PCJ

SHORT WAVES AND LONG DISTANCES

A TALE OF INGENUITY AND SCIENCE

Printed in Holland.

HEMS

PCJ

SHORT WAVES and LONG DISTANCES

a tale of ingenuity and science

Presented by

PHILIPS RADIO

R 841 E. – 1/829

H. M. the Queen of Holland and H. R. H. Princess Juliana before the PCJ microphone

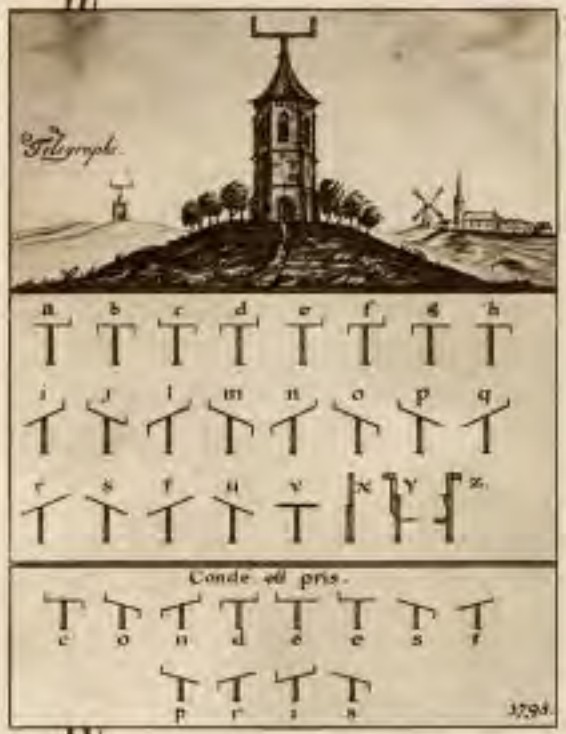
The history of mankind, as far as recorded, makes mention of many glorious pasts.

We read in old manuscripts about the ancient civilizations of the Indians, Chaldeans and Egyptians, about their mystic astronomical knowledge and about their mathematics, which probably already then had reached a high standard.

The history of the world tells us also about centuries in which the passions blazed fiercely, eras of seemingly endless wars, as well as centuries in which the oppressed peoples were still asleep and in which the spark of science was only kept alive in some monasteries.

Modern history commenced with a succession of great discoveries and inventions. The invention of the art of printing was the beginning of the new scientific age that culminated in the last century, the "age of the steam engine".

Our century however "the age of electricity" is the richest period in the whole known history of the world, miraculous and undreamed of possibilities are



Telegraphy in earlier days

A typical amateur short wave receiver

following one another. Yes, the age in which we are living, is surely the most interesting, the most romantic, and most adventurous of all times.

Certainly, we admit that the romance of duels and powdered wigs, of gallant knights, dragons and beautiful maidens belongs to the past, but the romance of the 20th century is on a higher level; it is experienced, bent over the microscope, when discovering a new bacillus, on the aeroplane, flying from continent to continent, at the radio-set, receiving a distress call from the icy wastes. The heroic deeds of our times are the marvels of science; its fascination lies in the triumph of the mind over matter.

One of the greatest scientific achievements of recent times is the one which enables us to bridge all distances.

This possibility, which even a short time ago scientists considered a thing of the far future, was suddenly realised when wireless telephony from one end of the world to the other proved possible.

And just because our age is so extremely rich in the applications of science, modern humans are getting somewhat supersaturated; yet, those who hear the voices of their fellow-men coming through the ether from the other side of the globe, cannot fail to experience a feeling of respect for this achievement.

It is already a good many years since we enjoyed for the first time the strange experience of listening in to a telephony transmitter.

Reception of the usual broadcasting-stations is no longer exciting; it has become a part of our daily life.

Ultra-shortwave reception, however, is by no means a common experience to most of us, on the contrary, it is a thrilling pastime packed with excitement.

