Two-Channel Conversion for AM-FM Receivers

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Details of simple changes which give the advantage of two separate receivers to tuner chassis which employ independent AM and FM channels but with coupled tuning capacitors. Ideal for binaural or stereophonic broadcast programs.

SOME TIME AGO, the writer made a few changes to a standard AM-FM tuner chassis in order to be able to listen to one program on FM while recording another on AM, or vice versa, all without realizing how advantageous this modification would be when radio stations started to use their two transmitters to radiate the two-channel signals for binaural or stereophonic programs.[1]

The whole idea is so simple and straightforward that anyone faced with the problem of providing both AM and FM programs simultaneously from a single tuner should come up with the same solution. However, since such a solution has not yet appeared in print, this one is offered as one way to accomplish the desired end.

At the time the modification was planned, there were no stations regularly broadcasting two-channel programs, but it must be admitted that there are times when two programs of interest are on the air at the same time, and the human hearing and interpreting mechanism is unable to cope with both at once. For this problem, the simplest solution is to record one of the programs. As one element of the writer's home system, a wire recorder was employed for just this purpose. The quality left something to be desired, but it was at least good enough to convey the information contained in the program—probably as well as any of several million table-model sets that serve as the sole entertainment medium in many households. At one time, this system employed two separate tuners—originally a wide-range t.r.f. tuner of the Miller type, with modifications of course, and the other an inexpensive FM tuner with a ratio detector.

The next step in the program of improvement included the design and construction of separate AM and FM tuner chassis, both tuned by means of push buttons. The FM tuner used relays to switch adjustable capacitors in the oscillator circuit, while the other used relays to switch the plate supply to any one of four single-channel fixed-tune chassis. This entire system was described in an earlier series of articles.[2]

The next step in the program was to secure a combination AM-FM tuner of good quality, with the idea of separating the sections so as to have the advantages of two-channel reception if desired. Because of its physical construction, the Browning RJ-12B was selected. In this receiver—as in several other types—the tuning is accomplished by two entirely independent variable capacitors, coupled together only by means of a dial cable. The modifications are now reasonably obvious. With the advent of two-channel broadcasting for binaural or stereophonic programs, the receiver becomes doubly useful.

Before discussing the actual modifications to the RJ-12B, let it be said that the general idea of these changes can be adapted to any AM-FM tuner which uses separate devices to tune the two sections. The Browning RJ-20 is similar to the RJ-12, and the Meissner 9-1091 may be converted in a similar manner. The details may differ, but the principle remains the same. For simplicity, only the changes to the RJ-12 will be described, and they are divided into two parts—electrical and mechanical.

Electrical Changes

The electrical changes required are simple, and are made primarily to permit the simultaneous operation of both channels. In the system for which this modification was made, the switching between AM, FM, and Phono is accomplished in the control amplifier. Therefore, since the phono and the TV inputs to the tuner were never used, it was preferred to eliminate this switching facility from the tuner chassis. However, to reduce current drain and consequent heating, a selector switch was used to permit operation of either channel separately or both together. This switch has three positions—the center providing for both AM and FM operation, the left position energizing only the AM tuner, and the right position energizing only the FM tuner.

In addition, neither the volume control nor the power switch were needed on the tuner chassis, both being provided elsewhere in the system. Therefore both of these were removed. As a matter of fact, when the RJ-12 is to be used in a typical modern system which incorporates a control amplifier, both of these components may be removed, leaving only the two central knobs on the tuner chassis—one for tuning and the other as the selector. However, for the modification, two tuning shafts were needed in addition to the selector switch, so in order to preserve symmetry, the a.f.c. switch was wired to the front panel, which is somewhat more convenient than its normal back-apron location. Thus we have four control positions on the front of the chassis—a.f.c. switch, tuning, selector, and blank. The original controls were, in the same order, the power switch, tuning control, selector, and volume. *Figure* 1 shows the

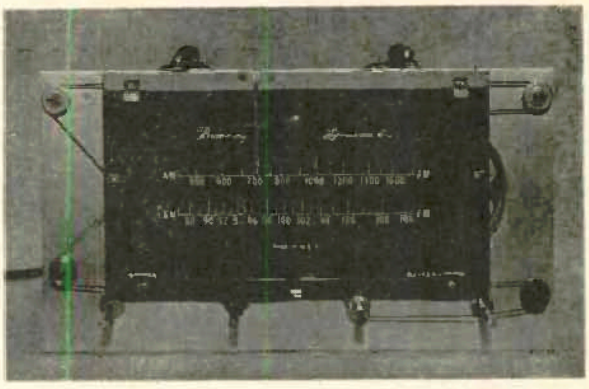


Fig. 1. External appearance of the converter Browning RJ-12B tuner, showing the two dial pointers.

