The Wireless World
THE PRACTICAL RADIO JOURNAL
25th Year of Publication

VOLUME XXXVII

JULY 5th—DECEMBER 27th, 1935.

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INDEX—VOLUME XXXVII

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The following abbreviations used after page numbers will save time and labour by indicating the nature of the reference, thus giving an idea of its value or otherwise, to the intending reader. *B.B.* = Broadcast Brevities. *Constr.* = Constructional article. *Corres.* = Correspondence. *Edit.* = Editorial. *Gen.* = General article. *H.T.* = Hints and Tips. *Illus.* = Illustration. *L.G.* = Listeners' Guide. *News* = News of the Week. *R.P.* = Readers' Problems. *S.P.* = Short paragraph *Appar. Commer.* = Apparatus, Commercial. *C.N.* = Club News. *F.G.* = Free Grid. *R.R.* = Random Radiations. *Rec. Commer.* = Receivers, Commercial. *Prelim. Art.* = Preliminary Article. *Parts* = List of Parts.

GENERAL INDEX

APART from the General Index, the following twelve classified indices, arranged alphabetically, are provided for the convenience of readers:—

- APPARATUS (Commercial).
- APPARATUS (Constructional).
- BOOKS.
- BROADCASTING STATIONS.
- LOUD SPEAKERS.
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CLASSIFIED INDEX

APPARATUS (Commercial)

(For Receivers, Loud Speakers and Valves, *see under* respective headings)

APPARATUS (Constructional)

(For complete Receivers, *see under* RECEIVERS, CONSTRUCTIONAL.)

BOOKS

BROADCASTING STATIONS

LOUD SPEAKERS

RECEIVERS (Commercial)

ILLUSTRATIONS

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

CONTENTS

EDITORIAL COMMENT

Interference with Empire Reception

India Takes a Hand

IN our issue of 17th May we referred to the distressing interference with short wave reception caused by morse stations, complaints of which from abroad were reaching us in large numbers. In our issue of 26th April we also published a letter from Mr. H. R. Meredith, discussing conditions of reception in Patna, India.

Mr. Meredith has now written further to us on the subject and has forwarded a number of cuttings from Indian newspapers, showing how seriously the matter is regarded there. It will be remembered that in our Leader we said that mere complaints of interference served little purpose, as it was no help in locating the source of trouble and we appealed to readers to endeavour to identify the interfering stations wherever possible. It is, therefore, of particular interest to learn that the Director-General of Posts and Telegraphs in India is taking steps to this end, for he has recently issued a statement saying that the matter has been under observation for some time, and that it is realised that considerable interference is experienced, usually from telegraph stations. It is stated that identification of the interfering stations must first be made and then representations can be forwarded to the administrations controlling them. The Department of Posts and Telegraphs is taking this course of action.

We hope that this example will be followed elsewhere. If official bodies join in an effort to clear short wave broadcasting channels and particularly Empire transmissions from this interference, a very valuable improvement in reception conditions may be expected to result. Listeners all over the world should bestir, first themselves, and then their proper authorities, to action.

This does not mean that individual efforts to identify interfering stations should be slackened because authorities may be prepared to undertake the work officially. In many places the authorities may not have the necessary facilities, and in any case, successful efforts on the part of listeners to identify offenders and report them is the best possible evidence to the authorities that the listening communities view these interruptions of the short wave programmes seriously.

Propaganda Wireless

Proposals for this Country

A *STATEMENT* has recently been published to the effect that a scheme is on foot and approaching realisation for the establishment of a broadcasting station in England, the avowed object of which is to broadcast propaganda to counter continental broadcasts which are inimical to the interests of communities here.

However sympathetically such a proposal might be received it can be stated without fear of contradiction that there is not the remotest chance of a licence being granted for the establishment of such a station here, and those who are promoting the scheme are evidently doing so in ignorance of the position. The State has vested a monopoly of Broadcasting in the B.B.C., and this was done for the very purpose of ensuring that stations should not be set up by independent bodies.

It would be intolerable if concessions were made which permitted independent propaganda broadcasting when the very principle is offensive to national opinion in this country.

Variable Selectivity

Improving the Standard of Quality

By W. T. COCKING

SINCE the requirements of selectivity and quality are conflicting, it is clear that the ideal receiver would be fitted with variable selectivity in order that the optimum conditions for any and every station may be realised. The attainment of variable selectivity has hitherto proved difficult, but it is shown in this article that it is by no means hard to obtain a wide range of control if the design be carried out correctly.