A typical amateur short wave transmitter

A so-called QSL card received by PCJ

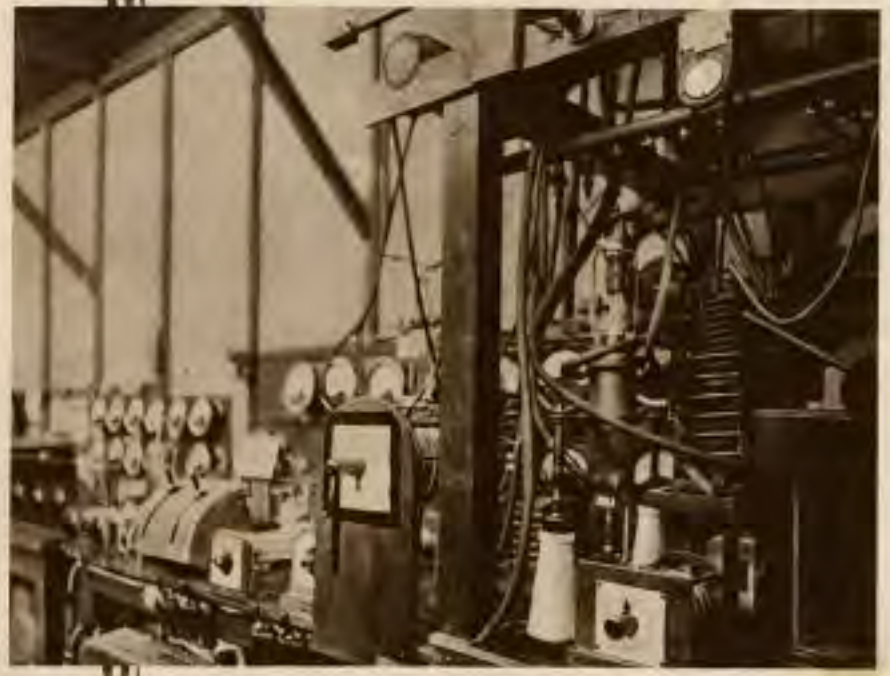
Imagine for a moment you are sitting in front of a good short wave receiver, the phones put on, or listening to the loudspeaker.

Just turn the oscillation control to check the performance of the apparatus; if everything is all right a slight hiss will indicate that the receiver is oscillating. Now carefully turn the vernier of the tuning control. Suddenly you imagine to hear traces of a signal, you turn back a little, again adjust carefully and then, with kind of a plaintive note, and ups and downs in the signal strength you hear the morse-signals from an amateur transmitter somewhere in the opposite part of the world.

Turning a little further, you tune in many of such transmitters, and if you have the advantage of being able to read the morse-code, you may read the signals of English, French, German, Scandinavian, Dutch, Russian, Japanese, American, Australian and many other amateur-stations.

Turn the dial still further and with a tremendous strength the rhythmic and clear-cut signals of some post-office automatic transmitter break in; it may be the transmitter of Nauen, Rome, Melbourne or Malabar (Java).

Still further the knob is turned and after passing a great number of official and amateur-stations you hear the whistle of a powerful carrier-wave. You turn away the reaction control, wait a moment and then ... the clear voice of the announcer telling you in Dutch, English, French, German, Spanish and Portuguese that it is the Philips experimental short wave station PCJ calling the world on 31·3 metres.



Power amplifying stage; in the background the oscillator stages

Radio telegraph services maintain contact between all continents and countries for the benefit of trade and traffic; but now the time has come to establish a "world broadcast" to unite all continents, countries and all out-stations and isolated communities. The active pioneering part the Philips Laboratories took in this, will be explained on the following pages.

PCJ and its purpose

Since it was proved that the radiowaves, under 100 metres, possess special advantageous features for radio transmission and make it possible to bridge the biggest distances with small power, radio has been revolutionized.

The extraordinary features of the short waves were soon utilized for telegraphic communications; but short wave radio telephony proved, until recent years, practically impossible.

To telegraph from Holland to the Indies on the long waves (over thousand metres) it proved necessary to use a power of some 300 kW. The long wave telephony transmitter of the Transatlantic Service (approx. 5000 km) also uses a power of some hundreds of kilowatts.

For wireless telephonic communication with the Dutch East Indies, on a very long wave, it would be impossible to construct a transmitter of sufficient power, to bridge the 20,000 km.

But the results obtained with short wave telegraphy made one wonder if it were not possible to establish a telephony service over the same distance with short waves.

