The Alden-Somerbridge Set

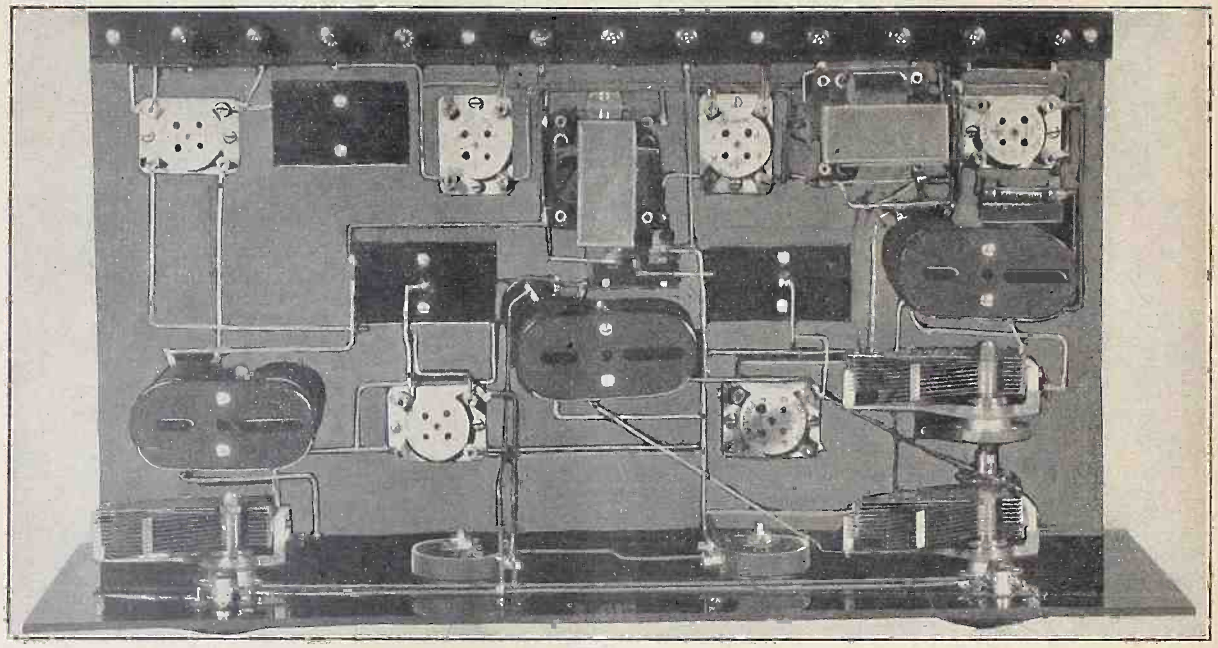

FIG. 1
Looking down upon the interior of the receiver.

By Wendell Buck

IN the earlier days of radio a circuit or a circuit principle was developed as a whole and offered to the radio builder. We had, for example, the regenerative principle, a very startling improvement in efficiency over the crystal. Then came the first radio frequency amplifier circuits, which, placed before the regenerative detector, added miles to the operator's distance range, not to mention a very welcome increase in selectivity. Gradually radio frequency amplification developed and expanded into the many forms and manifestations which we know today, including the ever popular Neutrodyne principle.

Today there is a tendency toward claims that this circuit and that circuit are different and better. This is not true, of course, of all the circuits presented, but it is true of some. There has been a decided tendency, however, toward neglecting the overall efficiency of the complete circuit, due to stressing one particular virtue or strong point.

This has been particularly true of the radio frequency and of receiving circuits.

Maximum selectivity and sensitivity can only be obtained through radio frequency amplification. In attempting to find something really new in the RF side of a circuit many designers are losing sight of the fact that a radio receiver is primarily built to receive broadcast programs. An unstable RF amplifier, which distorts the signal, is hardly suitable for the average radio fan, regardless of its theoretical possibilities or its qualities as a laboratory model.

The Alden-Somerbridge Circuit

The Alden-Somerbridge circuit not only uses an entirely new and original system of RF amplification and stabilization, but co-ordinates with high efficiency and perfect stabiliation the component circuits of the completed receiver. The radio frequency amplifier passes on to the detector no noises of its own making. The detector receives an undistorted output from the RF amplifier, which is in turn passed on to the audio amplifier and is delivered through the speaker as a true rendition of the original broadcasting.

