is all set (or should be), shouts ring out: 'There she goes .... - up a bit .... faster! ..... stop .... no, the other way!!**!!' At last, the trackers get their target on the cross-wires, press foot-switches and the laser is fired with a sharp crack.

About 8 ms later a faint 'echo' of light should return to be collected by the large mirror, amplified, displayed on a c.r. oscilloscope screen and photographed. Knowing the speed of light we can then determine how far away the satellite was when hit.

On the 14th January 1965 at the uncivilised time of 0453 h we tracked, we fired, we scored (we think) - and again about 90 s later. Just then the satellite was about 1250 km away and the photographs obtained show, amongst others, pronounced echo spikes confirming the predicted range to be better than 5 km, but more shots would have been needed to turn our surmise into certainty. Unfortunately moon and weather were against us and S-66 went into eclipse before we had another chance to shoot.

The Americans have claimed some successes with their much more refined techniques but even there the echoes obtained have been fewer and weaker than expected. Now the French say that they have registered three hits from a high-altitude observatory in Provence - unfair competition, with their superior atmospheric conditions. Eventually we intend to fire the laser blindly, not in the colloquial sense, of course, but with its direction of aim and instant of firing accurately predicted, for use in daylight perhaps, when the satellite will be invisible. Two new huts have already appeared at Winkfield and one of them will soon house a special 10" telescope and tracking mount. With the aid of precise timing circuits we should then be able to determine the range of our target with an error not exceeding a few metres, rather than kilometres, something no other method can possibly achieve.

I would like to take this opportunity of thanking all of you who kindly volunteered to help us in our tracking operations - to gaze at stars in the sky in the cool of an evening while others are content to watch more ephemeral stars on flickering screens in their overheated homes. Explorer XXII should come out of hiding again early in March and, weather permitting, will find us well armed and ready to lase at the slightest provocation - any volunteers?

W. S. Newman

CHRISTMAS AT BUTLIN'S

"Staff Entertainment" was what lured me to join the staff at the Clacton Camp. Change, I thought, food, board, money and entertainment. All of it came true with one extra: cold, cold weather.

A mini-bus collected a few of us from the station in Clacton. At the camp we were allocated chalets. There were four bunks, a wash basin, a chair and plenty of drawers in each. A New Zealander was already unpacking when I got to mine. There was little to unpack though and much to explore. We

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started with the staff canteen. The entrance to this place was at the end of a 200 yard struggle against the cold wind blowing from the sea. Later, having gone through this agony six times a day (the return journey was just as bad) I couldn't help thinking of the murder mile back in Cyprus.

We had sausages and bacon that night. It was a disappointment to all. Later, we sat comfortably in the South Seas Bar and chatted to new friends while an accordion provided our entertainment. There was a variety of people around. Teenagers to fifty-sixty year olds. I noticed a well-dressed and obviously well-fed barrel of a man. Later, I saw him in a cook's uniform, as I thought he would be.

The next day, having received the uniform of a Western Bar porter, (black striped shirt, blue waistcoat, white apron) I was free until the evening. In the bitterly cold weather I walked to Clacton. People were rushing about making use of the last few hours of Christmas shopping.

Back at the camp the first night of work was hectic. People seemed to drink all the time and everybody was kept busy until 1.30 in the morning. I decided that, at the rate they were drinking, either we or they would run out pretty soon. However Christmas Day and night passed followed by Boxing Day and night with no apparent slowing down sign from the guests. Eventually on Sunday night we did run out of the more popular drinks and were allowed to retire a little earlier than the previous nights (or mornings).

From the second day I had been there, I had already decided I was not spending my next Christmas at Clacton: not even as a guest. Though there was a lot of entertainment going on and the staff could join in most of them (when off duty) the cold weather stopped me from really enjoying myself. The different buildings were scattered over the camp and one always tended to stay put rather than face the cold. I managed to watch a few competitions, have a dip in the heated indoor pool, play table tennis and lose money to the one-arm bandits. Looking back at it now, I think I must have had a good-time. It was good fun passing double whiskies down the bar for the washer-up lady to empty into bottles. We drained these at a staff party one night, after the bar was closed. Almost everybody had enough drinks while on duty; we just had to be careful the supervisor did not catch us in the act as that was all she warned us against. Also to our satisfaction the food improved after the first night. Christmas dinner was complete with turkey, something I would not have had if I had stayed at home.

