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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.

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EDITORIAL COMMENT

Wavelength Allocation

New Influence on Receiver Design

THE allocation of wavelengths for wireless transmitters is a matter to which much thought has been devoted in the past. There are so many problems encountered that a perfect solution to them all is really out of the question, particularly as the matter is complicated by international questions.

Although the international aspect cannot be entirely ignored even in America, it is of much less importance in that country than in Europe, and it is thus more easily possible to settle problems on their technical aspects. The American Radio Manufacturers' Association has recently been considering this question of wavelength allocation, with particular reference to broadcasting. In its recommendations to the Federal Communication Commission the Association lays particular emphasis upon receiver performance, and, in order to show the importance of this, has amassed a large amount of data on 1935 and 1936 models of broadcast receivers.

The average performance of sets of these two years shows surprisingly little difference, and the Association points out that with the present station spacing of 10 kc/s only, it is unlikely that there will be any marked improvement in fidelity or selectivity in the next few years. It points out that the present popularity of the superheterodyne is likely to continue, for both technically and economically it offers big advantages over the straight set. The superheterodyne, however, suffers from liability to certain special forms of interference, among which prominence is given to that caused by a transmitter working on a frequency close to the intermediate frequency. Interference may also be found from stations working on multiples of the intermediate frequency, or when the frequency separation of stations is equal to the intermediate frequency.

While these forms of interference can undoubtedly be greatly reduced by suitable design of the receivers, the result is naturally an increase of cost, and most manufacturers prefer to try to avoid the interference by a suitable choice of the intermediate frequency. With the present allocation of stations, however, a particular intermediate frequency will only permit freedom from interference in one part of the country, and different frequencies must be used in others. Hence the present lack of uniformity in the frequencies employed in the receivers of to-day.

How Choice of Wavelengths Can Help

It is suggested that this difficulty could be got over by a more suitable allocation of station wavelengths and, in particular, by leaving a clear channel to which the IF amplifier could be tuned. One intermediate frequency for all receivers could then be standardised and, as well as reducing the possibility of interference, would prove an economy in receiver production.

This suggestion opens up an interesting possibility and one which we may hope to find given serious consideration by those responsible for European wavelengths. In any case, there is no doubt that the only hope of appreciable improvement in the future lies in closer co-operation between those whose business it is to settle wavelength questions and those who are responsible for receiver design.

Rejecting Whistles

A NEW TYPE OF BALANCE FILTER

THIS article deals with the various known types of tunable filters used for the elimination of heterodyne interference, and introduces a new type which the author (its originator) describes as a "Balance Filter."

By **P. K. TURNER, M.I.E.E.**

(Hartley-Turner Radio, Ltd.)

NOW that there is an increasing tendency to demand a certain amount of "top" in radio reproduction, the question of a whistle-filter is getting more and more important.

Admittedly, so long as one sticks to RF or IF amplifiers based on the band-pass filter idea, whistles form only part of the interference, since side-band splash is very prominent; but even so most people find the continuous whistle much more offensive than "monkey-chatter." And where high-selectivity circuits and tone-correction are used, side-band splash is so reduced that such a set has quite a surprising power of getting a pleasurable programme through interference, provided an efficient whistle-filter is fitted.

The first attempts at whistle-filters seem to have been simply low-pass filters arranged to cut out the whistle and all higher frequencies. In order to be effective on all likely whistles they were mostly designed to cut at 5 kc/s or thereabouts, and so definitely ruined the quality; we will not consider them further.

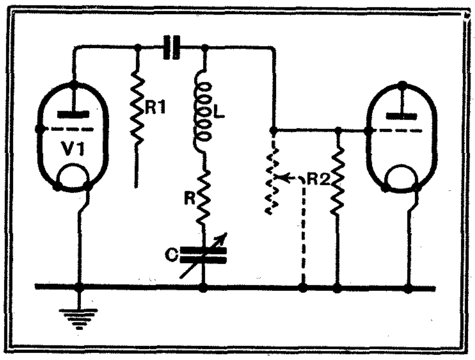

Fig. 1.—An acceptor filter, which acts more or less as a short-circuit across the amplifier at the resonant frequency.

The only "filters" which can pretend to be effective at reasonable cost are those embodying tuned circuits, which are adjusted by the user to cut out one particular frequency with the minimum of interference with others.

The most obvious design of this nature consists simply of an acceptor circuit across an amplifier coupling or a rejector in series with a coupling load; both these can be quite effective, and are therefore worthy of a little consideration.

The acceptor filter is shown in Fig. 1, and it is quite easy to find what are its requirements. Calculation shows that its performance depends on two things. First, the losses in coil and condenser must be small—i.e., the resistance R (which represents these losses) must be low compared with the reactance of the coil or condenser at the tuned frequency, which latter we will refer to as X_o. Secondly, X_o must have the right relationship with the other impedances in the circuit. It is easily shown that the important characteristic of the rest of the circuit is the resistance R′ given by putting R1, R2, and the anode impedance of V1, all in parallel.

At the resonant frequency, the total impedance of the filter is R, and if it is

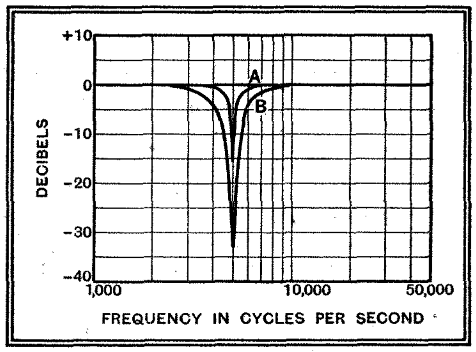

Fig. 2.—Typical characteristics, under different conditions, of an acceptor filter.

to do its job of being effectively a short-circuit across the amplifier, R must be much less than R′. At far-off frequencies the impedance of the filter is the reactance of L or C, and this must be large compared with R′ if the loss is then to be negligible.

