How to Rate the Power of Radio Stations

(By Carl Dreher in "Radio Broadcast.")

BEFORE broadcasting appeared to amuse and vex the world, radio engineers were concerned with the power of wireless telegraph transmitters. These, in 1916 and thereabouts, were mainly of the spark type, consisting essentially of a motor generator feeding 500-cycle alternating current to a high tension transformer, which charged a condenser in connection with a suitable spark gap and oscillating circuit, and so ultimately produced high frequency oscillations in a radiating antenna. Such sets, in America, were rated in terms of energy input to the primary of the step-up transformer. The most popular size of set for ship-toshore work was rated at 2 kilowatts on this basis. Possibly 15 per cent. of this energy got to the antenna, which therefore received something in the neighbourhood of 300 watts of radio frequency power. The set designers of that day preferred to talk about input to the transformer, for one reason which was obvious—the greater ease of measuring power at a commercial frequency and low voltage, and another reason which their self-esteem probably did not allow into the upper stories of their consciousness very often—the fact that 2000 watts sounded more impressive than 300, and did not illuminate the miserable over-all efficiency of the transmitter too unsparingly.

The Germans, however, with that tactless thoroughness which has given rise to various emotions in other peoples, were already rating their radio transmitters in terms of radio-frequency power in the antenna—"Turm-Kraft," as they called it, which, literally translated, means "Tower-Power." When a German said he had a 250-watt radio set, he meant that it could put that much energy into a suitable antenna. In the United States, when radio telephony came into its own, we adopted this basis of grading transmitters. Practice in this regard is not uniform all over the world, however.

This is pointed out by Captain P. P. Eckersley, chief engineer of the British Broadcasting Company, in an article on "Power: a Vexed Question," in the "Radio Supplement" (London) for March 5. Eckersley gives the following table for a "Standard 1½ Kilowatt Set":—

Point of measurement.	Power.	Used by
Total high tension input to set from transformers.	6 kw.	Some Continental organisations.
Power to anodes of oscillating vales.	1.5	British and all members of the Geneva Bureau for comparison purposes.
Power to aerial.	1.0	American and some Continental.
Meter-amperes.	300	Governments and scientific bodies.

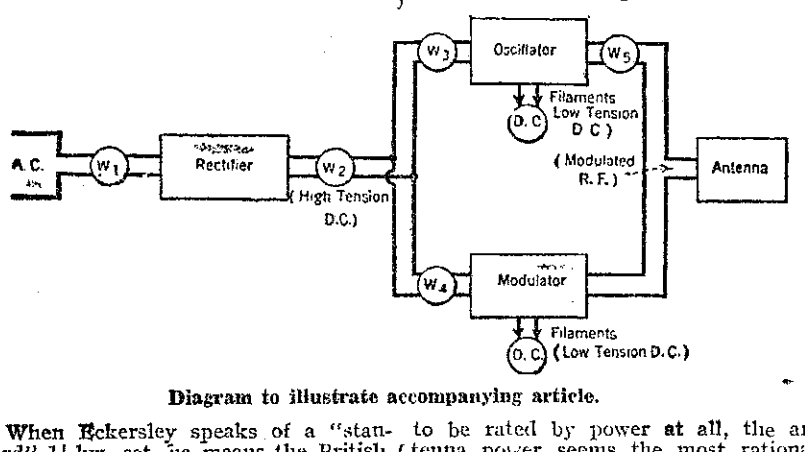

Diagram to illustrate accompanying article.

When Eckersley speaks of a "standard" 1½-kw. set, he means the British standard, of course. The British rate their sets on the basis of power delivered to the plates of the oscillators. As tubes now go, their efficiency in converting high tension direct current into radio frequency oscillating energy is about 60 per cent. Thus the power delivered by the oscillators to the antenna is about two-thirds of that received by the plates, or working in the other direction, if we multiply the output of the oscillators by 1½ we get the high tension input. It follows that to convert the power of an American station to the British standard, we must multiply by a factor of 1.5, while if we wish to rate British stations according to American practice we must multiply the nominal power by 0.66.

To me the American-German method of expressing power seems more logical. The output is what counts. The ultimate energy (radiated energy) is very difficult to ascertain, thus we are unable to follow the really scientific procedure of expressing the power of the station in terms of that quantity. The next best thing is to work in terms of radio-frequency power in the antenna. The antenna current may be measured with reasonable accuracy, and the resistance of the antenna at a given frequency is likewise determinable. The power equals the square of the current multiplied by the resistance—a law not confined to antennas. If telephone stations are to be rated by power at all, the antenna power seems the most rational figure to be chosen. If we are to stop at any point ahead of the antenna, the total input to the rectifiers is just as pertinent as the high tension input to the oscillators, and will please the press agent of the station much more. In the above table the 6 kw. rating is just as defensible as the 1.5 kw. rating, and perhaps more so, for there is some warrant for expressing the power of a machine in terms of the total input, when the output is in a form not readily measured. For example, we talk about a 0.5-kw. electric heater or flat-iron, this being the power absorbed by the heating element. In such cases the power consumption, which determines the operating expense, as well as the effect on the supply circuits, is the chief quantity of interest to the user.