Only experiments could prove if this were possible, and if so, to what extent.

Crystal oscillator and multiplying stages

The Philips Laboratories at Eindhoven (Holland) with their innumerable resources, were certainly the best equipped to conduct such expensive experiments.

Not only was thought given to a possible two way connection in the near future with the Indies (which has come into existence in the meantime) but also of a possible world-wide broadcast service.

The wavelength was chosen with a view of obtaining good universal reception.

The object of the experiment was not recordbreaking – in such case a less carefully designed transmitter would have been sufficient – but to find out whether a really reliable wireless transmission over very long distance was possible.

"There are more things in heaven and on earth...."

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 and 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

Six phase high tension rectifier

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.

Many experiments showed that the upper layers of our atmosphere play a very important part in the still insufficiently explained marvel, namely that the radio-waves, contrary to expectations, travel around the earth's surface.

Theoretically, radiowaves behave exactly as light, which can easily be understood, as both are phenomena of the same nature, that is to say an oscillation of the world-ether. A beam of light travels exclusively along perfectly straight lines and so does a beam of radiowaves. But if this is the case, how do radiowaves appear to bend round the earth?

One of the best known theories explaining this effect is that of Kennelly and Heaviside.

This theory assumes an ionised layer of gas at a height of 50–200 km above the earth's surface, which acts as a kind of bent mirror by means of which the radio-ray is reflected until it reaches its destination.

This theory of the "Heaviside-layer" proved to be insufficient to explain all observations, although it was proved that such a conducting layer exists in our atmosphere and that certain wavelengths at certain hours of the day as a matter of fact, are reflected as predicted by the theory.

According to results of the latest investigations, the radiowaves penetrating in the conducting layer alter their velocity, which results in a refraction effect that causes the waves to bend round.

Research, in its present stage, cannot yet explain sufficiently what happens to the radiowaves when

Some reports, press cuttings and QSL cards following the PCJ transmissions

The "five-language" announcer of PCJ before the microphone

leaving the aerial and before penetrating in the conductive layer, nor how the beam finally leaves the layer and reaches its destination.

The radiation from a shortwave transmitter is propagated in two manners: there is a wave propagated along the earth's surface that very rapidly dies away by absorption; the main part of the energy, however is radiated upwards at an angle depending upon the relation between wavelength and aerial-system, and leaves the earth's surface, being propagated under certain conditions, almost without loss of energy in the upper atmosphere.

This illustrates how it can be possible that a shortwave transmitter is received with great strength thousands of miles away whilst it is found impossible to obtain reception at a distance of a few hundred miles from the transmitter.

The "down" on the peach

Dr. Balth. van der Pol, of the Philips Research Laboratories, illustrated in a striking way the present stage of research by declaring on the occasion of one of his lectures: "We may consider the atmosphere as the down on a peach; this gives the relation of the thickness of atmosphere to the diameter of the earth. If we wish to telegraph to our antipodes we should not ask: how do we get from the surface to the down, but how do we get, without leaving the down, to the other side".

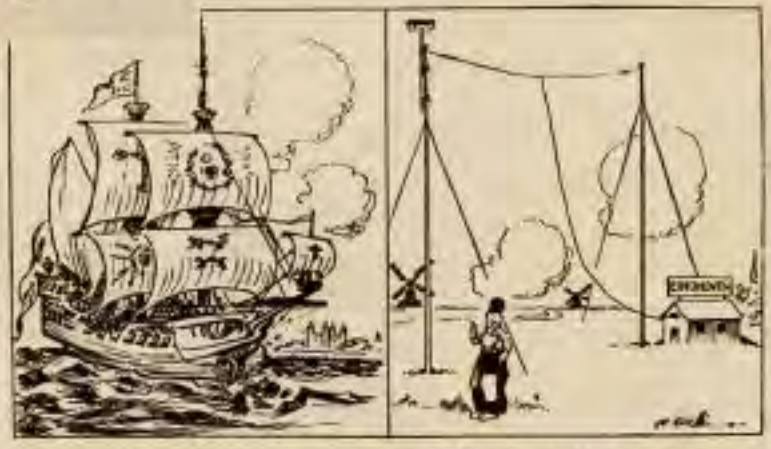
Crystal control

Telephony transmissions on ultra short wavelengths are often unsuccessful, because of the inconsistency of the transmitted wavelength.