AT a time when the attainment of the highest standard of quality demands the retention of modulation frequencies up to 10,000 c/s and the requirements of selectivity necessitate the sacrifice of frequencies higher than 4,000 c/s, it is clear that some compromise between selectivity and quality is essential. The most pleasing result to the ear is not secured by perfection of reproduction if this entails a large degree of interference, nor is it given by complete absence of all interference if this leads to the absence of the entire upper register from the reproduction. Most listeners prefer a compromise between the two extremes, for few will dispute that a pleasanter effect is obtained when the quality is sacrificed only as far as is necessary to reduce interference to the point at which it is not intrusive although it may not be completely inaudible.

It will be clear, therefore, that since the interference conditions are different for every station, and even vary frequently for each station, the optimum degree of selectivity must also vary for every station, and will be different for the reception of the same station in different localities. The ideal receiver would consequently be fitted with continuously variable selectivity so that its characteristics could be altered at will to suit the particular receiving conditions existing at any moment and in any district. This has long been recognised, but it is surprisingly difficult to devise a means of varying the selectivity of a receiver which is satisfactory from all points of view, and it is only recently that any considerable degree of success has attended the efforts of designers.

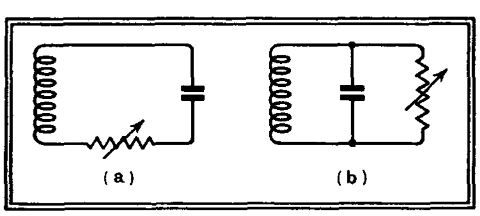

Fig. 1.—The selectivity of a single circuit can be varied by means of a series variable resistance, (a) of low value or a shunt resistance, (b) of high value.

There are two distinct methods of obtaining variable selectivity. With the first, the inherent selectivity is of such an order that no serious degree of sideband cutting occurs, and it is increased when necessary by the application of reaction. This method has been adopted in the Single-Span receivers so far described in *The Wireless World*, and it has the great merit of simplicity. It is, however, open to the objection that the degree of selectivity obtainable is limited by the appearance of self-oscillation. With the second method, the inherent selectivity is made as high as the designer judges necessary for the avoidance of interference, and it is reduceable by some means for reception under conditions of moderate or little interference. A much wider range of control is possible in this way, and it is the means to be adopted which we have now to consider.

Methods of Varying Selectivity

Since the selectivity of a tuned circuit depends upon the Q(= ωL/R = reactance/resistance) of the circuit, and the inductance must normally be fixed, an obvious method of varying the selectivity is to vary the resistance. This may be done in two ways: a variable resistance of low value can be connected in series with the circuit as shown in Fig. 1 (a), or one of high value in parallel as in Fig. 1 (b). Where only a single circuit need be controlled, either of these methods is satisfactory, although open to the objection that the sensitivity must vary also. When we remember, however, that the IF amplifier of a modern superheterodyne may contain as many as six tuned circuits, we can see that the control of one circuit alone is likely to have little effect. Even if its selectivity were completely destroyed, the remaining circuits would normally cause excessive sideband cutting. Each circuit must be controlled if satisfactory results are to be secured, and the difficulties of controlling six circuits by this means are obvious, for six variable resistances, each independently screened, and ganged for operation by a common spindle, would be needed!

Now, in IF amplifiers the tuned circuits are usually arranged in coupled pairs, and it is well known that the degree of selectivity obtained depends very greatly upon the coupling. If a pair of tuned circuits be coupled loosely together, the resonance curve takes the form shown by curve A of Fig. 2, while if "optimum" coupling be used, the curve is broadened to the shape shown by B. If the coupling be still further increased, two humps appear (curve C) and the system becomes of the band-pass type. Unless the coils are of low Q it is inadvisable to couple them very tightly, otherwise the trough between the peaks becomes very pronounced. On the other hand, unless the circuits have a large value of Q the selectivity with loose coupling will be low.

Ideally, therefore, the resistance of the circuits should be increased with the coupling so that the double-hump appears only as a minor irregularity in an otherwise flat-topped response curve. So much depends on the band-width required, or, rather, the ratio of the resonance frequency to the band-width, that it is impossible to lay down any hard and fast rule, and experience shows that with a fairly high resonance frequency a variation of resistance is unnecessary for high quality sound reproduction.