To show how the power varies, we may analyse the actual conditions in one modern station at an arbitrary power level chosen for illustration only, and considerably below the full power and rating of the station. Fig. 1 will aid the reader in following the energy transformations involved. We start with the rectifier, which consists of 12 tubes fed from an ac. source, suitable alternating voltages being applied to plates and filaments. The first wattmeter, W1, reads 135 kw. The output of the rectifier is about 11 amperes dc. at 9300 volts, corresponding to 102 kw. on the d.c. side. This high tension power is split equally between the oscillator and modulator frames of the set. Thus, W2 being 102 kw., W3 and W4 will each equal 51 kw. As W3 is the plate input of the oscillators, the British rating of the set at this level would be 51 kw. Assuming 66 per cent. efficiency, the oscillators deliver 33.6 kw. of radio-frequency energy (W5). This would be the American power rating of the transmitter for the illustrative output power we have chosen.

Another factor, however, must be taken into account. The oscillators and modulators require filament current, which in this case is in the form of d.c. Each tube takes 45 amperes at 15 volts, or 0.675 kw. If eight oscillators and 12 modulators are used, the former absorb 5.4 kw. and the latter 8.1 kw. for filament heating alone.

The total power consumption of the set is 135 kw., a.c., and 13.5 kw., d.c., adding up to a total of 148.5 kw. The mean r.f. power delivered to the antenna is 33 kw., an approximate power efficiency, overall and for this particular adjustment, of 20 per cent. Of course we must take into account, in comparing this figure with efficiencies of other machines, that we require at least as much energy to modulate the carrier as to produce it in the first place. Another element which prevents the over-all efficiency of even the best modern radio transmitters from attaining a more respectable level is the fact that several units must function in tandem, owing to the peculiar nature of the machine as a whole. The rectifier has an efficiency of about 75 per cent., and the oscillator of 65 per cent., which are middling good performances in the field of energy transformation. Taken together, however, they drop somewhat below 50 per cent. Then when we add the burden of filament heating, and the large energy consumpiton of the modulator, we ruin the efficiency of the transmitter considered as simply an energy transformer. But to consider it in this way alone is meaningless. It is as much as to say that a beautiful and healthy woman is useless because she is a poor piano mover. We rate such a woman by her physical beauty; we rate a modern radio telephone transmitter by its acoustic beauty, i.e., fidelity of reproduction. Efficiency in the narrow sense is allowed to go hang, very properly.

However, as energy is sacrificed apparently so recklessly in the best broadcasting stations, that is the more reason for not rating them at any intermediate stage, when the question of range and power is being considered. If power ratings in radio are to be made uniform internationally, therefore, the radio-frequency power delivered to the antenna would seem to be the most valid basis of comparison.

The metre-ampere product as an expression of the effective range of stations takes the radiating qualities of the antenna into account, and is hence a step in advance of power ratings in terms of mere watts. Even then, however, we must consider percentage modulation, as Captain Eckersley points out, and as yet no one has worked out a rigid formula including this variable. Practically, as probaby most stations run their modulation around 80 per cent. peaks, this factor cancels out in many instances, leaving metre-amperes or watts in the antenna as a valid basis of comparison between transmitters the frequency of which does not differ too widely.

MESSAGE TO LISTENERS

Mr. R. Leslie Jones, hon. secretary of the Wellington Amateur Radio Society, on the eve of his retirement from the secretaryship, has issued the following statement to the listeners of New Zealand:—

On the eve of my retirement from the position of hon. secretary of the Amateur Radio Society, Wellington, I would like to offer a few suggestions in regard to the question of broadcast listening.

Without in any way presuming to know all there is to know about New Zealand broadcasting(I feel a word from myself will probably clear the air a great deal

The work I have been carrying out for listeners throughout New Zealand has necessitated a daily close study of the past, present, and future of radio matters. I look upon the past work for radio as a labour of love entirely, and I hope my efforts will bring forth fruit for future listeners.

Many long hours of close scrutiny into the broadcasting business has been necessary, and frequently I nave had to make a decision and stick to it.

No one has any idea of the enormous amount of work which the Wellington society has done for listeners in New Zealand, and they never will honestly realise what our president, Mr. J. H. Owen, has done.

The society is entitled to the credit for having kept the Broadcasting Company up to the mark, and I am delighted to say to the New Zealand listeners that, in my humble judgment, the company is honestly endeavouring to do its best to meet the wishes of the vast body of listeners throughout the Dominion. I for one have said and written some very strong remarks about the company and its affairs.