If L is too small and C too large for the rest of the circuit, the "cut" will be good, but there will be too much loss at other frequencies; if L is too large and C too small, the dip in the response curve will be nice and narrow, but not deep enough.

But in practice the values of L and C are almost fixed, for as C is to be a variable condenser it cannot exceed 0.0005 mfd. if we are to use what is easily obtainable; and in order to cover the right range of frequencies this means that L must be about 1.5-2 H. Hence, in practice, the resistance R′ must be adjusted to suit these values. These are two very simple rules which govern the design: to keep them simple I have left out sundry corrections.

(1) The "cut," i.e., the ratio of output with filter to output without, at the tuned frequency, is simply R/R′.

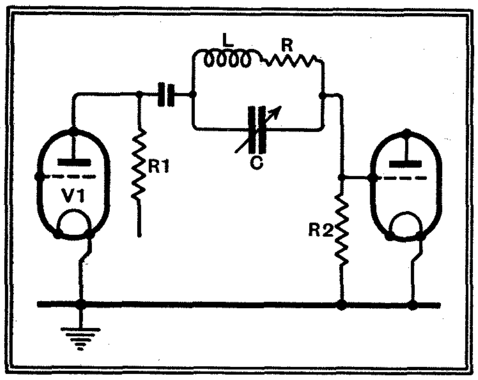

Fig. 3.—A rejector filter; compare with the acceptor circuit of Fig. 1.

(2) The cycles off tune at which there is about 30%, or 3 db., loss is $\frac{0.08R'}{L}$ or $\frac{2R'}{25L}$

As an example, if we have a 10,000-ohm valve, a 20,000-ohm load, and a 0.1-megohm grid leak, then

$$\frac{1}{R'} = \frac{1}{10{,}000}\left(1 + \frac{1}{2} + \frac{1}{10}\right) = \frac{1.6}{10{,}000}, \text{ or}$$

$$R' = 6{,}250 \text{ ohms.}$$

If now we have a 2-henry coil with loss

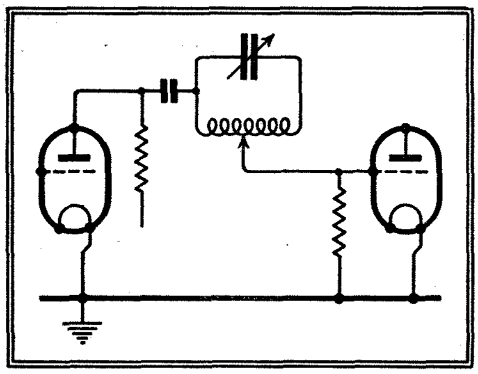

Fig. 4.—An alternative arrangement of the rejector filter for use in a transformer-coupled stage; it is referred to in Appendix I.

resistance (at the tuned frequency) of 1,000 ohms, then

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(1) the "cut" is $R/R' = 1{,}000/6{,}250 = 0.16$, or approximately 16 db.

(2) there is 3 db. loss at $2R'/25L$ or $\frac{12{,}500}{50}$ or 250 c/s each side of the tuned point.

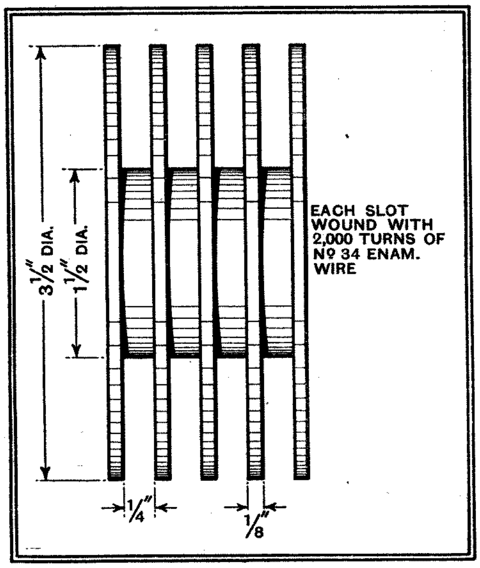

Fig. 5.—Design for an air-cored inductance coil. Each slot of the former is wound with 2,000 turns of No. 34 enamelled wire.

The curve will be more or less like A of Fig. 2: the cut is fairly sharp but not deep.

Now suppose that we use the same coil, but after a pentode valve with an impedance of 0.5 megohm, and with a load of 50,000 ohms; we have

$$\frac{1}{R'} = \frac{1}{10{,}000}\left(\frac{1}{50} + \frac{1}{5} + \frac{1}{10}\right) = \frac{0.32}{10{,}000}, \text{ or } R' = 31{,}250 \text{ ohms.}$$

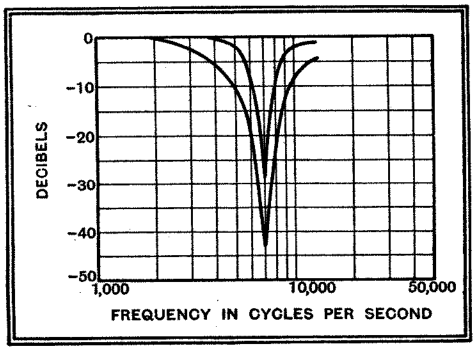

Fig. 6.—Curves of a filter wired to the circuit of Fig. 3, with the coil of Fig. 5.

The cut is now $\frac{1{,}000}{31{,}250} = 0.032$, or approximately 30 db., and there is 3 db. loss at $\frac{62{,}500}{50} = 1{,}250$ c/s each side.