So, thank you Sir Billy for the money, the food (and the drinks), but no thank you, not next year; unless you manage to shift Christmas to a warmer day, that is.

U. Yilmaz

STAFF NEWS

Congratulations to:

Miss Audrey J. Jones, on her promotion to A.E.O.

Don and Joyce Mortimer whose application to adopt Simon Richard, a brother for Christopher and Alison, was granted at Slough Law Courts on 15th February.

Resignations

Mr. I. R. Pearson	T/A.E.O.
Mr. R. I. McKay	T/A.E.O.
Mr. M. M. Norman	T/S.A.
Mr. R. H. R. Wolfe	T/Telephonist
Mr. H. E. C. Fielding	T/A.E.O.

SPORTS AND SOCIAL CLUB

This has been a very quiet month, due to most people resting after Christmas festivities.

Unfortunately, owing to lack of support the Scottish Country Dancing has been discontinued. However for those interested the Slough St. Andrews Society hold fortnightly classes in St Mary's Church Hall every other Wednesday. I am assured that all are welcome.

At present the committee is negotiating with the House Committee of the A.C.O. with a view to holding a joint Dance. The function would be held here at R.R.S. and the provisional date is Friday, 26th March.

Final details are not yet settled, so watch the notice boards in the main corridor.

By the time this appears in print, we hope that the cigarette machine will have been installed, just outside the workshop door, initially selling only two brands, but if sales warrant we may expand later.

J. Juleff

Table Tennis

The Smith-Rose Cup Table Tennis tournament has been played off, resulting in a win by seven games to two for the North. Unfortunately, no ladies were able to play, but they can always enter for next year's competition, there now being time in hand for a bit of practice beforehand

C. D. Lovett

Bridge Club

Club evenings were held on 8th January and 9th February; the next will be held on Friday, 19th February. The pairs tournament organised jointly with the Road Research Laboratory was held on 29th January at R.R.S. Twelve pairs played in the canteen: RRL pairs played in N-S positions and RRS pairs, augmented by two RRL pairs, in E-W positions. It proved to be an organisers'

evening· the RRL secretary, Mr Dawson, and his partner were the winning N-S pair and Dr. and Mrs. Fooks were the winning E-W pair. It is hope to arrange another pairs tournament before the end of the season.

The third round in the NPL Inter-Divisional League was played on 12th January, when Dr. Dickinson and Mr. Zavody and Mr. and Mrs. Gordon-Smith were placed fifth. The next round will be played on 23rd February.

Jean Fooks

Smith-Rose Cup

It is hoped to arrange a Badminton tournament soon. Will anybody interested please contact Miss Peart (Spur D) as soon as possible.

A. B. Lowe

Chess

Chess evening is on a Wednesday in the Dining Hall from 7.30 p.m. Please contact either Mrs. Drakeford or myself if you would like a game.

A. B. Lowe

LETTER TO THE OUTSTATIONS

Dear Colleagues,

It is now possible to go home in more or less daylight and some of us are starting to realise that having an experiment ready for next spring is no longer equivalent to postponing the task indefinitely. Apròpos spring and all that, news which reached R.R.S. too late to be included in the formal notices, is that Alan Smith (R.R.S. Port Stanley) plans to get married early next month. Everyone here sends their best wishes to him and to his fiancée. For Alan it will be a pleasing culmination to the interests and experiences of service overseas with R.R.S.

Among our visitors this month we are glad to see Eivind Thrane from Norway among us again, and also Professor Bhar from the Institute of Radio Physics and Electronics.

A curious rite is being enacted at Ditton Park. A number of jolly coloured rods about three feet high have recently been placed on various parts of the administration building roof. These, we are told, are snow gauges. It has not snowed, the four most westerly rods have blown down and anyway winter is on the way out. Nevertheless, a good statistician will doubtless be able to get something out of the results, even if it's only that they provided a paragraph for

Yours sincerely,

the Editor