it possible for the scientific worker to make research his profession (subject, of course, to efficiency), concrete suggestions regarding methods of achieving this are essential; and as the committee is a comparatively small body it cannot expect to be acquainted with all the relevant facts concerning the conditions under which research is conducted at present. To overcome this difficulty it is proposed to associate with the committee a number of advisory panels consisting of persons in the principal research centres in the British Isles. Will those workers (whether already members of the Union or not) who would be willing to supply the information required, or to make definite suggestions concerning possible methods of improving these conditions, please communicate with the undersigned or some other member of the committee?

The present committee consists of the following:—Dr. O. L. Brady (Chemistry, Imperial College), Dr. J. W. Evans, F.R.S. (Geology, Imperial College), Mr. W. F. Higgins (Experimental Physics, National Physical Laboratory), Dr. A. Holmes (Geology, Imperial College), Dr. H. Jeffreys (Mathematical Physics, Cambridge), Dr. F. Kidd (Plant Physiology, Cambridge), Dr. M. C. Rayner (Botany, General Branch), Dr. C. Shearer, F.R.S. (Zoology, Cambridge), Mr. E. Sinkinson (Chemistry, Imperial College), Dr. C. West (Plant Physiology, Imperial College), Miss D. M. Winch (Pure Mathematics, Cambridge).

HAROLD JEFFREYS.

St. John's College, Cambridge.

WIRELESS NAVIGATION FOR AIRCRAFT.

THE determination of the position of ships at sea involves dead reckoning and the use of sights on terrestrial or celestial bodies. Dead reckoning methods often give fairly accurate results, even when no sights can be taken. With aircraft, however, drift plays so large a part that dead reckoning methods are not sufficiently trustworthy. Hence the necessity for other methods for determining position.

Directional wireless gives a means of finding one's position under almost any conditions, and thus enables navigation to proceed in cases where it would otherwise be dangerous, such as in fog. It uses chiefly the well-known property of loops, that if the plane of a loop makes an angle θ with the direction of propagation of the waves, the E.M.F. produced in the loop is $E_0 \cos \theta$. The rate of variation of this with θ is greatest when $\theta = 90^\circ$, i.e. when the signal strength is a minimum, and bearings have hitherto been obtained by turning the loop until the minimum is obtained.

There are two distinct ways in which this navigation might be effected:—

(1) The aircraft should emit ordinary wireless signals and directional stations on the ground determine various directions of the aircraft, the central ground station working out the position of the aircraft and re-transmitting it to the aircraft. This method has been used considerably by the Germans.

(2) There should be ordinary transmitting stations on the ground which should transmit ordinary wireless signals, and the aircraft should determine bearings of each of these known

ground stations, the navigator working out his position from these bearings. This method has very many obvious advantages over the first method, such as the fact that an unlimited number of aircraft can work out their own positions at the same time, and also the fact that in case of warfare the position of the aircraft need not be disclosed to the enemy. This second method was adopted in the R.A.F. to a great extent.

In attempting to place directional gear on aircraft there were considerable difficulties:—(1) There is much extraneous noise on aircraft; (2) the space available on aircraft is not abundant, and in any case it is not easy to get large loops; (3) the possibility that the waves would be deviated in the neighbourhood of the aircraft, thus producing errors which would have to be determined.

FIG. 1.—A, main aerial; B, auxiliary aerial.

It was obvious that the best amplification of signals that could be obtained would have to be used. Even with the best amplification known, it was found that the extraneous noise was so considerable that the ordinary minimum method of using a loop aerial to find direction was of very little use. Because of the extraneous noise the minimum was considerably widened, and even with powerful signals there might be a region as large as 40° to 60° where no signals at all were obtained. It was hence necessary to devise some method by which signals could be heard whilst the bearing was taken. For this purpose the following method was devised:—