Map showing places all over the world,

from where reports reached PCJ

A fine example of ancient Dutch art: Admiral Tromp, drawn by Jan Lievens



Commemoration Medal presented by the municipality of Eindhoven

With the usual modulating and receiving 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. Unfortunately, if no special precautions are taken, there will be "frequency-modulation", as it is called by the engineers, and this would cause a very bad distortion.

In the Philips transmitter, call sign PCJ, this difficulty has been overcome by the use of an oscillating quartz-crystal, which keeps the transmitting frequency constant between very close limits.

Some crystals show the so-called piezo-electric effect, discovered by Madame Curie. If such a crystal is compressed, an electromotive force is generated on its surfaces; the reverse is true, too – if an e.m.f. is applied, the crystal contracts.

In a crystal-oscillator this property of a thin plate of quartz-crystal, capable of oscillating mechanically at a very high frequency, is utilized to generate a current of very constant frequency.

In the PCJ transmitter the crystal-generated high frequency currents are amplified and multiplied several times until the desired transmitting frequency is obtained.

These currents are applied to a large watercooled transmitting valve type TA 12/20000 K having an input of 25–27 kilowatts at a plate voltage of 8000–12000 volts.

The generation of high powered short waves only became possible by the use of watercooled transmitting valves, a Philips speciality.

The Wireless World AND RADIO REVIEW

No. 490. Wednesday, April 27th, 1927. Vol. XX. No. 17.

EMPIRE BROADCASTING.

CONTENTS:

A Philips watercooled high-power transmitting valve for short waves

Dr. A. F. Philips before the microphone announcing the Mengelberg Concert

Results

The very first transmissions of PCJ during March 1927 became a huge success, as next morning a telegram was delivered in Eindhoven stating that the transmission was received with incredible strength, steadiness and purity by a radio-amateur at Bandoeng (Dutch East Indies).

Subsequent transmissions proved that this result was not due to sheer luck, but that a really reliable communication was established.

The stream of reports which has not ceased even now, began to flow to the transmitter at Eindhoven.

Reports were received from all parts of the world; many of them are indicated on the map to be found on pages 16 and 17.

Some of the reports, QSL cards and press cuttings received with reference to the PCJ transmissions are shown in the photograph on page 14; a reproduction of some very interesting reports appears on pages 22 and 23.