[1] With no intention of getting into this controversy as to the correct name—at least not in a constructional article—the writer respectfully refers the reader to discussions on this subject by Tinkham on page 22 and Canby on page 46.

[2] C. G. McProud, "Elements of residence radio systems." AUDIO ENGINEERING, Sept.-Dec. 1948. Reprinted in AUDIO ANTHOLOGY.

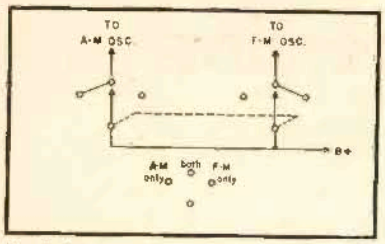


Fig. 2. Schematic of the switch connections to be made in making the conversion.

front of the modified chassis, which is but slightly different from a normal chassis. It will be noted that there are two dial pointers—the one at the top extends only to the AM dial scale, while the new one at the bottom extends upwards to the FM dial scale.

Taking the changes one by one, the following procedure should be followed. Remove the power switch and its associated wiring. Remove the volume control, leaving the wires disconnected but at the same location temporarily. One of the r.f. coils will have to be pushed slightly backward to permit the control to be removed. If done carefully, no damage should result. Now, remove the selector switch, leaving all its wiring intact. This will save a lot of tracing when connecting the new switch. All the shielded wires from the switch to the jacks on the rear apron may be removed, making it easier to get the switch out of the way. Next, remove the tip jacks marked AUDIO OUTPUT and RECORDER INPUT—the first and third from the left end of the rear apron when viewed from the back of the chassis. In the two holes, mount two 1.0-meg audio-taper potentiometers, wiring the arms to the adjacent tip jacks, and the ground end to a chassis ground lead. Connect a .05-μf capacitor from the junction of R_{11} and R_{12} (in the Browning diagram) —from which a shielded lead to the switch was removed—to the high end of the potentiometer nearest the AM end of the chassis. Connect another .05-μf capacitor from the junction of R_{13} and C_{14} to the high end of the other potentiometer. These two potentiometers permit adjustment of the outputs to equal levels.

Install a two-pole three-position switch (Centralab 1462) in the hole from which the selector switch was removed, and connect the new switch as shown in *Fig.* 2. The remainder of the leads should be connected so that the indicator tube works on both sections of the receiver at the same time. To accomplish this, connect the lead from pin 5 of the 6AL7 socket to the AM a-v-c bus; connect pin 4 to the ground end of the discriminator network; and connect pin 6 to the "high" side of the discriminator output, through a 1-meg. resistor. Thus the plate supply is connected to the AM oscillator in the left and center positions of the switch, and to the FM oscillator in the center and right positions.

New A.F.C. Switch

The normal a.f.c. switch in this chassis is a single-pole double-throw slide switch mounted on the rear apron. By prying up the tabs on the sides of this switch, the slider element may be removed and upon replacing the rear bakelite plate of the switch, the wiring is not disturbed and the terminals serve merely as tie points. Install a single-pole double-throw rotary switch on the front apron where the power switch was, and connect three wires from the old switch to the new one, making sure to maintain the same operating arrangement.

After cutting the shafts to the same length as the original tuning shaft, the electrical changes are completed. One hole remains unoccupied on the front apron—that from which the volume control was removed.

Mechanical Changes

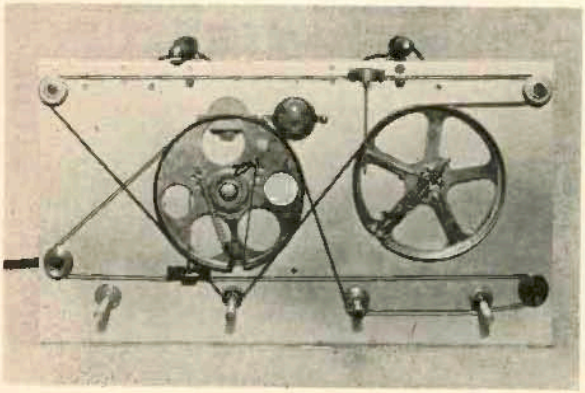
The first step is to remove the dial and all the dial stringing. Then remove the large pulley from the AM tuning capacitor shaft, and remove the smaller pulleys from both capacitor shafts. Mount a ¼-to-⅜ shaft extension on the FM capacitor shaft, and firmly attach a new 4-in. pulley to this extension, making sure that the dial cable opening in the pulley is at the bottom when the capacitor is half meshed. Remount the 4-in. pulley on the AM capacitor shaft, with the groove of the FM pulley about 1/16-in. further from the panel than the AM pulley. Mount a tuning shaft of the same type as the present one in the hole from which the volume control was removed, and mount two ¾-in. ilder pulleys as shown in *Fig.* 3. These pulleys must be free to turn easily, and eyelets for mounting them are usually supplied with the pulleys. Note that the bottom of the left idler is on a line with the top of the right one, and that this line is slightly above the bottom edge of the glass dial plate. A third idler pulley should be reamed out to run freely on the ¼-in. selector switch shaft.