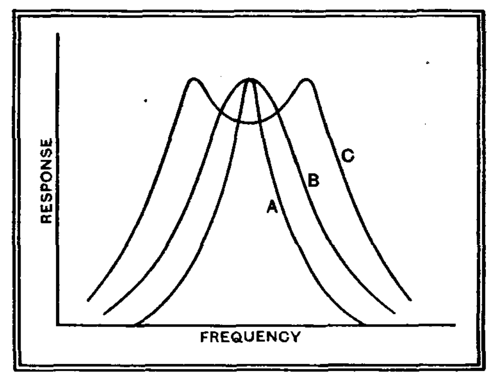

Fig. 2.—The resonance curve given by a pair of coupled tuned circuits varies with the degree of coupling. With loose coupling, it is sharp (A) but with optimum coupling (B) it is still single-peaked, while with tighter coupling (C) two peaks appear.

Before going more deeply into this question it is as well to consider methods by which the coupling can be varied. The chief systems of coupling are shown in Fig. 3. With common capacity coupling (a) the band-width is controlled by the capacity of the condenser C, and it would appear that this would offer a simple means of obtaining continuously variable coupling by the use of a variable condenser for C. There are two objections to this,

Variable Selectivity—

however, and the first and less serious is the difficulty of obtaining a condenser of large enough capacity, since a variation of some 0.005 µF. would be needed. The second objection is that the response is not

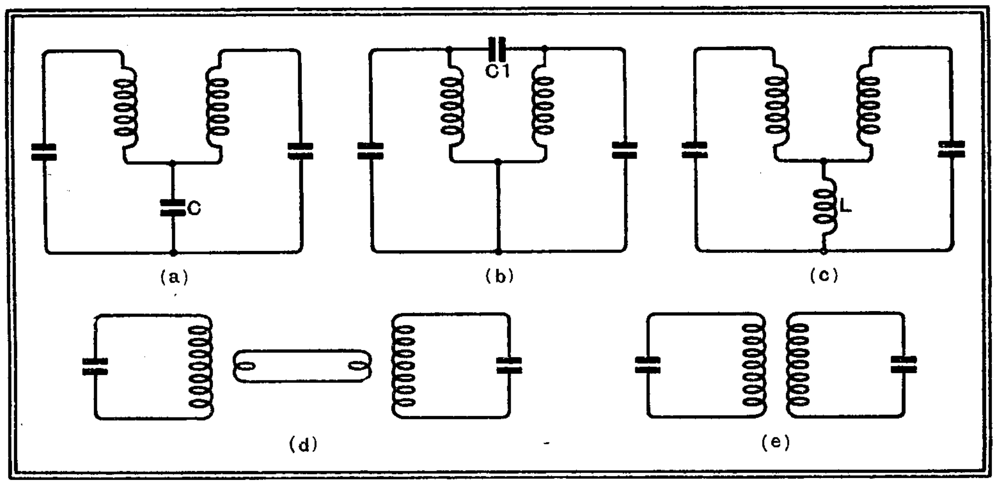

Fig. 3.—The chief methods of coupling circuits are shown here. At (a) the coupling is by common capacity and at (c) by common inductance, whereas with (b) a top-end capacity coupling is used. The link-filter is shown at (d) and mutual inductance coupling at (e).

broadened by an increase in coupling an equal amount on either side of resonance. Referring to Fig. 4, if A be the response curve with loose coupling, that with tight coupling takes the form of curve B. It can be seen that if a change be made in the coupling, the receiver must be retuned so that the carrier frequency lies in the centre of the resonance curve.

Filter Couplings

When top end coupling is used (b) the capacity of the coupling condenser C1 is of more manageable proportions, being of the order of 1 µµF. This circuit still suffers from the objection that the peaks do not open out symmetrically about the resonance frequency, but to one side, as in Fig. 4. The second peak occurs on the other side of resonance, however, and this applies also to inductive coupling (c), which has also the objection that a small variometer L would be needed to alter the coupling. Another and at first sight attractive circuit is link coupling (d), but this again suffers from the same disadvantage in the manner in which the peaks open out.

When we turn to the fifth circuit (e) in which the coupling is provided by the mutual inductance between the two coils, we find that, as long as the coupling is due to this alone, the peaks open out symmetrically, and we obtain the type of curve exhibited by Fig. 2. This system of coupling is thus the only one which theoretically can give the desired results, and, as practice amply supports theory, it is accordingly the only method which need be considered.