The curve is like B of Fig. 2; fairly deep, but rather wide. Note that the loss resistance R *only affects the "cut."* A better coil will give a deeper cut without widening it. On the other hand an increase of R′ makes the dip in the curve both deeper and wider.

Another important point to be noticed is the effect of changing the tuning point. As the frequency goes up, R will almost certainly increase, so that the cut will be less deep. Also, as the width of the dip is constant in cycles, it will be *comparatively* less as the frequency goes up. Summarised, the cut is both deeper and wider as the tuned frequency is lower.

In order to correct this, and at the same time give a control of the band width of the dip, it is best to make R′ adjustable by putting a variable shunt across the grid leak, as shown dotted in Fig. 1.

The Rejector Circuit

The rejector filter is shown in Fig. 3, and in its actual behaviour is very much like the acceptor filter. In exactly the same way, at any given frequency the depth of cut is controlled by the loss resistance R, while the width is governed by the resistance of the rest of the circuit. But there is one important difference: with the rejector the cut is deeper and proportionately wider as the frequency goes *up*—just opposite to the acceptor.

There is another difference: the important circuit resistance is not in this case that of valve, anode load, and grid leak all in parallel. It is that of valve and anode load in parallel, added to that of the leak. The rules for depth and width of cut are not so simple in this case, and I give them in Appendix I.

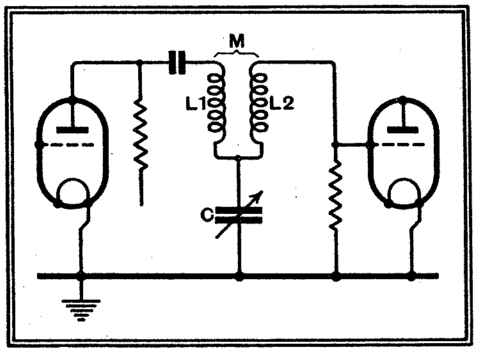

Fig. 7.—The Campbell Sifter, in which coil losses are unimportant.

Both the acceptor and rejector circuits can be made quite reasonably efficient, and two types of the rejector have actually been on the market for two years or so. The main difficulty is to keep the coil losses low enough to get a reasonably sharp dip. A coil of 1.5 or 2 henrys which shall be really efficient at 10 kc/s or thereabouts is not at all easy to design. For really first-class results an air-cored coil is essential, and Fig. 5 shows the design of one which has been found good and not too expensive. Used with an air-condenser in the circuit of Fig. 3, it produced the curves of Fig. 6, which are for two different values of shunt across the grid leak.

The biggest difficulty is the bulk and large stray field of the coil; for a big stray field also means a big capacity for picking up *other* stray fields. In a mains-operated set it is practically impossible to get the coil out of hum fields, and no screen less than about a 9in. cube may be used for fear of losses. The only solution is careful placing and orientation of the coil: a silent point can usually be found.

Recently a smaller coil with a dust core has been produced. This is much better as regards stray field, and is cheaper and less bulky, but it is not so efficient.

At first sight the Campbell Sifter seems a much more promising arrangement, for coil losses do not matter. The circuit is shown in Fig. 7, and its behaviour is in theory almost exactly the same as that of the acceptor circuit of Fig. 1, except that M, the mutual inductance between L1 and L2, replaces L of the acceptor. Since the losses in L1 and L2 do not enter into M, the filter should be exceedingly good.

Actually I have found it disappointing,

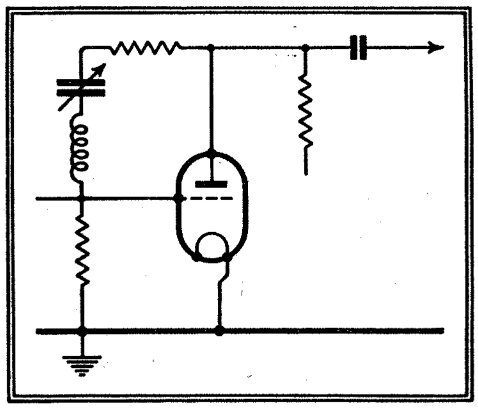

Fig. 8.—Baggally's Retroactive Filter.

the difficulty, as usual, being in the coil. The coil losses, it is true, do not enter into M, but it still does not follow that the voltage induced in L2 will be exactly 90° behind the current in L1. If an iron core of any kind is used, hysteresis and eddy current effects prevent this; in a close-coupled air-cooled coil, capacity from L1 to L2 gives trouble; in either case the cut will be quite a poor one. With a rather loose-coupled air-cored coil the cut is good, but the output will not come back to near normal at frequencies above resonance. The difficulty with the coil is increased by the fact that each half of the coil must have the same inductance as the whole coil of the acceptor, so that twice the total turns are needed.

Better Coils Wanted

As far as my own experience has gone the success of the Campbell Sifter depends on a new coil design; and the necessary time for this is better spent on improved circuits.

Baggally's Retroactive Filter is a highly ingenious arrangement described by Baggally in *The Wireless Engineer* for December, 1935. The circuit of Fig. 8 is used. It has the effect that when the impedance of the acceptor circuit is low negative feed-back is put on the valve, so that the output is reduced. The cut obtained is very sharp, as can be seen from the curve of Fig. 8*a*, reproduced from his article. Personally, however, I do not find the arrangement convenient.

There are two reasons for this. First, the amplifier has to be to a considerable

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extent designed round the filter; one cannot just drop the circuit into any set. Second, if one uses a coil with fairly high losses, it is necessary either to use a valve of low conductivity or to cut down its goodness in some way. The reason for this is given in Appendix II.