At first glance the technical theory in back of the Alden-Somerbridge system may seem a bit complicated to the average radio fan. Before going deeply into the practical angle of building the receiver it will be well to clarify the theory and advantages of the Alden-Somerbridge system so that the builder will understand thoroughly just what the circuit is, how it is different and better, and what he can expect from the completed receiver. A comparison of the leading forms and systems of radio frequency amplification will bring to light the outstanding features of the Alden-Somerbridge system and their advantages as worked out finally in the 6 or 7-tube receiver (depending on the kind of audio used).

Simple Forms of RF Amplification

The simplest form of RF amplification is the regenerative detector. A detector tube, operating in a regenerative circuit, performs two functions: It rectifies the incoming signal and at the same time amplifies tremendously the radio frequency energy present in the circuit. The plate circuit of the vacuum tube is "tuned" or placed in resonance with the incoming signal to obtain maximum regeneration. In the tickler feedback method the plate coil is placed in inductive relation to the secondary and variation of this coupling produces regeneration to the extent desired. It is important to note that if the plate circuit is in exact resonance with the grid circuit that excessive or self-oscillation will occur, which may prevent the reception of signals.

The second method, and the one in which we are most interested, is the tuned plate system, in which a variometer is used to place the plate circuit as closely to resonance with the incoming signal as is desired. A variometer is simply a coil so constructed that one-half can be placed in a varying inductive relation to the other half. It is perfectly possible to tune any radio circuit by this method, exactly as a coil and condenser tune the circuits with which we are most familiar.

Other Systems

The second step in the development of the radio frequency amplifier was the untuned transformer which transferred the incoming signal from stage to stage exactly as an audio frequency transformer does. If any considerable wavelength band is to be covered, the transformer must have its resonant point broadened out by means of an iron core.

Next the tuned RF amplifier was developed. There are so many variations of this type that it is impossible to cover the field thoroughly aside from the basic circuit, with which all are familiar. (See diagrams on page 8.) The RF transformer in this type of circuit consists of a primary or plate winding and a secondary or grid winding, which is tuned by means of a variable condenser. For balancing purposes often potentiometers, series plate resistances, absorption shields, etc., etc., are used. The point that this circuit could be made free of self-oscillation did more to popularize it and radio generally than any other single radio advance. It was found that the number of turns in the plate coil could be cut down to the point where the oscillation would not occur at even the lowest wavelength. Control, consequently, was simple enough even for the novice.

With the material broadening of the wavelength band for broadcasting stations at about this time, it was found difficult to cover from 200 to 550 meters. The energy transfer from stage to stage became less and less as the circuit was tuned to longer wavelengths. In an attempt to solve this mechanical difficulties were encountered.

The attention of set and circuit designers was then turned toward electrical circuits which would preserve the desir-

A New Neutralization Plan

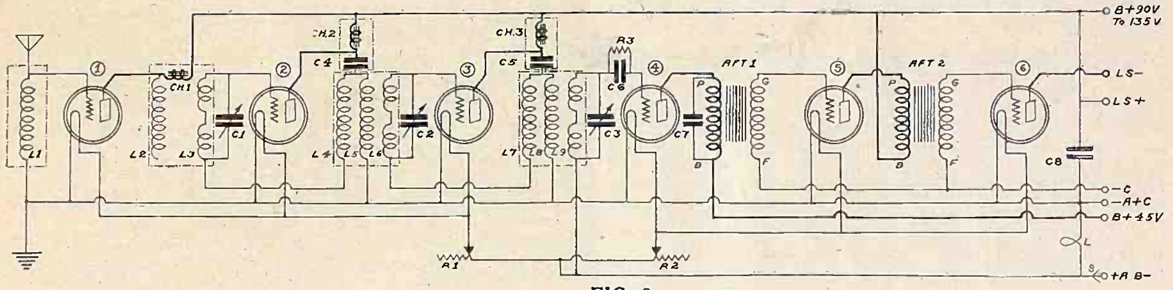

FIG. 2

The circuit diagram of the Alden-Somerbridge balanced receiver.

able characteristics of the tuned RF sets and at the same time give more overall efficiency. Chief among the new circuits was the Neutrodyne.