Following the diagram of *Fig.* 4, carefully restring the AM dial cord. This cord is shown in solid lines and should be drawn up so as to be quite tight, with the spring extended to about 1½ times its normal length. Where the dial cord wraps around the knob shaft, it is suggested that three turns be taken. Test the stringing before proceeding, making sure that the knob shaft turns freely and that the dial cord behaves properly in the shaft depression.

Following a similar procedure, string the FM cord, using the dotted lines of *Fig.* 4 as a guide, and again test the operation thoroughly before proceeding further.

It is suggested that two similar dial pointers be obtained—the writer prefers the type which are made of a fluorescent plastic as they are easily seen. Since one is to slide along the top of the dial plate and the other along the bottom, try them out first, and cut off short enough that they clear, yet long enough to reach the dial calibrations. Then remount the dial plate and attach the top pointer, using a few drops of radio cement in addition to crimping the back of the slider. The vertical line at the left end of the dial scale indicates the position of full meshing of the capacitor plates for both sections. Therefore, the pointer should be secured to the dial cord at this end of the dial and with the capacitors fully meshed.

The FM pointer is similarly mounted to slide along the bottom of the dial plate. This may take some careful adjustment to make sure that the pointer passes the other cords without catching, but it can be done with a little care. It is suggested that the sliders be given a light coating of Lubricate or some similar lubricant.



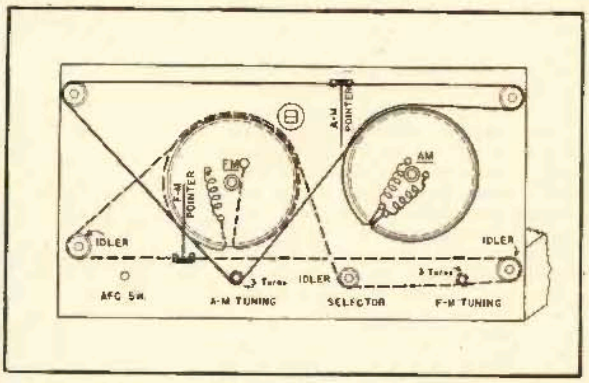


Fig. 3 (left). The tuner chassis with the dial plate removed to show the dial stringing. Fig. 4 (right). diagram of the dial stringing. The solid line indicates the path of the AM cord and the dotted line shows the path of the FM cord.

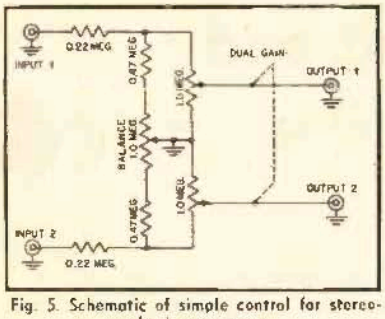


Fig. 5. Schematic of simple control for stereophonic programs.

Output Circuits

For use as a tuner capable of receiving two separate monaural channels, nothing further is required, since the two output jacks on the rear apron provide the AM and FM signals independent of each other. However, for binaural use, some means of controlling the volume of both channels simultaneously is an advantage. Therefore it is recommended that a separate control unit be provided. This unit can be as simple as possible, containing only a dual potentiometer, relying upon the two output controls on the tuner chassis for balancing levels between the two sections of the receiver. If a more elaborate unit is desired, so that either channel can be connected to either power amplifier or to both at will, it is equally possible to make such an arrangement. In any case, if the unit is to be used primarily for stereo programs, the balancing control is desirable. *Figure* 5 shows a simple control, without any provision for switching, yet equipped with the balancing feature. This entire unit can be mounted on a small bracket or on an unused space on the front panel of the installation. To reduce the number of *apparent* controls, it is suggested that the complete unit be assembled using an IRC Concentrikit, with the balancing control operated by the outside knob, and the dual potentiometers operated by the small inside knob. The parts list shows the components for either type of construction.

A more flexible control system is shown in *Fig.* 6. The selector switch has five positions—(1) both AM and FM channels feeding separate output circuits, with AM on output 1 and FM on output 2; (2) same as (1) except that AM is on output 2 and FM on output 1; (3) AM feeding both output circuits; (4) FM feeding both output circuits; and (5) stereophonic, with the dual volume control and the balancing control in the circuit. The only eventuality not provided for is the reversal of the stereophonic sources, which could become necessary in certain instances. This was not included because of the impracticality of locating a four-pole six-position switch of reasonable dimensions. However, it is probable that some standardization in channel usage will occur, so that the FM channel is always on the left and AM on the right, or vice versa. Since the normal orchestra arrangement places the high-frequency instruments predominantly on the left, it is probable that FM would be the left channel.

