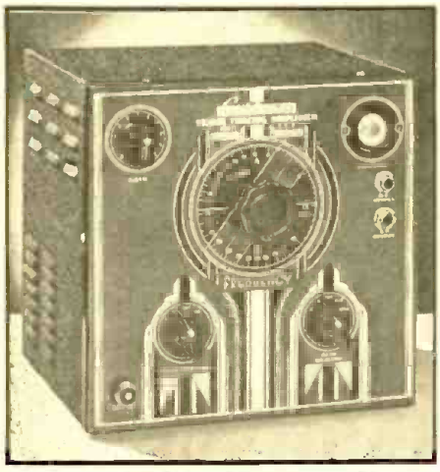
SIGNAL TRACING AMPLIFIER

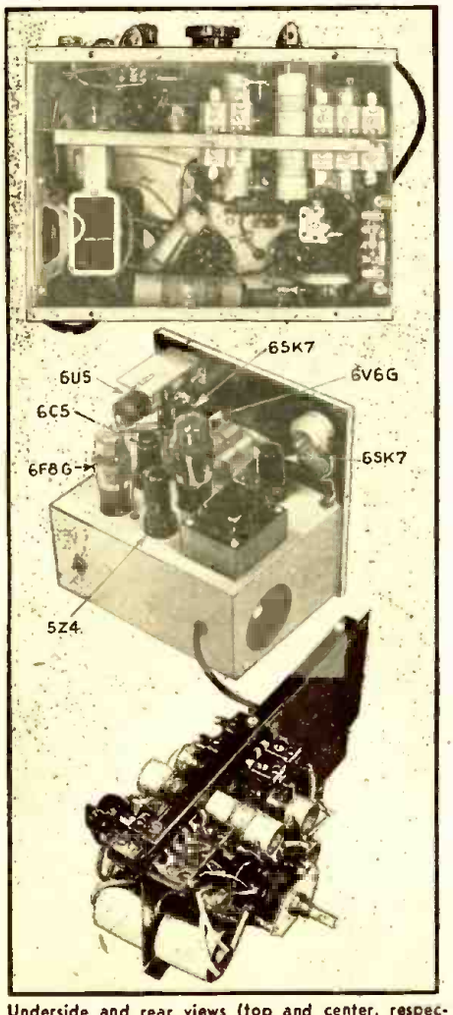
An Effective Radio Servicing Tool

The Signal Tracing Amplifier here described has been devised to aid radio Servicemen in quickly spotting faults in the remaining 10% of service problems the average radio repair man fails to clear quickly if only because they are not total "failures." The 10% of "unusual" cases of intermittent operation, internal noise, instability, low sensitivity, "dead spots", and an assortment of other cases, must respond to proper stage analysis with the Signal Tracing Amplifier.

L. M. DEZETTEI.



The completed Signal Tracing Amplifier.



Underside and rear views (top and center, respectively) of the Signal Tracing Amplifier; and, a close-up of the coil and trimmer arrangement.

DURING the past year, "Signal Tracing", as a method of locating circuit failure, especially intermittent cases, has grown in popularity. This popularity is not due to the fact that most units now on the market have built-in voltmeters, measure power output or indicate audio signal, but only because (for the first time) an instrument has been made available which will allow operating frequency, relative R.F. gain, and oscillator performance to be checked. Any competent Serviceman does not require a "robot" with a half-dozen "eyes" to locate the receiver fault. He can usually place the failure in the audio, I.F., R.F., or oscillator stages within a few moments' inspection.

THE 10% OR "PROBLEM" SERVICE JOBS

Eliminating tube failure, 90% of the service cases encountered are total "failures". The set is "dead," distorted or weak; and the causes lie in shorted or open condensers, open resistors, chokes, field coils, burned-out power transformers, worn insulation and loose connections. The remaining 10% may be grouped into a class of unusual cases, most of which have been serviced at a loss since they represent intermittent operation, internal noise, instability, low sensitivity (with voltages and other parts in perfect condition), "dead spots" and a varied assortment of cases which defy description.

It is with these cases that we are primarily interested. If we have an instrument capable of checking approximate stage gain, identifying frequency of operation and locating poor bypassing, we have a tool which is invaluable to the Serviceman.

The instrument described here *is* such a tool. The principle is not new, but the application is.

For the first time, an amplifier is presented which has approximately constant gain throughout the broadcast and I.F. bands allowing stage gain to be checked stage-by-stage. In addition, the range has been extended to 17 mc., covering the most important shortwave channels. Oscillator performance may be checked at the higher frequencies where the greatest trouble is encountered; and frequency may be measured with sufficient accuracy to determine whether or not the oscillator is operating on the proper beat; and of more importance, the determination of proper tracking may be made. Intermittent cases due to R.F., oscillator, or I.F. failure may be located quickly and low-gain stages may be located easily.