The Neutrodyne Principle

With minor variations, the Neutrodyne circuit is similar to the ordinary tuned radio frequency receiver. The difference is that energy is passed from the primary to the secondary as in all circuits of this type, but at the same time, energy which is not in phase (or we might say "not in step") with the signal being impressed on the grid is introduced into the circuit to an extent that neutralizes the normal tendency of the circuit to break into oscillation.

The difficulty with the Neutrodyne from the experimenter's point of view is that it is difficult to construct a set of this type from parts which are already adjusted at the factory. The apparatus to neutralize correctly this type of set is usually far above the pocketbook of the average fan. The skill required to do it right usually comes only with long practice.

The Alden-Somerbridge circuit offers the experimenter and builder the advantage of the tuned radio frequency and the Neutrodyne circuits, with the added advantage that the parts are available with all of the variables properly adjusted and definitely fixed at the factory. The actual receiver, as shown in Fig. 2, contains some points which are radically new and as interesting now as the Super-Heterodyne and the Neutrodyne were in their natal stage.

Features of the Circuit

The circuit diagram shows a radio frequency choke coil, in the untuned antenna stage, which permits the reception of stations covering the entire broadcast band. Leaving the antenna stage untuned permits the accurate logging of both the dials of the receiver, regardless of the length of antenna used with the set.

The radio frequency amplifier circuit is the invention of Dr. George A. Somersalo. It represents the result of six years of research and experimentation in his laboratory. A bridge circuit is employed which effectively balance out the undesirable excess energy from the plate circuits of the tubes and allows uniform amplification over the entire wavelength band.

In practice the action of the circuit is this: The broadcast signal is impressed on the grid of the first tube and produces a response in the plate circuit of the same tube. The plate current is supplied for this tube through the radio frequency choke coil CH 1, which prevents the RF energy built up in the plate circuit from being by-passed through the B voltage circuit to the ground. It is seen then that this radio frequency energy must enter the coil L2 from which it is transferred to the grid coil L3 of the second tube. A similar action takes place in this tube, except that the direct current voltage of the B supply is kept out of the windings L4 and L5 by the blocking condenser C4. If this condenser were not there, direct current of high voltage would be imposed directly upon the grids of the tubes, preventing their action as amplifiers.

Inductance Bridge Secret of Balancing

In Fig. 2 we have the circuit diagram of the Alden-Somerbridge receiver, which employs the new system of stabilization, invented by Dr. Somersalo, the medium being a mutual inductance bridge. How the balancing is obtained can be best explained with the aid of Fig 3. The input circuit is connected between the grid and the plate. In order to prevent the terrific high direct current voltage, which is supplied to the plate, from reaching the grid, a large blocking condenser, say about 1 mfd., is placed in the plate-grid circuit. These are known as C4 and C5 in Fig. 2. In series with the tuned input circuit is a balancing coil, LB. This coil is inductively coupled to the output inductance. The purpose of this coil is to offset the feedback through the inherent capacities of the tube. In this arrangement we have a bridge, the character which can be best determined by the balancing condition.

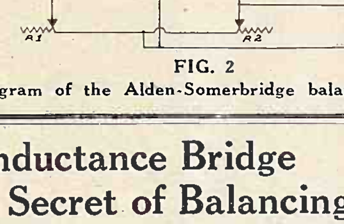

FIG. 3

The diagram showing the method of balancing the circuit.

$$\frac{L1}{M} = \frac{C1 \text{ plus } C2}{C2}$$

where L1 is the self-inductance of the output coil, M the mutual inductance between L1 and the balancing coil LB; C1 and C2 the inherent tube capacities.

In the actual neutralizing process we may adjust the balance by slightly altering the position of the balancing coil or changing its number of turns, or by using an external condenser between two of the electrodes. If we wish to have a very small balancing coil we have to add capacity between the plate and the grid; when using a comparatively large balancing coil, the external capacity has to be placed between the grid and the filament.

Utilizes Inductance

The radio frequency energy must, of course, pass through these coils, and it is at this point that the most interesting action of the Alden-Somerbridge circuit takes place. Fig. 3 gives the theoretical circuit of one amplifier tube in the hookup. The problem is to balance out the undesirable capacity effects of the tube and at the same time achieve maximum energy transfer to the grid of the succeeding tube. Going back to the case of the variometer in the plate circuit of the regenerative detector, we can easily see that in effect we have the same thing in the plate circuit here. We have an inductance, one part of which can be varied in inductive relation to the balance of the coil, and we can tune this circuit effectively by this means. Here, of course, the problem is a little different, as we have the effect of the secondary inductance to take into consideration.