Two loops at right angles are used. These loops are rigidly fixed together and rotate round the same vertical axis. When one of these loops is on its maximum the other will be on the minimum. When the maximum or main coil is used alone, the maximum of the signals is first roughly obtained, and then the second or auxiliary coil is introduced, the connections of this second coil being reversed from time to time. If the main coil is on its maximum the reversal of the auxiliary coil will not alter the strength of the signals, but if the main coil is not correctly on the maximum the reversal of the auxiliary coil will give signals of different intensity; hence the method to employ is to rotate the coils, using the main coil alone until somewhere near the maxi-

On the ground, when two or more of these

The noise of the engines can be minimised by increasing the amplification of signals, but magneto noise cannot be eliminated in such a way because, as the amplification is increased, the effect of the magneto disturbance also increases. It was absolutely necessary to determine methods to cut out this magneto disturbance. It was found that the magneto disturbance was principally due to the emission of very short waves of the order of 5 to 30 metres. The most effective method for cutting out these disturbances was completely to shield the magneto system. The

FIG. 2.—Outward journey. Dotted line, thus — · — · — indicates actual track of machine as followed by map reader.

Long-distance flights have been made in which, under adverse weather conditions and without reference to the ground, by the sole use of directional wireless the machine was navigated with extraordinary accuracy. The details of a flight from Biggin Hill to Paris and back to Brighton are shown in Figs. 2 and 3. The aero-

plane was above the clouds half the time, and the navigator was in a position which precluded any possibility of seeing out of the machine. He was, nevertheless, able to direct the course of the machine, forecast the time of arrival half an hour in advance with an error of less than two minutes, and find the force and direction of the wind deflecting the machine from her course from time to time, such predictions being found to be accurate when compared with the meteorological report later in the day.

In certain circumstances excellent results can be

last fifty-nine years—for he had qualified to practise medicine, and had become a demonstrator of anatomy in the Royal College of Surgeons in Dublin before he was seventeen years of age!—and upon the development of the medical school in Cambridge, where he was professor of anatomy for thirty-six years. While acting as demonstrator in anatomy at the Royal College of Surgeons he was a student at Trinity College; at the age of twenty-five he became professor of zoology there, and eight years later succeeded to the chair of anatomy and surgery. At Trinity

College he developed that craving for encyclopædic knowledge which throughout his life he was continually striving to satisfy. He was especially devoted to the study of Celtic archæology and ancient Egyptian literature, and in his own subject his wonderful powers of memory and his persistent accumulation of facts by personal observation gave him a knowledge of the details of anatomy and the literature relating to it which was almost uncanny and at times disconcerting to those who sought his advice. For, without intending to discourage youthful adventurers in anatomical research, the formidable record of what had already been accomplished, which he was able to give quite impromptu to one who was contemplating some original investigation, was responsible for bringing to nought not a few budding aspirations. Prof. Macalister never seemed to realise the crushing effects of his vast erudition. In the latter years of his life he often discussed with the writer the efforts he had made to encourage men to do research, and his difficulty in understanding why so little came of it.

When he succeeded to the chair of anatomy in Dublin he took Sir George Humphry, of Cambridge, as his guide and master, and began a series of detailed investigations in comparative anatomy and especially myology; but when he became Humphry's successor he devoted himself more and more to osteology, and to the end of his life he continued to collect data and fill note-book after note-book with the records of his observations and admirable pencil drawings. Unfortunately,

only a relatively small proportion of these results have been published. When, from time to time, his friends pressed him to make his work available for other anatomists, he would modestly disclaim that any journal would find space for the contents of his voluminous note-books, or urge that they were always available for anyone to use; and, in fact, he was ever generously ready to give the results of his work to anyone who asked for them. Prof. Macalister spent his life in amassing facts, and avoided generalisation and the formulation of explanations

FIG. 3.—Return journey. Dotted line, thus — · — · — indicates actual track of machine as followed by map readers.

obtained when only one beacon station is available. This is especially useful when the beacon is at one's destination, when head bearings alone are used.
J. ROBINSON.

PROF. ALEXANDER MACALISTER, F.R.S.

IN the death of Prof. Macalister, at the age of seventy-five, British anatomy loses a singularly gentle and kindly master, who, in a quiet and unobtrusive way, exerted a great influence upon the teaching of his subject during the

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