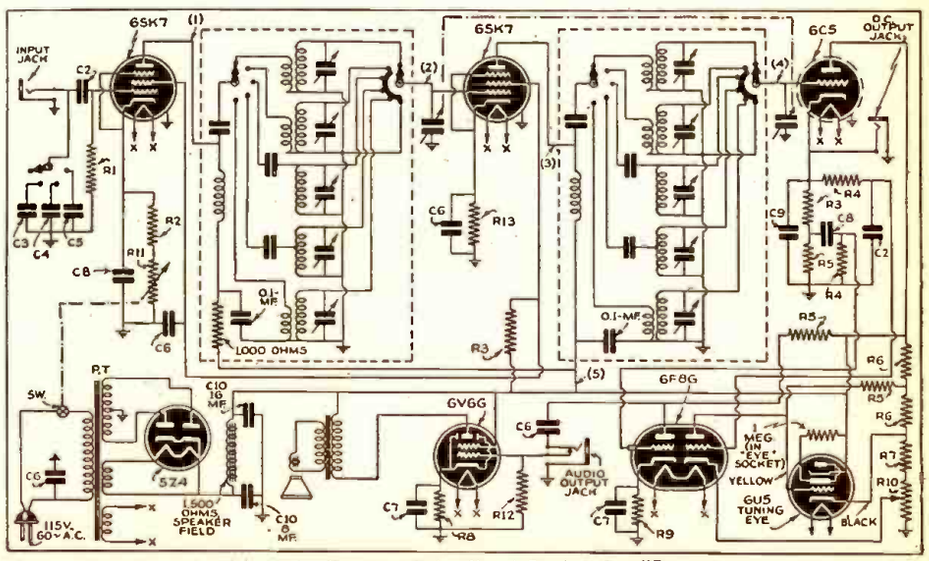
CIRCUIT

Essentially, this unit consists of an untuned input stage with a capacitative attenuator allowing signal input to be attenuated by factors of 1, 10, 100, and 1,000. This untuned stage is followed by 2 tuned stages working into the input of an *infinite-impedance detector.*

The audio component of the R.F. signal is amplified and made available for use with speaker, headphones, meter, or oscilloscope.

The D.C. rise, due to rectification, is amplified and applied to a 6E5 electron-ray indicator ("eye") tube. Operated thus, the electron-ray tube indicates the presence of a signal whether modulated or not.

To facilitate the use of the instrument, the dial reads directly in frequency. Two



Schematic diagram of the Signal Tracing Amplifier.

scales are provided, one for the low-frequency, broadcast and high-frequency bands, the other for the I.F. and police bands. The proper scale and multiplying factor being determined by the scale on the band switch. The scale reads frequency directly and since only 2 scales are used, they are open, and minor divisions of frequency allowing faster and more accurate operation may be made.

The basis of this instrument consists of a kit, essential parts containing a ready-drilled panel, cabinet and chassis, a 2-gang, 442 mmf. tuning condenser, and a completely-wired and tested R.F. assembly consisting of 10 coils and rotary coil switch. The coils are matched to extreme accuracy and, if directions are followed, no trouble will be had in calibrating the unit after it has been assembled.

ASSEMBLY AND WIRING

The best method of assembly is as follows:

Wire all heater, power supply and D.C. circuits, taking special care to run all leads close to the left of the chassis (looking into underside of chassis with the front towards you) so that they will fall into the notch when the R.F. assembly is placed into position. The detector cathode filter, and the audio coupling network, may be mounted into place; the voltage divider and plate resistor assembly however should be temporarily left unfastened. It may be mounted after the R.F. assembly is in place.

Carefully check all wiring since a great many connections will be inaccessible after the R.F. unit is in place. All connections should be complete at this point except the 1st R.F. plate lead (numbered 1 in the schematic diagram), which should be cut 1½ ins. long. The lead from the 2nd 6SK7 grid to the switch (numbered 2), should be cut 4 ins. long. The lead from the 2nd 6SK7 plate should be cut about 8 ins. long for ease in threading through a grommet in the stage shield connecting to the R.F. choke on the rear of the switch assembly (numbered 3) after which it may be cut short to prevent excessive lead length. The lead (numbered 4) from the 6C5 grid to the coil switch should be cut 2½ ins long; and the lead (numbered 5) from the R.F. assembly to the proper "B+" point on the voltage divider. All of the above leads should be in place for ease in soldering to the coil switch after assembly.