Action of All Stages Is Identical

The action which takes place in all succeding stages is identical. As many of these stages may be used as desired. For all practical purposes the receiver circuit shown in Fig. 2 does nicely. It will get you down to the noise level without any difficulty in any location. Amplification can be maintained at a high level for reception of distant stations, and stations nearby may be tuned in without the slightest danger of tubes "spilling over." Those familiar with the action of tuned radio frequency receivers under these conditions will recognize this as a very strong point in favor of the Alden-Somerbridge system.

The detector circuit is non-regenerative for quality, and the audio frequency parts should be chosen with the end in view of delivering to the speaker a signal which is truly enjoyable to hear. If power tubes of the 171 to 210 type are to be used in the last stage, either an output transformer or the convenient choke coil and condenser may be used to keep the plate circuit of the last tube from the speaker windings.

[*Constructional data on the Alden-Somerbridge receiver will be completed next week, issue of November 6.*]

How to Get Rid of Squeals

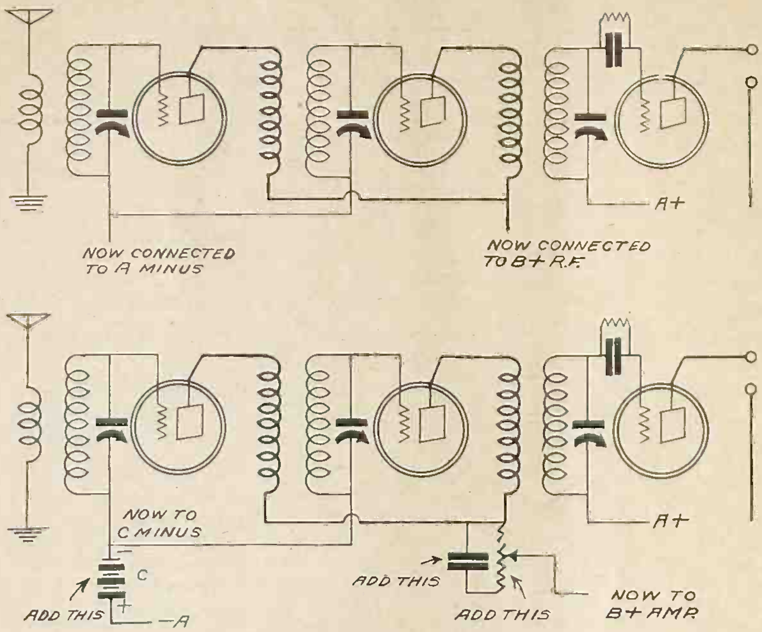

FIG. 1

The essential details of the wiring of a tuned radio frequency receiver, up to and including the detector, as shown is the top diagram, to illustrate leads that will be changed so as to embody the Bernard system of neutralization. The changes to be made are illustrated in the lower diagram. In most sets the audio C battery will be used, so that only the variable high resistance and the bypass condenser need be added to the set.

By Herman Bernard

Associate, Institute of Radio Engineers

ANY one possessing a tuned radio frequency receiver, particularly of the popular 5-tube variety, may be considerably annoyed because the set squeals when low wavelength stations are being tuned in. On the other hand, the set may squeal on the high waves and not on the low ones, because of attempted stabilization by high frequency resistance, which is great at the low waves, and effective there, but rapidly declines as the wavelength increases.

Several appropriate methods exist whereby the squealing tendency of the set may be overcome, and while some ways may be a little bit more effective than others, complete reconstruction of the receiver might have to be embodied in the solution. The method now under consideration does not require reconstruction, but only a few slight changes and the addition of three inexpensive elements. It adds no control to the existing set in the sense of requiring any constantly adjusted part.

The balancing or neutralizing system is the same one that was first used in the Bernard receiver (October 16 issue), and it consists of introducing a negative bias on the grids of the radio frequency amplifying tubes, in conjunction with a variable high resistance in the B plus lead that feeds the direct current to the plates of these bulbs. The resistance may be 2,000 ohms, either an Electrad Royalty Type F or a Centralab, or may be as low as 400 ohms, depending on the B plus amplifier voltage. For 90 to 135 volts use 400 ohms.