The balancing control provides a loss of about 3 db in each channel in the center position, with a variation of 3 db in the level of either channel as the control is rotated from one end to the other. If the control unit is to be used with amplifiers at any appreciable distance, it would be desirable to add two cathode followers, as shown in *Fig.* 7. There is some additional gain in this circuit so the balancing control has a mid-position loss of 6 db in each channel, with a range of 6 db from one end of the control to the other. The output from this arrangement is approximately the same for all positions of the switch, and one additional position has been added to permit reversal of the sides in the stereo position. The output impedance is sufficiently low that amplifiers may be located up to 20 feet from the control unit without appreciable frequency discrimination.

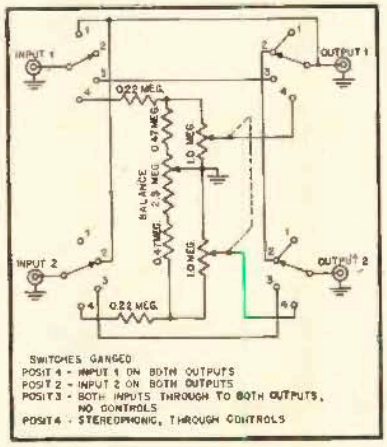


Fig. 6. The addition of a switch provides greater flexibility in the operation of the converted tuner. With the switch at A, input 1 is connected to both outputs; at B, input 2 is connected to both outputs; at C, each input is connected to a separate output, without the volume and balancing controls in the circuit; at D, the inputs are connected through the controls for binaural programs.

PARTS LIST

Receiver Modifications

1 2-pole, 3-position switch, Centralab 1462
1 SPDT rotary switch
2 1.0-meg audio-taper potentiometers, small size
2 .05-μf capacitors, 400 v., paper
1 Dial drive shaft with panel bearing
3 ¼-in. idler pulleys
1 4-in. dial pulley, with tension spring
1 Shaft extension, ¼-in. hole, ⅜-in. shaft
2 Slide-rule dial pointers
Nylon dial cord

For Figure 5

1 1.0–1.0 meg. dual potentiometer, audio taper
1 2.5-meg. potentiometer, linear or, if concentric control is used
1 IRC K-2 Concentrikit
1 IRC KS-2 Universal Shaft Kit
1 IRC B11-239 base element
1 IRC B13-137 base element
1 IRC M13-137 base element
4 Input jacks, RCA Phono type
2 0.22-meg. resistors, ½-watt
2 0.47-meg. resistors, ½-watt

For Figure 6

Same parts as for Fig. 5, with the addition of
1 Centralab 1414 switch

For Figure 7

Same parts as for Fig. 6, except for the substitution of the following for the resistors listed:
2 0.27-meg resistors, ½-watt
2 0.39-meg resistors, ½-watt
4 0.47-meg resistors, ½-watt
2 0.1-meg resistors, 1-watt
2 10,000-ohm resistors, 2-watt
2 3900-ohm resistors, 1-watt
2 Noval sockets
2 12AU7 tubes
2 0.1-μf capacitors, 600 v., paper.

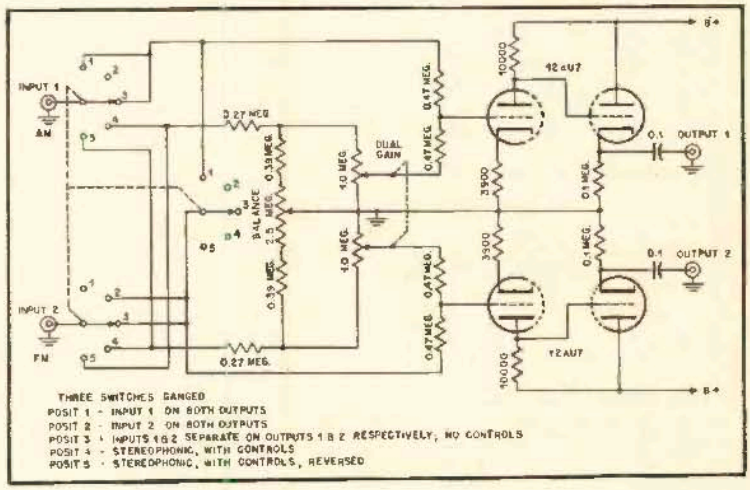


Fig. 7. Similar switching plus the addition of two cathode followers may be preferred because of the lower output impedance offered with this arrangement.