I believed, and still believe, there was just cause for action on behalf of the listeners. Still, we must be reasonable now, and give credit when and where it is due; and I place on record the fact that the general manager, Mr. A. R. Harris, is, in my judgment, fully alive to the fact that listeners will demand from him the best possible service that can be obtained for the limited capital available with which to provide the broadcasting service.

I have been in very close touch with the company and its staff for some considerable time, and am now convinced that the past activities of the Wellington society, and for that matter all societies, throughout New Zealand have not been in vain.

Taranaki complains that 2YA cannot be heard to advantage; Wanganui says 2YA comes in good; someone else will say some other station comes in good. What can we do?

The suggestion is made that 2YA should test out on Auckland's wavelength. With this idea I heartily agree, and I hope the test will take place shortly. It must be remembered experts decided upon the existing wavelengths with full consideration to Australian wavelengths; and we must not forget that important point.

Wellington possesses a very fine transmission station, supplied by the Standard Telephones and Cables, Ltd., and as time goes on various improvements, or, rather, a better understanding of the apparatus, will be obtained by the engineers responsible for the control of the station. It must be borne in mind that every piece of mechanism requires experimenting with, and I have no doubt but what even better results will be obtained from 2YA.

The service is not perfect, the transmission likewise, but perfection comes with knowledge and usage.

Listeners will find the coming winter months full of real pleasure from broadcasting, and I advise everyone who has not provided his home with a receiving set to get busy, even if it be a modest crystal. I urge all farmers to provide themselves with a receiving set, as they are the ones who will receive the greatest benefit from radio broadcasting.

Farmers who have not listened-in on their own set have no idea at all of the enormous benefit to be derived from listening-in.

I confess I have made a hobby of radio, and have received untold benefit therefrom; and radio is available, practically speaking, just when you feel like listening-in. If you don't want it, just leave your set turned off—surely that is simple enough.

I admit the Government should make it possible for licensees to pay half-yearly, or even quarterly, if desired. No doubt this will be rectified shortly.

"All things come to those who wait." We have not waited very long, surely? A few short years, and now we hear from all over the world.

My final message to New Zealand listeners is: Support your local listeners' society; if not a member, join to-day. Your local society deserves your support, and much good will come from your so joining.

R. LESLIE JONES.

Wellington.

EARTH-BOUND RADIO

HEAVISIDE LAYER THEORY.

In accepting the Heaviside theory of wireless transmission, scientists have precluded the possibility of getting in touch with any of the planets through the medium of the radio waves now used.

The Heaviside theory holds that there is a layer above the atmosphere, impenetrable by radio waves, that deflects these waves back to the earth, and it is through the acceptance of this theory that scientists have accounted for the freakiness of the short-wave transmissions, whereby signals are heard over tremendous distances, but are inaudible a few miles from the sending point.

The attempt to listen-in for Martian signals was made this year, just as it was made last year, when the planet was comparatively close to the earth, and nothing of scientific importance was expected to develop from the tests. The recent peculiar blanket that has smothered radio reception in the east has let to the experiments in most of the cases, it was said. The blanket has been attributed both to the nearness of Mars to the earth, to the aurora borealis, and to other unknown causes.

CANBERRA A "DEAD SPOT"

RECEPTION VERY WEAK.

It has been found that Canberra, the seat of the Federal Government, is almost a "dead spot" for radio reception. Canberra is 207 miles from Sydney, and is thus within the range of both Sydney and Melbourne stations, yet owners of even five and six valve sets complain of bad reception, in which fading and static play no small part. Interruption is also very troublesome, but this can be accounted for by the huge powerhouse at Bastlake, and also to the power lines running about Canberra. Further, the innumerable electrical machines used in road-making and excavating are likely to cause trouble. Several well-known personages at Canberra have smashed their wireless sets, or returned them, in disgust, and one official of the Federal Capital Commission smashed his five-valve set to pieces, and bought a pianola. Incidentally, his set was constructed specially to suit Canberra conditions.

HINKLER AND THE MOTH

There was a dramatic interruption at 4QG, Brisbane, during the time Lieutenant Bert. Hinkler was speaking, some few nights ago. A moth, attracted by the bright valves, crossed a safety gap, and short-circuited the high tension supply. The station was off the air for a few moments, and the director of the station explained to Mr. Hinkler what had happened.

When the station was started up again, and the microphone was switched on, Hinkle remarked that he did not intend to say much about that moth, but could not help remarking that an Avro-Avian had much better habits, and would not have done a thing like that. The secret of the joke lies, of course, in the fact that the "Moth" is another type of light aeroplane, a contemporary of the Avro-Avian.

A complete receiving set in a hand ring is being marketed in America, priced at 5s. Headphones are unnecessary.