The Balance-Filter is a new introduction, and my enthusiasm for it must perhaps be discounted a little because it is my own baby. The circuit is shown in Fig. 9. As will be seen, the output has two components; first, the voltage across C1, which is controlled by the values of C1 and R1; and second, the voltage in L4, which (for a given M) is controlled by C2. It can easily be proved that these may always be made equal and opposite (giving zero output) by adjusting the values of two of the components, and this holds even if all components are imperfect, including M. Of course, *very* bad components may spoil the sharpness of cut and give losses at all frequencies; but the cut still remains deep.

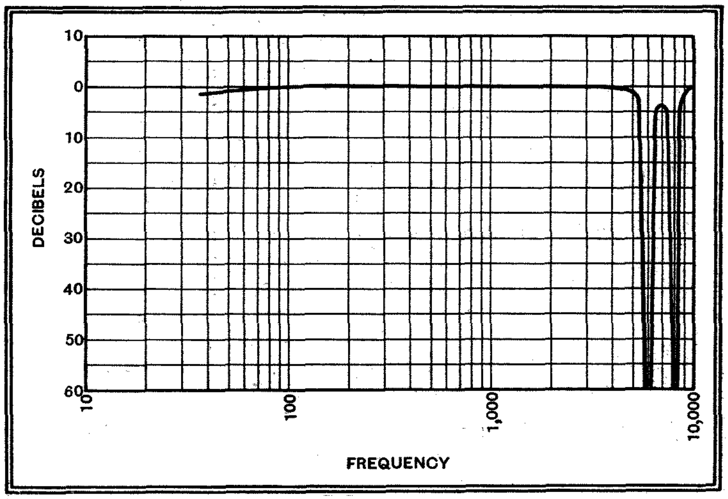

Fig. 8 (a).—Curve of the filter shown in Fig. 8. (Reproduced from "The Wireless Engineer.")

Circuit Calculations

The actual frequency at which the dip occurs is calculated as for a circuit of capacity C2 and inductance L2 plus M: if the transformer L2-L4 is a one-to-one and closely coupled, this means approximately an effective inductance of $2L_2$. The rule for frequency is, approximately,

$$f^2 = \frac{25{,}000}{(M+L_2)C_2},$$ with M and L_2 in henrys, C_2 in mfds.

A second condition which I call the "balance condition" has to be fulfilled to get zero output; it is

$$\frac{R_1}{R} = \left(1 + \frac{L_2}{M}\right)\frac{C_2}{C_1}$$

Both the above are for perfect components. The effect of the losses on the frequency is small, but they modify the "balance" condition in a manner to be discussed later.

Reverting to the balance condition already given, it should be stated that losses in L2 and C2 (represented by R) are taken account of. It is only losses in C1 and M that have been neglected.

Looking at the condition in detail, usually L2 and M will not change with frequency, but, of course, C2 will, being the main tuning adjustment. If now we gang C2 and C1 together, then C2/C1 is constant, being 1. So that if R does not change with frequency R1 must not either; in fact, operation of the two-gang condenser is all that is required.

But in practice R *does* alter. It almost always increases as the frequency goes up. So that after setting the condenser to cut down a whistle, it is usually necessary to adjust R1 to get rid of it completely; the higher the frequency the larger R1. Even if R were constant, there are still the effects of losses in C1 and M, which were neglected above; it is easily shown that they have the same general effect.

It would appear, then, that two adjustments are necessary. In fact, in the experimental models of the balance filter a whole series is necessary. First the condensers are set to best "cut." Then R1 is adjusted, with a considerable improvement. But this change of R1 means that a slight readjustment of the gang condenser gives a still deeper cut, but in turn calls for a final adjustment of R1.

In the type now in use I have adopted a rather neat method of getting over this. As stated above, it is usually—as far as my own experience goes, *invariably*—the case that R increases as frequency goes up, so that R1 must be increased to maintain the balance condition. But the same result is obtained if C2/C1 is decreased as frequency goes up. But as frequency goes up, both C2 and C1 have to be decreased; what is required is that C1 should not be cut down as much as C2, though they are both on the same shaft.

But this is easy. All we have to do is to put a small fixed condenser across C1. For example, if both condensers are of 0.0005 mfd. max. value, and we put 0.0001 mfd. across C1, then when C2 is at 500, C1 = 600 m-mfds., and C2/C1 = 5/6. But for C2 = 100, C1 = 200 m-mfds., and C2/C1 = 1/2.

By choosing the right value of fixed "trimmer," the needed value of R1 may always be made the same at two different frequencies—say 8 and 10 kc/s, for example. If R1 is then fixed, the loss of "cut" at 7, 9 and 11 kc/s (due to R1 not being just right) will often be negligible. But if it is thought worth while a "padding" condenser can be put in series with C1 before putting the "trimmer" across it. The balance can then be made quite correct at *three* frequencies, and the residual error at other frequencies will always be negligible.

Before giving some results of tests on Balance Filters I want to put down a few words about methods of test, which are not so simple as might appear.

First of all, the measurements should be made on a constant input basis and in a practical amplifier, to reproduce as closely as possible the conditions of use. This means that the output will vary from a fraction of a volt to 200 V or so at the anodes of the power valves, and so one needs a multi-range output meter of fixed input impedance on all ranges.

Whistle, Hum and Background Noise

With an amplifier set to give, say, 200 V output, and the filter giving maximum "cut," there will probably be found a minimum reading of *at least* 10 volts of combined whistle, hum and background noise. So I introduce between output valves and meter (i.e., after all the amplification) a high-pass filter cutting at about 2,000 c/s, to cut out the hum and most of its harmonics. This will reduce the minimum reading to 1 volt or so.