Before we can consider the precise arrangement which we can adopt, it is necessary to decide on the coils which are to be used, for the degree of coupling necessary will depend on their efficiency. We shall, moreover, confine the discussion to intermediate frequencies of the order of 465 kc/s, for it is not difficult to demonstrate that with a lower frequency of some 110 kc/s it is desirable to increase the circuit resistance with the coupling in order to prevent the appearance of excessively prominent humps in the response curve. Moreover, the use of low intermediate frequencies is less prevalent than formerly on account of the greater ease of elimination of second-channel interference with a moderately high frequency.

In designing a coil we have not only to consider the efficiency of the coil alone but its efficiency when connected in circuit and used with its tuning condenser. At the frequencies under consideration, dielectric losses in the condenser, valve-holder and valve base are by no means negligible, and profoundly influence the choice of a coil. Compactness is also a point of importance, and it is hardly practicable to employ a coil with a larger overall diameter than one inch, nor one having a length much greater than this figure. The use of an iron-core of suitable type, therefore, becomes very desirable.

Owing to its comparatively low losses an air-dielectric trimming condenser is de-

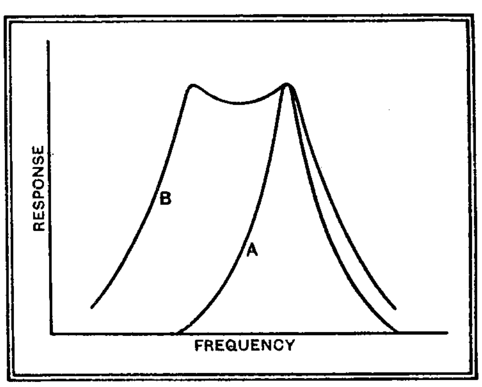

Fig. 4.—Certain methods of coupling give an unsymmetrical opening of the peaks. Curve (A) shows the results with loose coupling, and (B) when it is tight enough for the two peaks to appear.

sirable, but types at present available of suitably small dimensions have a capacity no more than 65 µµF. For resonance at 465 kc/s with this capacity an inductance of 2,000 µH is needed. Coils having this order of inductance and unscreened gave resonance curves of the type shown in Fig. 5 when used with a VMP4 valve and having only the load of a valve voltmeter on the secondary. Curve A is for the case of untapped coils with optimum coupling, and a stage gain as high as 300 times is obtainable. The curve is not quite symmetrical, for it gives an attenuation of 7.5 times at 10 kc/s off resonance on one side as compared with six times on the other. The gain, however, is rather high for safety in a practical receiver in even one IF stage, and with two stages it would probably be impossible to maintain stability. It was reduced, therefore, by tapping down both primary and secondary, to 91.5 times, and the resonance curve then became B. A considerable improvement in selectivity is evident, for the attenuation at 10 kc/s off tune now becomes 16 times and 14 times for the two sides, and it is very clear that the losses in the external circuit are playing an important part.

When an attempt was made to screen a transformer of this nature, however, many difficulties arose. Owing to the large field

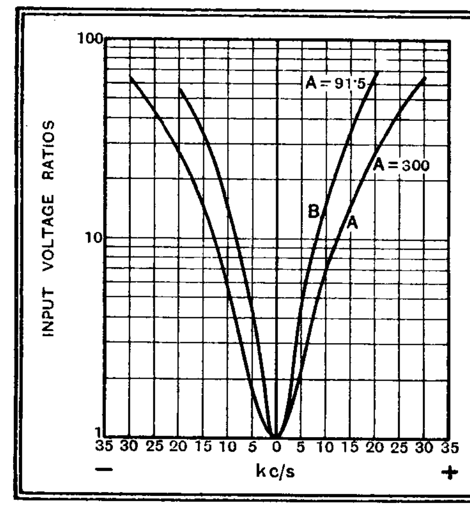

Fig. 5.—The results obtained with unscreened coils of 2,000 µH. inductance with air-dielectric trimmers are shown here for two different degrees of coupling.

of the high-inductance coils, the screen considerably lowered the efficiency, and it also proved difficult to obtain sufficiently loose coupling between the two coils in a can of reasonable dimensions, while the physical dimensions of the air-dielectric trimmers added to the difficulties. Now experience had shown that it was possible to produce a considerably more efficient coil, although of lower dynamic resistance, if its inductance were lower, for in the given winding space it was possible to employ greater sectionalisation. A coil of 500 µH inductance was found to be about the optimum when wound with Litz wire in ten sections. It is out of the question with such a coil, however, to employ an air-dielectric trimmer, for the capacity required to tune it to resonance is some 300 µµF.

The question arose, therefore, as to whether the more efficient coil would still be better if it were tuned with a mica-