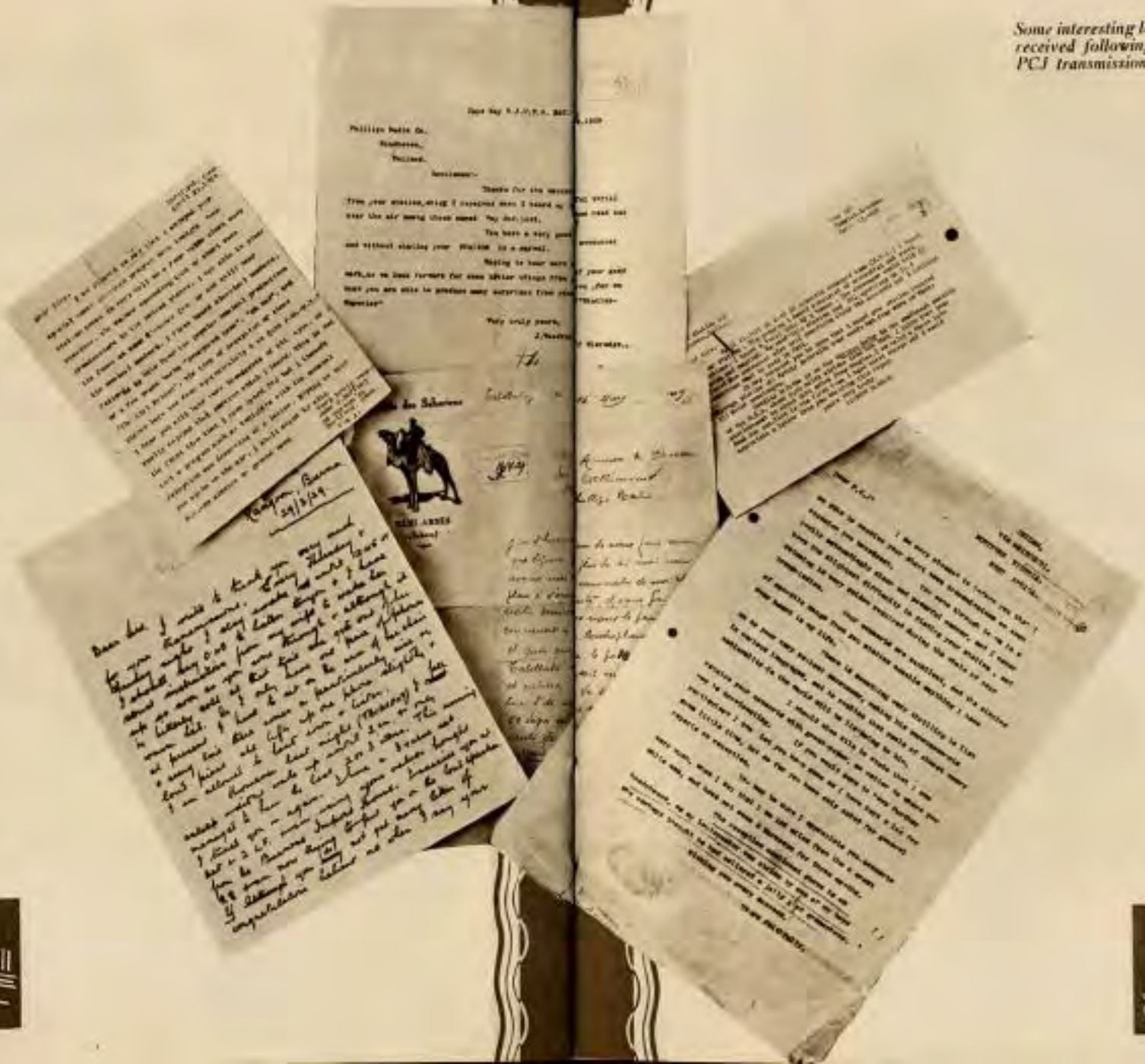
During 1927 several relays of the Daventry station, specially destinated for the British Dominions, were successfully carried out.

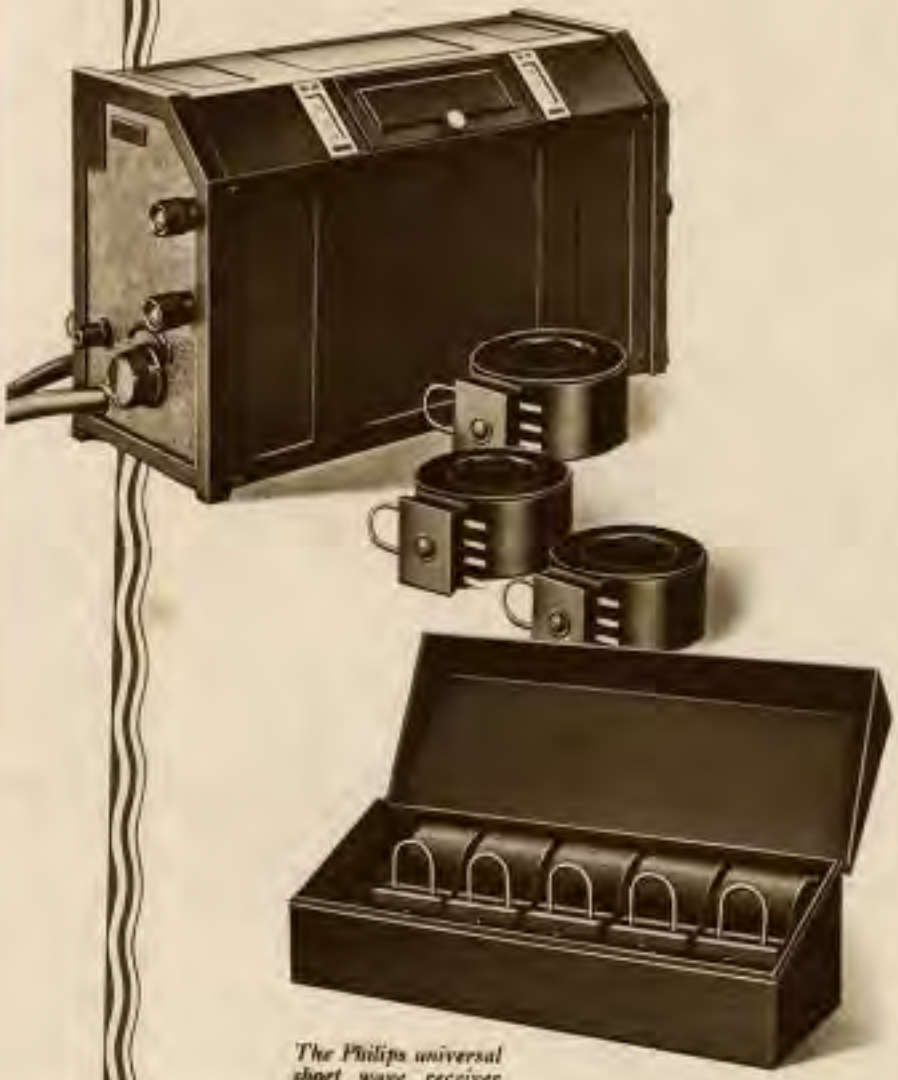
So splendid was the reception of these relays that it inspired the cartoonist of the British radio weekly "Wireless World" to draw the remarkable cartoon reprinted on page 8, with their kind permission.