Next, since the input must be fairly big to get a readable output through the filter, we must face the possibility of harmonics being generated. It must be remembered that even a 1 per cent. harmonic will give much more output than the filtered fundamental. So I put in a low pass filter also, set to cut at 8,000 cycles when testing on 7,000, and so on.

There is still left the background noise. Since some of this comes from the source, it is not sound to turn down its output by its volume control. The only check (the source being a beat oscillator) is to turn it down to zero beat. This leaves the background noise unchanged, and one can compare the output at zero beat with that at the tuned frequency of the filter, and so find what is the output in the latter case.

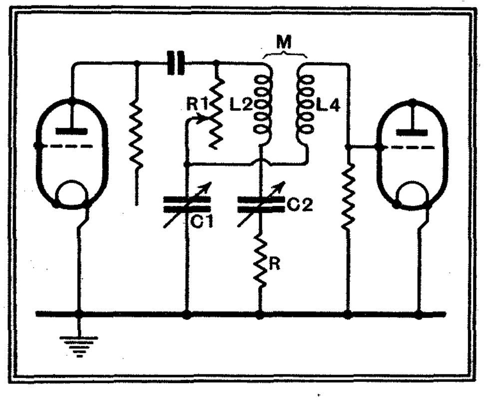

Fig. 9.—The Balance-Filter, as devised by the author.

It must be remembered that with the whistle on, our reading is the resultant of whistle and background noise, the latter being of no particular frequency. We must, therefore, add the *squares* of the two to get the resultant, i.e., the voltage needed is found thus:

Total voltage with source at filter frequency = V_F.

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Voltage with source at zero beat, which is background noise = V_B.

True output at filter frequency = $\sqrt{V_F^2 - V_B^2}$.

Note that if $V_F^2 = 1V$ and $V_B = 0.95$ V, we have $V_F^2 = 1$, $V_B^2 = 0.9$; hence (True volts)$^2 = 0.1$, and true volts = about 0.3. In other words, if the true voltage is less than about one-third the total, it is not measurable with any accuracy. Conversely, if the total voltage is more than three times the background, the correction is negligible, and the total can be taken as the true output voltage.

Lastly, as the various additions to the circuit will affect the response of the amplifier, it is advisable to make each measurement by switching in and out the filter under test and plotting the actual drop in output thus found.

The filter used for the following tests had two small bakelite-dielectric condensers ganged up, and a smallish dust-cored coil measuring 1⅝in. diam. and 1¼in. long. This was wound in three sections, two being L2 and one L4. No attempt at screening or shielding was made, and all parts of curves below 40 db. drop are shown dotted, as readings were uncertain. It is believed that in most cases the "cut" was 50 to 60 db.

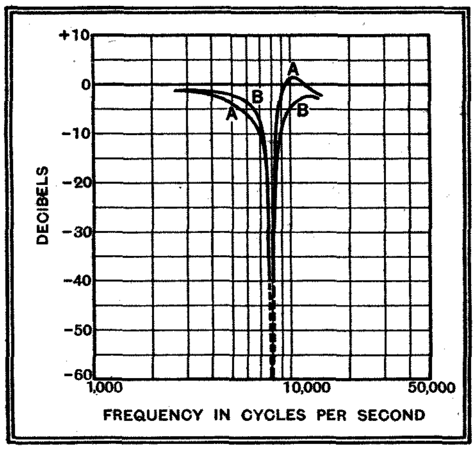

Fig. 10.—The effect of output load on the balance filter.

Fig. 10 shows the effect of output load. For curve A the filter was working into a 0.25-megohm grid leak; for curve B into a loaded AF transformer which put a load of about 10,000 ohms (besides inductance and capacity) on the filter. It will be seen that there is surprisingly little difference in performance.

Fig. 11 shows the effect of input load, and it is obvious that this is much more important. To emphasise the differences, these curves were taken with the filter tuned to a low frequency (7 kc/s) and working into 0.25 megohm as output load. For curve A the total input load was 2,500 ohms; for B 10,000 ohms, and for C 20,000 ohms. Curve A of Fig. 10 was for about 6,000 ohms, the input there being a 9,000-ohm valve with 15,000-ohm coupling resistor.

Lastly, Fig. 12 shows the effect of changing the filtered frequency, the conditions in each case being about 6,000 ohms input and transformer output load as for curve B of Fig. 10.

Two conclusions may be drawn from these curves. First, the filter always gives an exceptionally deep "cut." In most of the cases shown the actual output voltage at the critical frequency was adjusted to 100 without filter and the output with filter varied from 0.1 to 0.5 volt; in no case was the resulting signal audible above the background.

Secondly, there is no necessity for critical impedance-matching. Using the coils and condensers described, output impedance matters little so long as it exceeds, say, 10,000 ohms, and it need not be a pure resistance; input resistance should not exceed 10,000 ohms.

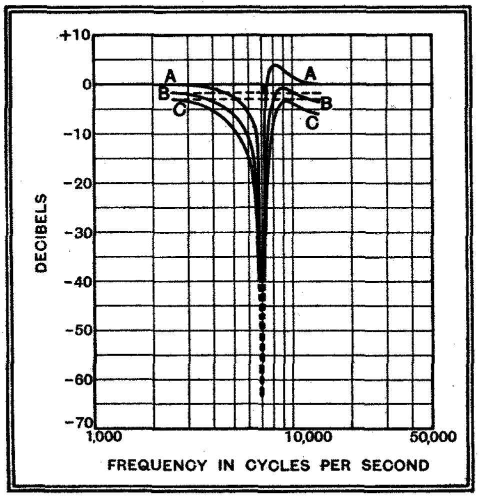

Fig. 11.—Showing the more drastic effect of input load variations (compare with Fig. 10).