The three items to be added are the C battery, the variable high resistance and a fixed condenser across this resistance to bypass the radio frequency currents, preventing them from passing through the resistance element.

As most receivers now have C batteries in the audio channel, and all sets using power tubes certainly must have them, in only infrequent instances will it be necessary to buy a C battery. If one is to be purchased it should be of the 4½-volt type (Eveready No. 771).

Fig. 1 shows the pertinent wiring connections of an existing 5-tube tuned radio frequency set, up to and including the detector, but not showing the conventional pair of transformer coupled audio stages, as these have nothing especial to do with the squeal killing.

Usually the grid returns of the two radio frequency amplifying tubes are connected to A minus. We desire to connect instead to C minus. The C battery therefore is connected with positive post to A minus. The return of the two RF grids to A minus is broken and a common lead made of the two buses, preferably with a flexible lead going to the C battery. We may desire a negative bias of only 1½ volts or perhaps 3 or 4½ volts, so the flexible lead comes in handy.

Two Important Factors

What the negative bias shall be will depend on a few factors, principally the plate voltage and hence plate current, and the nature of the tubes.

If the receiver has a separate B plus RF lead it is a simple matter to connect this to one side of the variable high resistance and join the other terminal of this resistance not to B plus RF, but to B plus amplifier, the highest B voltage you use in the set, right at the battery. The resistor will drop the voltage to the required amount. Do not forget to connect a fixed condenser across the resistor, the capacity of this condenser being .00025 mfd. or more, up to say 1 mfd. Select whatever value you have on hand. If you have no such condenser it might be advisable, in purchasing one, to favor the higher capacities.

Should the set not have a separate B plus RF lead, but a common B plus amplifier lead, say of 90 volts, this being used for the two RF tubes and the two audio tubes, then it will be necessary to disjoin the B plus lead from the ends of the two RF primaries to which it goes (second and third primaries from left in the diagrams), and make the B battery connection through the variable resistance, as described. In such a case some place on the baseboard or subpanel of the set should be found for the resistor, since it requires only a ¼-inch hole for mounting, and once the resistor is properly set it need not be touched again.

The Neutralization

To balance the receiver, select the particular station that gives you the most trouble. Start with a negative bias of 1½. This is easily obtained by using the 3-volt post of the C battery as C plus and joining the C minus lead of the set to the C minus 4½-volt post of the battery. The actual bias is 1½ because it is merely the difference between 3 and 4½. The lowest negative in any connected battery system is always equivalent to zero.

Now set the variable resistance so that minimum resistance or zero resistance is in the circuit. If the set squealed previously it should do so now, by all means, because the extra bias aids this, and the B voltage is as high as before, or most likely higher. Now very gradually and carefully turn the resistance knob until the squeal disappears. It may so happen that as the squeal disappears the volume falls off considerably. This would be due to the inadvertent inclusion of too much resistance, so go back just the tiniest fraction of a degree until the volume is strong again, but without squeals.

Now tune in stations at other wavelengths, both higher and lower, and notice whether any squeals are heard. On some very critical wavelength for your location and receiver just the faintest trace of a gurgle may be heard when tuning in, but this may be dismissed as unimportant or insoluble, since it may be due to the wave of that station beating against the wave of another, or to atmospherics or the antenna or primary circuits having a fundamental wavelength the same as that of the particular station under discussion, or a harmonic of that station's fundamental. In all neutralized sets this very faint audible sound may be tolerated and it is not a bit annoying, since signals drown it out.

Straightening Out Difficulty

In certain locations greater energy is required for one or two stations to make them decently receivable than for bringing in any other local, so it is often a good plan to use one of these as your guide, getting the desired volume by adjusting the resistor. If it is found that squealing results on other wavelengths when the weak stations are made properly audible, then it is well to increase the negative bias to 3 volts, instead of the previously tried 1½, and increase the RF plate voltage, very slowly. This introduces high negative bias so as to permit much higher plate voltage with little change in current.

The set that never was intended to squeal, yet does squeal, is a nuisance not only to your neighbors who have sets, because when they listen in their programs