Some very interesting photographs of the transmitter are reproduced on pages 8, 10 and 12.

During June 1927, the PCJ station had the great honour of receiving H. M. the Queen of Holland and H. R. H. Princess Juliana in its studio. The royal address to the Dutch East and West Indies was received with perfect clearness as stated in a radiogram received at

Some interesting letters received following the PCJ transmissions





The Philips universal short wave receiver

Eindhoven exactly eight minutes after the last word was spoken. On April 28th of that year, Beethoven's 9th symphony played by the Amsterdam orchestra and conducted by Dr. Willem Mengelberg, was broadcast to the world.

In the course of time many prominent personages entered the studio of PCJ to address the world and invariably with the same success.

It might be of interest to state here that up to now 20 different languages have been spoken before the PCJ microphone.

The reception of ultra-short waves

Although the methods of reception employed for ultra short waves are practically the same as those utilized for broadcast reception, some troublesome effects may occur which can render reception difficult if not impossible, if no special attention has been paid to the construction of the short-wave receiver.

Such effects are body capacity, high losses in coils and condensers, insufficient contacts, unstability and reaction of the low frequency amplifier, microphonic noises and some others.

Another rather annoying feature of many home built short wave receivers is their often violent radiation that may spoil all short wave reception within a radius of a couple of miles.

Philips engineers built a short wave receiver that meets all difficulties of this kind and possesses many other remarkable features. The Philips short wave set incorporates one stage R. F. amplification, which not only prevents radiation and improves the sensitivity, but adds greatly to the stability and ease of tuning.

"Radio encircles the World"

From a drawing by Louis Rosenstein inspired by the phenomenal success of PCJ

The R. F. amplifying valve is of the screen-grid type A 442. The tuning is done with a carefully designed condenser, provided with an efficient vernier control, which enables very fine tuning.

A variable condenser is also employed for the reaction control, which is smooth and easy throughout the tuning range which covers all wavelengths between 10 and 2000 m.

This is made possible by means of six interchangeable coil units, each containing two coils.

Interchanging a coil unit is very easily done by opening the small flap and pushing the coil into its socket.

The detector valve is of a non-microphonic type especially designed for this set. After the detector follow two stages A. F. amplification, each of which gives, thanks to the wonder valve A 415 and the special Philips transformer, an almost ideal amplification of 45 times. The last stage is provided with a penthode valve ensuring both perfect tone quality and big volume.

A very efficient volume and selectivity control is obtained by regulating the filament current of the R. F. valve.

This really universal set which makes reception possible of the ultra-short, the short, and the long waves, possesses still another most valuable feature, in its facilities for the connection of an electrical pick-up. In this way records may be reproduced through the loudspeaker with a hitherto never experienced volume and richness of tone.

The set has been designed with an eye to the often severe climatic conditions and is electrically and mechanically "tropic-proof".