It is, however, desirable to use a coil designed for the circuit[1]. Any old coil of the right inductance will give a deep cut; but if its losses are very high or the coupling between its two parts is too weak, the rest of the curve may be unsatisfactory.

APPENDIX I.

With R1 and R2 as in Fig. 3,

$$R' = \frac{R_a R_1}{R_a + R_1} + R_2$$

where R_a is the anode impedance of V.

Call X_0 the reactance of the coil at the tuned frequency f_0 ($X_0 = 2\pi f_0 L$)

Then, approximately,

(1) Depth of cut $= \frac{RR'}{X_0^2} = \frac{RR'}{40 f_0^2 L^2}$

(2) There is 3 db. loss at p cycles off tune, where

$$p = \frac{\pi f^2 L}{R'}, \text{ or } \frac{p}{f_0} = \frac{X_0}{2R'}$$

In practice, the cut is controlled by shunting the grid-leak, as for the acceptor filter, to give the cut required at the moment.

There is, however, another method of control of the rejector which makes it often more convenient to use. This is shown in Fig. 4. In effect, it makes the coil into a transformer; the tuned frequency and losses are practically unaffected, but the matching to the rest of the circuit is controlled by the tap switch. When the rejector is used in a resistance coupled circuit, as in Fig. 3, the circuit resistance is usually too high, and a variable shunt across the grid leak is the best control. But for use in a transformer-coupled stage the tap switch of Fig. 4 is usually preferable.

[1] It is understood that separate parts and complete filters to the author's design will shortly be on sale.—Ed.

APPENDIX II.

Baggally shows that for minimum output we have the following condition, where R is the loss resistance of the acceptor:

$$R = R'_a/\mu',$$

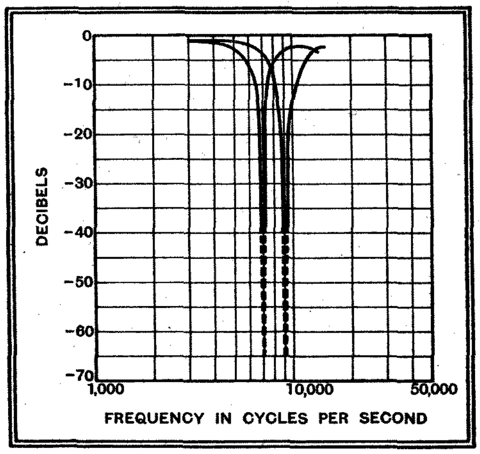

Fig. 12.—Effect of changing the filtered frequency.

R'_a and μ' being the *effective* anode impedance and magnification of the valve. Since the effective conductivity of the valve is μ'/R'_a we have $RG' = 1000$, with G' in mA/volt.

Hence for a good modern valve of G = 2, or thereabouts, R cannot exceed 500 ohms for balance, which means a very good coil. If R is higher than this, G' must be reduced, say by artifically raising R_a by means of resistance added between the valve anode and the rest of the circuit. But since the effective mag. of the whole stage depends on G', one has to lower this, which is undesirable and may get one into other difficulties.

CLUB NEWS

The Ilford and District Radio Society

This old-established radio society has now entered upon its sixteenth year and is making a special feature of television and ultra-short-wave work. Those interested are welcomed at the weekly meetings, which are held at 8 p.m. on Thursdays at St. Alban's Church Room, Albert Road, Ilford. On Thursday next (December 10th) a demonstration of a new receiver will be given by Mr. H. T. Stott, A.M.I.R.E., of Bulgin's. Full details concerning the society can be obtained from the Hon. Secretary, at 44, Trelawney Road, Barkingside, Ilford.

The Croydon Radio Society

An interesting lantern lecture on cathode-ray tubes was recently given by Mr. A. F. Hollins, of the Mullard Wireless Service Co. A large number of questions, including television problems, were dealt with. On Tuesday, December 15th, at 8 p.m., Mr. H. G. Salter will conclude the first half of the winter session with another of his ever-popular musical programmes. The Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, South Croydon, will be pleased to give full details of the society's activities to enquirers.

The Radio, Physical and Television Society

Several interesting lectures have been given recently, including those on the cathode-ray oscillograph by Dr. C. G. Lemon, short-wave receivers by Mr. J. G. Hobbs, A.M.I.R.E. (G2QG), and bacteriological methods by Lt.-Col. C. G. Coppinger, R.A.M.C. Readers are cordially invited to attend the meetings, which are held at 8 p.m. on Fridays at 72a, North End Road, West Kensington, W.14. Full details of future lectures may be had from the Hon. Secretary, at 48, Fitzjames Avenue, W.14.

Current Topics

NEWS OF THE WEEK IN BRIEF REVIEW

Not many countries can boast of having a woman engineer on the staff of their broadcasting organisation. Here is Miss Klara Dalland in the control room of the Oslo station with Mr. Gythfeldt, the chief controlling engineer. Miss Dalland has just received an appointment at Norwegian broadcasting headquarters after serving for a period on the engineering staff of the Vädso station.

A Noteworthy Anniversary

TEN years have passed by since the opening of the first Empire beam service. The first circuit linked England and Canada, the stations being Bodmin and Bridgwater at the home end and Yamachiche and Drummondville in Canada. This was followed by links to the other parts of the Empire. The success of the beam service led to the Imperial Wireless and Cable Conference and the subsequent amalgamation of these two services.

Arabian Nights Entertainments

THE Rome short-wave station which works on 25.40 metres now transmits certain of its news services in Arabic for the benefit of Italy's Moslem subjects. At these periods Arabian music is also transmitted. At present these special transmissions are given on four days a week only, but may be extended later.

