from the transmitter.

In plain language, this means that with an effective beam transmitting antenna one kilowatt of radiated energy is as effective as 200 kilowatts from an ordinary non-directional antenna.

Even then, this is not the whole story, for we may apply the same principles to the receiving antenna with practically the same increase in efficiency—i.e., 200 times. Consequently, with effective beam antennas at both transmitting and receiving ends, the over-all efficiency increases something like 200 multiplied by 200, or 40,000 times!

Again in simplest language, this means that one kilowatt radiated from and into beam antennas is about effective as 40,000 kilowatts just "splattered" round! In addition, they eliminate one of the causes of periodic fading—the out-of-phase signal arriving from "over the other end" of the world—the long way round.

This periodic fading is at present one of the main troubles associated with amateur short-wave reception, and unfortunately the simple types of short-wave receiver favoured by the average short-wave listener are largely to blame for the accentuation of this surging. Special receivers are in use at the present time which give good, steady signals when the reception of the same station on an ordinary regenerative set would be surging in and out so badly that intelligibility would be reduced almost to zero.

Furthermore, by what is known as multipoint reception, this fading trouble may be still further reduced. Broadly speaking, this system consists in the erection of two or more receiving stations at points some distance apart, the basic idea being that when the signal at one receiver is fading that at the other station is steady, or vice versa.

By "mixing" the outputs from these two (or more) receivers, the fading at one receiving location is largely balanced out by the other station, and practically steady reception is obtained.

Such a receiving installation is, of course, not practicable for the individual listener, but it is more than likely that any scheme for Empire broadcasting would include the local broadcasting stations as an essential link, and that the special short-wave transmissions would be rebroadcast on normal wavelengths. The "Empire" broadcasts could thus with advantage form an integral part of our ordinary broadcast service—possibly form a special session. Any idea of a regular 24-hour reception service is as unnecessary as it is impractical.

Even without beam transmission and multipoint reception, but using a suitable type of receiver, a long series of tests have proved that short-wave reception from 5SW (Chelmsford, England) was sufficiently steady for rebroadcasting purposes in New Zealand over long periods, and this consistency could be further improved by the methods outlined above.

Numerous excellent rebroadcasts of PCJ—notably by station 4ZL, Dunedin—have gone a long way toward showing that rapid periodic fading is not a sine qua non of short-wave rebroadcasts. This station (4ZL) some time ago regularly rebroadcast PCJ every Saturday afternoon without a break for months, and the excellence of these transmissions was a byword in the southern city. The effectiveness of reception is largely a function of seasonal and hourly time against wavelength used.

If the transmitting wavelength is fixed, the daily period of best reception varies with the season, and there should be no insuperable bar to making slight adjustments to the time of the "Empire session" if it proved impracticable to alter the transmission wavelength at seasonable intervals. A point worthy of note is that none of the countries to be served lie within the initial skip distance of the wavelength ranges that would be used. The writer's idea has not been to attempt a detailed exposition of the factors involved, but to point out some of the lesser appreciated points.

The scheme is about as feasible as a commercial telephony system (already operating between England and Australia).

Surely, if private enterprise can initiate and maintain for years without fee or tangible remuneration such stations as the Philips-owned PCJ and PHI, the financial and technical objections to an "Empire scheme" are bogeys, rather than actualities.

PCJ Short-waver.

As the fame of PCJ is world-wide, and as it was the pioneer regular short-wave experimental station, some brief particulars of it will no doubt interest "Record" readers.

PCJ came into being in March, 1927, for the specific purpose of studying, experimentally, the problems associated with and peculiar to short-wave telephony transmission. It had previously been demonstrated that the band of wavelengths lying below 100 metres made possible phenomenal distance telegraphic communication with very small output powers—previous standards were revolutionised. The part played by world amateurs in this development is well known and appreciated.

Short-wave telephony, however, had proved until that time practically impossible; still, if telephony could be made practicable on these short waves, long-distance broadcasting would change from a dream into a reality.

The Philips Laboratories, at Eindhoven (Holland), with their innumerable resources, were certainly the best equipped to conduct such costly experiments. Not only was thought given to p ssible two-way communication with the Dutch East Indies, but also of a possible world-wide broadcast service—really a much more ambitious objective than the establishment of an "Empire" scheme.

Accordingly the wavelength was chosen with a view to obtaining good universal reception. The object of the experimental transmitter was definitely not record-breaking—in such case, a less carefully-designed transmitter would have sufficed—but to find out whether a really reliable broadcast transmission over very long distances was possible. In the transmission and propagation of the ultra-short waves, several very strange phenomena, that often can only be partly overcome, occur.

There is, for instance, the so-called fading effect familiar to all broadcast listeners. In the reception of the ultra-short waves, however, this effect is much more pronounced so that the strength of reception may vary several times within the space of a minute, or even of a second. There is further the influence of the hour of reception on the signal strength.

The most favourable time of reception depends upon the wavelength employed, an on the season of the year. The bad influence of fading, too, depends to a large extent on the wavelength employed, on the distance between transmitter and receiver, and on some other hitherto not fully known factors.

The propagation of the very short waves is entirely different from that of the long waves, and is of such a complicated nature that only recently scientists have got an idea of what really happens between transmitter and receiver. Constancy of the transmitted wavelength is of vital importance in ultra-short-wave telephony transmissions.

With the usual modulating systems the speech currents delivered by the microphone are intended solely to vary the amplitude, and not the frequency of the oscillations generated by the transmitter; unless special precautions, so-called "frequency modulation," takes place, causing acute distortion.

In the case of PCJ, frequency stability is obtained by the use of an oscillating quartz crystal—this is a thin wafer of quartz held between two metal plates. Depending upon the thickness of this quartz wafer it may be excited to expand and contract mechanically at a definite frequency and with great constancy.

These minute mechanical oscillations are accompanied by minute voltages developed, and these control the first valve in the transmitter, which valve, though it be only a small receiving type, controls the transmitted frequency of the entire transmitter, which may be radiating many kilowatts of energy.

The oscillations from the initial val are then multiplied in frequency in several succeeding amplifying stages until the desired transmitting frequency is obtained, by which time the valve proportions have grown from that of the humble Philips miniwatt to the huge 20-kilowatt water-cooled types having an input of 25 to 27 kilowatts and requiring a plate voltage of the order of 8000 to 12,000. The transmissions of PCJ have, of course, been reported on from every corner of the globe, and the careful analysis, co-ordinating and filing, of these reports has been a work of no small magnitude.

As a result, the Philips laboratories have accumulated a veritable wealth of data of particular significance to the establishment of a British Empire broadcasting scheme.

The idea of Empire broadcasting is, of course, not new. The following extract from the English paper, "Wireless World," dated as far back as April 27, 1927, is headed "Empire Broadcasting."

> "For the second time in the short history of broadcasting it has been left to Holland to steal a march on this country, and in fact on Europe generally. . . . Now again Holland sets the example by leading the way in short-wave broadcasting. . . . We congratulate Holland, and the Philips Company in particular, on the enterprise shown in establishing a broadcasting record, more especially as the purpose is apparently

(Continued on page 29.)