To place the R.F. assembly in the chassis, move the voltage divider as noted above, start the switch shaft through the proper hole, thread the braided ground strap through the hole near the gang condenser (where it will be soldered first to the chassis) above the chassis, and to the center shield and wiper of the gang condenser, and gently push the unit into place, taking care that no leads are caught between the lip and the chassis. It is a tight squeeze between the 6C5 socket, but it will make it if care is taken.

Rearrange all misplaced wires and fasten the panel in place using the nuts on the switches and input jack to bind it in place. A gap should appear on both sides and on the bottom between the folded lips on the panel and the chassis to allow room for the case when in place. Three self-tapping screws fasten the R.F. assembly to the chassis, after which it should be "bended" to the chassis with the lengths of braid soldered to the shield. The plate and grid wires should be attached and dressed-down to the chassis, and well away from each other, to prevent unwanted feedback. A washer should be placed on the shaft and the knob and pointer lined-up with the gauge lines on the dial. It will be noted that

the pointer is non-symmetrical. The end identified by the small drill hole near the knob should be placed on the "A" scale and the knob fastened in place so that the pointer line falls just below the horizontal dividing line between the A and B scales when the condenser is rotated to full capacity. This is the correct position for proper calibration.

CHECKING

The unit is now ready for a preliminary test. The band switch should be set to the broadcast position which corresponds to the identification A x 10; an antenna should then be coupled to the receiver. If all wiring has been done correctly, local broadcast stations should be heard with the multiplier switch in the 1X position and the gain dial at 1. Remember that this control works in the opposite direction from the usual volume control.

A signal generator is required for the next step. Each set of coils is accurately matched, but slight differences in wiring and input capacities require that the trimmers be adjusted for the high-frequency end of each band. Using the signal generator, the following adjustments should be made: Band No. 1, Long Wave "A" set dial and test oscillator to 140 kc., and adjust trimmers 1 and 2 for maximum indication of the "eye". Full input gain and the attenuator set at 1X should be used for preliminary indication, all being reduced as the peak is reached, just as in aligning any radio chassis.

The "eye" gives a very sharp indication and it is well to use phones during preliminary calibration. Band No. 2, "B" is aligned at 400 kc.; Band No. 3, A x 10 at 1,400 kc.; Band No. 4, B x 10 at 4,000 kc.; and, Band No. 5, A x 100 at 14,000 kc., using the electronic "eye" to adjust for maximum sensitivity. The proper adjustment is at the point where the "eye" just starts to close with the gain control (P11) in the full "on" position and the input test prod shorted to chassis (no signal).

THE DOUBLE-CHECK

One point of importance should be observed. Circuit oscillation will result with the bottom of the chassis unshielded, and therefore it will be necessary to use a piece of metal pressed tightly to the bottom and touching both lips of the chassis and coil assembly to shield the unit during calibration, moving it so that the trimmers for each band are just accessible for adjustment.

Due to the amplified action on the electron-ray indicator the range over which it operates is extremely small. Less than a 10% variation in input will show "full open" to "full closed." Therefore, in use, the maximum sensitivity should be used: R.F. gain "full on" and the attenuator in the "1X" position. After the signal has been located, the gain may be adjusted for proper "eye" operation.

Since the audio component must be filtered from the detector output, a slight lag will be noted in the eye operation due to the resistance - capacity filter of 1. meg. resistor and 0.05-mf. condenser. In tuning, the condenser should be rotated slowly to avoid the possibility of missing the signal.

HOW TO USE

The use of the instrument as an indicator is simple. A signal from a test oscillator or transmitting station is tuned-in and by applying the test prod in rotation from antenna, R.F. grid, detector grid, etc., we are able to note a low-gain stage or a "dead" stage. Since the "eye" is extremely sensitive, noisy stages will be shown up easily.

The unit may be employed as an "isochrometer," indicating exact zero-beat and zero-phase difference by feeding both the known and unknown frequencies into the input. Beats between harmonically related frequencies will also be indicated.

The test prod may be placed in contact with any R.F. circuit without changing the circuit resonance or loading to an appreciable extent. The A.C. output is available for headphones or oscilloscope use, as is the D.C. output from the detector. One word of caution, however. The use of an oscilloscope with a Frequency-Modulated oscillator should not be attempted, since the resulting curve will have the resonance characteristics of the signal tracer as well as the receiver and the result is useless in interpreting the actual receiver characteristics.

Since it is necessary to keep the input capacity low to prevent changing the characteristics of the circuit under test, a small 2 mmf. condenser is built into the end of the test lead. Since the coaxial cable used presents a capacity as does the input capacity of the tube plus the wiring capacity, we have a condition which limits the sensitivity of the unit by a factor of 25:1 (the input capacity before the 2 mmf. condenser is 50 mmf.). Due to this fact, when the unit is to be used to check for a defective bypass condenser, for field strength measurements or frequency measurement from weak stations, an improvement may be made in sensitivity by making a new lead using unshielded wires and an Amphenol MC1F connector, and placing a 50 mmf. condenser in series when used for direct antenna connection.