Poland and Foreign Languages

IT is reported that the foreign language lessons which have been such a feature of certain Polish stations are to be discontinued on the ground that listeners are not profiting by them to the extent which was hoped. It is not stated whether or not the authorities have been influenced by the fact that increasing knowledge of foreign languages means increasing ability to imbibe foreign culture by listening to stations in neighbouring countries.

Europe Leads America

INTERESTING figures concerning the production of sets in the U.S.A. and Canada show that in the past six months of this year the former country produced $2\frac{3}{4}$ million sets valued at 10 million sterling. Canadian production figures for the corresponding period are not yet available, but during the whole of 1935 Canada produced rather less than a quarter of a million sets valued at some $3\frac{1}{2}$ million sterling.

In view of the above figures it is interesting to recall that a few years ago the United States possessed more broadcast receivers and listeners than the rest of the world put together. Nowadays, however, Europe is in front of America in the number of radio-equipped homes, the respective figures being estimated at 23 million for the U.S.A. and 25 million for Europe, excluding Russia.

An Ambitious Programme

CANADA'S new Broadcasting Commission is to make a thorough investigation into broadcasting conditions in the Dominion, and it is expected that several new stations will be built and others increased in power. It is a foregone conclusion that more attention is to be paid to broadcasting in French for the benefit of Canada's French-speaking population.

St. Bernard Up to Date

IT has been decided to equip all the refuges in the Italian part of the Alps with transmitting as well as receiving sets. Each life-saving expedition which sets out from the various refuges will be equipped with a portable transmitter and receiver so that it may keep in touch with its base. The refuge stations themselves will be able to communicate with special stations in the valleys in those cases where landline facilities are not available or have broken down through bad weather.

Jewish National Station?

IT is reported from Central Europe that plans are afoot to hire or build a transmitting station either in Switzerland or Czechslovakia for the purpose of spreading Jewish culture. In some quarters it is stated that the main object is the counteracting of anti-Semitic propaganda from certain other European stations.

Wireless Amateurs' Trophy

WILLIAM S. PALEY, President of the Columbia Broadcasting System, has been so struck by the useful service which amateur transmitters have rendered to the community, such as during the disastrous floods in America early this year, that he has presented a trophy to be awarded annually to the amateur adjudged to have performed, by means of radio, the most meritorious service to the community during the preceding twelve months. Seven sculptors have been invited to submit suitable designs for the trophy, which will be in the permanent custody of the American Radio Relay League. The annual winner will have his name engraved on it and will also receive a small replica. The first award, covering the year 1936, is expected to be made on March 15th next. Five famous men, headed by Admiral Grayson, have been selected to serve on the Board of Award.

Wireless Aids for Aircraft

ALL South African main airports are soon to be equipped with the latest type of wireless direction-finding and blind-landing apparatus. Details of the new equipment, which includes the Lorenz apparatus were discussed at a recent meeting of the South African Radio Relay League. The decision to equip the airports in this manner has been taken as a result of extensive experimental work that has been carried out at the Cape Town Airport.

British Sound Recording Association

THIS society has now been firmly established, and all who are interested in home or professional recording are invited to obtain full particulars from the Hon. Secretary at 7, Ernest Close, Beckenham, Kent. The subscription is purely nominal, and for those who live too far away to be able to attend the regular meetings a scheme of associate membership has been arranged. The Association meets at 44, Valley Road, Shortlands, Kent, at 8.30 p.m. on alternate Thursdays.

A full programme of lectures, demonstrations, and visits to places of interest covering all phases of sound recording is being arranged for the winter months. At recent meetings lectures have been given by well-known experts on sound recording on discs and sound recording on films.

Australian S.W. Transmission

DURING December, Sydney VK2ME will transmit on 9,590 kc/s (31.28 metres) every Sunday at the following times, all G.M.T.: 6 a.m.—8 a.m., 10 a.m.—4 p.m.

During the same period Melbourne VK3ME will transmit on 9,510 kc/s (31.55 metres) daily from Monday to Saturday from 9 a.m. to noon (G.M.T.).

I.E.E. Wireless Section

THERE will be a special meeting to-day (December 4th) at 7 p.m., when a paper, illustrated by demonstrations, will be read by Messrs. E. A. Speight, Ph.D., and O. W. Gill on the Post Office Speaking Clock.

The Radio Society of Great Britain

THE amateur movement in this country is in a remarkably healthy state if one can judge by the state of the finances of the Radio Society of Great Britain. Subscriptions which total £2,270 are £306 higher than last year. The balance of income over expenditure is £315.

An Engineers' Meeting

DISAPPOINTMENT with the alleged inactivity of the Institute of Radio Engineers has prompted Mr. C. W. Watson and other radio engineers, stated to be members of the Institute, to call a meeting to discuss the matter.

The meeting will take place at the Bedford Room, Hotel Russell, London, at 4 p.m. on December 7th.

Anyone wishing to attend should communicate with Mr. Watson at 22, St. John Maddermarket, Norwich.

The Institute of Radio Engineers referred to has no connection with the well-known American Institute of the same name.

Sound Recording

PART II.

SUB-STANDARD FILMS: MECHANICAL RECORDING: GENERAL CONCLUSIONS

By S. R. EADE, A.M.I.E.E. (Of the Research Dept., B.T.H. Co., Rugby)

AFTER discussing methods of sound recording that are adaptable to home or amateur use, the author goes on to explore the possibilities of sound-on-film (sub-standard size) gramophone records and other specialised systems of mechanical recording

SOUND film of 16 mm. width is now well known and is capable of giving a satisfactory quality of reproduction. The reasons why it does not meet the home recording need can be summed up as expense and technical complexity of the apparatus and processing operation. It is, however, of great interest technically and is worth studying in some detail.