It is interesting to state that the overall dimensions of this remarkable set are only $12^{3}/_{16} \times 7^{3}/_{4} \times 5^{1}/_{4}$ inches.

Either battery supply or a mains unit may by used.

A typical scene in Holland famous for its "bulbs" and its "waves"

PHILIPS
RADIO

MAKERS OF:—

Receiving Valves
Transmitting Valves
Rectifying Valves
Speakers
Transformers
Power Units
Amplifiers
Microphones
Condensers
Radioplayers
Rectifiers
Pick-ups
Neon Signs
X-Ray Tubes
X-Ray Apparatus
Lamps
Motor Lamps
Lighting Diffusers
Lighting Reflectors
Etc., Etc.

How to Make Your Short-Wave Radio All Electric

PHILIPS 3003 "B" and "C" POWER UNIT, £12/15/-.
PHILIPS 3000 "B" and "C" POWER UNIT, £8/15/-.

WE HOPE that this booklet will be instrumental in persuading many broadcast listeners to turn to the short-waves for a new thrill and a new and little-explored type of radio entertainment. Each night such super stations as PCJ and PHI Holland, 5SW England, 2XAF America, and RFN Russia, broadcast to all those who have short-wave receivers.

In this supplement we want to show briefly how present receivers can be made as simple and convenient as broadcast sets, and this information will also act as a guide to those about to explore the low wave-lengths.

PHILIPS 1917 TRICKLE CHARGER, £2/15/-.

POWER

NINETY-FIVE PER CENT. OF SHORT-WAVE RECEIVERS DERIVE THEIR POWER FROM BATTERIES, WITH THEIR ATTENDANT TROUBLES, owing to the fact that it is commonly believed that any A.C. operated device will introduce "hum" on these waves.

This is quite incorrect, however, when Philips Power Supply apparatus is used, for with a Philips "B and C" Power Unit and Trickle Charger, signals may be heard at their best and entirely free of any A.C. interference. This happy condition is brought about by not allowing A.C. current to enter into the wiring of the set.

This means that the D.C. tubes may be retained, and no alterations whatever are required to the wiring of the set. Filament heating is obtained from the usual accumulator, which is kept in a fully-charged condition by the trickle charger. THE INGENIOUS SWITCHING OF THIS CHARGER DOES NOT ALLOW THE RECTIFIED CURRENT TO PASS THROUGH THE FILAMENTS OF THE RECEIVING TUBES, as the charger will not operate until the receiver has been switched off.

As D.C. Tubes are used and heated from a direct current source, no hum can possibly develop in the filament supply or associated wiring.

IT IS USUALLY FOUND THAT RECEPTION IS STEADIER AND MUCH QUIETER UNDER THESE CONDITIONS THAN WHEN "B" BATTERIES ARE USED. Dry cells introduce many foreign noises, often attributed to static, and do not maintain their rated potentials over long periods under load.

'A' POWER.
'B' POWER.
'C' POWER.

TRANSFORMERS

For short-wave receivers, we recommend that the Philips Audio Transformer be added to any set not equipped with this component. It is of the high permeability type, and most compact in design.

When used with Philips tubes, the best possible matching will exist between tubes and their plate impedances. This is important when maximum sensitivity and quality reception is expected. It is made in one ratio, viz., 3–1, and is suitable for use in both the first and second stages of audio frequency amplifiers, where quality reproduction is of paramount importance.

TUBES

In short-wave work a special detector tube is desirable for satisfactory reception of distant stations. In producing the "Four-Fifteen" and "Six-Fifteen" tubes, the Philips laboratories have made available two super-sensitive detectors and first stage audio amplifiers, which only differ in filament voltage.

FOR THE LAST STAGE, THE B 405 IS IDEAL. This tube has an impedance of 2500 ohms and a mutual conductance of 2mA/V. These characteristics make the tube stand out as being really efficient for the output stage. When worked in accordance with the operating data, undistorted output is obtained from the speaker on all well-modulated stations.

PHILIPS 4003 AUDIO TRANSFORMER, 27/6.

PHILIPS B405 POWER VALVE, 15/-.
PHILIPS A415 SPECIAL DETECTOR, 13/6.