LIST OF PARTS

Condensers

Two paper, 0.05-mf. 400-V., C2;
One mica, 200 mmf. and 1—250 mmf. in parallel for 450 mmf., C3;
One paper, 0.005-mf. 400-V., C4;
One paper, 0.05-mf. 400-V., C5;
Five paper, 0.1-mf. 400-V., C6;
Two electrolytic, 10 mf. 25-V., C7;
One paper, .01-mf. 400-V., C8;
One mica, 500 mmf., C9;
One dual electrolytic, 8-16 mf. 450-V., C10.

Resistors

One 0.25-meg., ½-W., R1;
One 0.15-meg., ½-W., R2;
Two 50,000 ohms, ½-W., R3;
Two 1 meg., ½-W., R4;
Three 0.1-meg., ½-W., R5;
Two 10,000 ohms, ½-W., R6;
One 7,500 ohms, 1-W., R7;
One 250 ohms, 1-W., R8;
One 1,000 ohms, ½-W., R9;
One 5,000 ohms potentiometer, R10;
One 15,000 ohms, potentiometer, with switch (special taper, Carron B1097), R11;
One 0.5-meg., ½-W., R12;
One 500 ohms, ½-W., R13.

Tubes

Two 6SK7s;
One 6C5;
One 6F8G;
One 5Z4;
One 6U5;
One 6V6G.

Additional Parts

One essential parts kit, consisting of 5-band 2-stage R.F. coil assembly, 2-gang condenser C1, dial and hardware, punched chassis and panel, metal case, switch and R.F. cable. Carron CCH;
One 3-in. dynamic speaker with matching transformer and 1,500-ohm field;
One single-circuit jack;

One 2-circuit jack;

Six octal sockets;

One Amphenol MEA-10 visual tuning "eye" assembly;

One Amphenol PC-1-M male chassis connector;

One Stancor P-6010 power transformer;

One power line cord;

Three small bar knobs;

Miscellaneous hardware, hookup wire and braided ground strap wire.

This article has been prepared from material supplied by courtesy of Allied Radio Corp. in cooperation with Carron Mfg. Co.

RADIO IN THE NORTHWEST

RADIO wavelengths are weaving a network of medical security over the wilds of the Northwest Territories. Aided by 2-way radio sets, 9 resident doctors employed by the Territorial Council supply the medical needs of about 10,000 Indians, Eskimos, trappers, traders, miners and missionaries scattered throughout 1,300,000 square miles of icefields, rock and lake country and barren islands.

Their practice extends from the northern boundaries of the 3 Prairie Provinces and part of British Columbia to the far reaches of the Arctic circle and from the western end of Labrador to the Yukon Territory.

The outpost Physicians previously served only northerners within reach of dog teams or boats and canoes. These restrictions usually held them within a 100 miles radius of their stations except for airplane mercy flights. Now northern ether waves crackle day and night with medical messages from resident doctors at Aklavik, Fort Smith, Norman, Pangnirtung, Resolution, Chesterfield, Port Radium, Yellowknife and Simpson. Trading posts, missions and Royal Canadian Mounted Police stations throughout the silent tundraland pick up and send the mercy messages.

The Hudson's Bay Company, oldest trading firm in the British Empire, has installed 2-way radio sets in 78 of its 215 northern posts. Each post has at least one employee able to send and receive radio messages and plans are being made to install 25 additional sets next summer.

When aid is required, one of the Government doctors is called to the radio station. The emergency is described and the physician tells the operator what medicine or treatment is necessary.

All far-north settlements are stocked with medical supplies. Emergencies ranging from measles to childbirth have been met by radio prescription!

Should weather unfavorable to radio blot out urgent messages in one direction, signals are stretched to far-off sets, sometimes reaching a doctor 1,000 miles off.

ROY CARMICHAEL,
Montreal, Que., Canada

ORCHIDS

An orchid, Walter, to WOR, for their swell job of dramatizing the construction of a bomber. Listeners received practically first-hand information on the process, from A to Z, via the following remote pick-ups: designing and planning, and the processing of raw materials, at the Carnegie Illinois Steel Co. and the Revere Copper and Brass Co.; the manufacture of machine tools, Cincinnati Milling Machine Co., engine construction, Pratt and Whitney (Hartford, Conn.); plane assembly, Lockheed aircraft plant (Burbank, Calif.); finally, a bomber went aloft over Long Island, N. Y.