The major fields of usefulness of 16 mm. sound-on-film are educational, publicity, entertainment, where the expense of its full-sized brother is not justified, and, to a much less extent, home entertainment. This latter field will be much more fully developed when comprehensive libraries of films become generally available. Means for recording one's own talkies in this medium are at present, and likely to remain, outside the financial resources of the average amateur.

The great majority of 16 mm. sound films are made by optical reduction or re-recording processes from 35 mm. films. Two or three cameras are, however, available for direct sound and picture recording on 16 mm. One of these is of particular interest because the sound record is made by acoustic-photographic means without an intervening electrical link. The operator speaks directly into the camera, and so the range of sound pick-up is of course limited.

Any single-film system of this type suffers from the same difficulty as that mentioned for 35 mm. film. That is to say, the photographically fast emulsion required for obtaining the picture negative does not provide sufficient resolving power to obtain the required definition on the sound record.

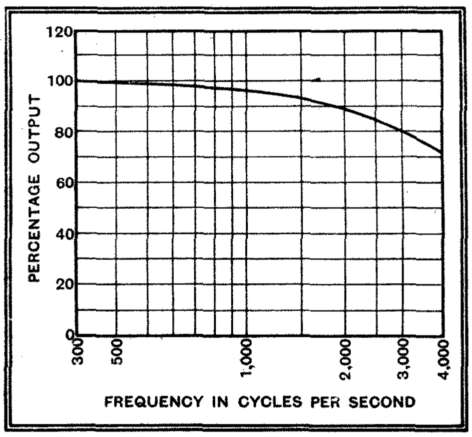

Fig. 7.—Attenuation due to finite slit width in 16 mm. recording.

It is standard practice to run 16 mm. sound films at the same frame frequency as 35 mm. prints, that is, twenty-four pictures per second. This fact allows direct optical reduction of the picture from 35 mm. negatives. Now, because the film width is 16 mm. compared with 35 mm. for its full-sized brother, and because a picture frame proportion of 3 to 4 is preserved, the linear speed of 16 mm. film is approx. 2/5 that of 35 mm.

The attenuation which occurs at a frequency of 10,000 cycles per second on 35 mm. records, due to finite slit width and photographic considerations, will occur in equal measure at only 4,000 cycles per second on 16 mm. records. This attenuation is a serious problem and means that very accurate control is necessary to obtain satisfactory sound quality. For the same reason it is preferable to make a 16 mm. print by optical reduction of the sound track from a 35 mm. negative rather than to re-record or record the sound directly on 16 mm. stock. This point will be further elucidated later in this article.

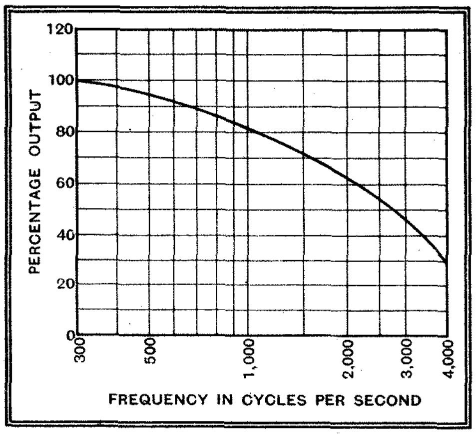

Fig. 8.—Losses due to lack of resolving power will increase inversely with the lower linear speed of 16 m.m. film.

Volume range, on the other hand, is not so seriously curtailed, because a modulation depth of 0.060in. is maintained, compared with 0.075in. for 35 mm. variable area. A track of 0.060in. amplitude is obtained by utilising only one row of sprocket holes and placing the track where the second row would normally be on 16 mm. silent film. An increase in effective background noise is, however, inherent, and this causes a further slight decrease in volume range.

With regard to direct recording on 16 mm. film, if we consider a two-channel system (that is to say, separate cameras and films for sound and picture), the overall result to be expected can be computed from the figures we have quoted in the 35 mm. case. In the first place the apparatus must be as accurately made and operated as in the 35 mm. system, and the only difference will be that we use 16 mm. film at a speed of 36ft. per minute. If we assume a recording slit width of 0.0005in. as the lowest reasonable size, the attenuation due to this alone will be as shown in Fig. 7. Now the losses due to lack of resolving power in the emulsion at any frequency will be increased inversely as the lowered linear speed, and will be as shown in Fig. 8.

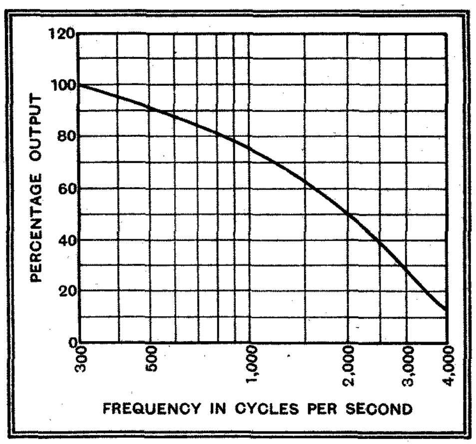

Fig. 9.—Overall high-note attenuation of the printed sub-standard film.

If now we make a print by contact from the negative so obtained, a further loss will be introduced which will give a frequency characteristic for the final record approximately as shown in Fig. 9. Comparison should be made with Fig. 6 in last week's instalment, which relates to 35 mm. recording, to appreciate the losses involved. In addition the volume range will have been lowered by about 8 db., chiefly due to the effective noise level being increased.

Any method of re-recording in which a 35 mm. print is reproduced and the electrical output fed to a camera to record a 16 mm. negative will, of course, suffer from similar losses. It is often suggested that electrical compensation may be introduced to improve the frequency characteristic, but this is not a satisfactory solution, as it can only increase the track ampli-