Featuring voice control and receiver silencing circuits this universal adaptor will work with just about any transmitter in the medium power bracket.

Double Sideband With the Heath DX-100

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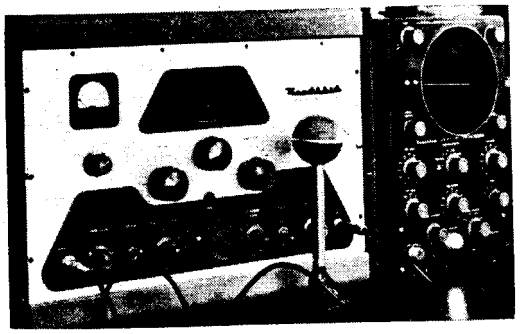


It begins to appear that the subject of double sideband, suppressed carrier transmission is going to create even more controversy than single sideband. The AM "diehards" don't like it because "it still sounds like single sideband to me", and the "sidewinders" do not like it either for, "it takes up twice as much room". I recently had the pleasure of talking to the Santa Barbara Radio Club about this mode of transmission, and little groups were still standing around gesturing wildly when I left at 11 p.m. Most of them were SSB operators.

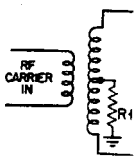
The discussion brought out the mis-conceptions that appear to have gotten started about double sideband. It does not take a special receiver to tune in double sideband stations. Any receiver that is capable of receiving SSB transmissions will work fine on DSB. While testing a DX-100 converted to DSB on 75 meters, I contacted stations with receivers ranging from surplus to Collins 75A4's. All reported satisfactory reception. Again and again, I was able to break into round-tables without anyone being the wiser. (Actually, I made quite a pest of myself while testing the adapter on the low end of 75.) Since the stations were only receiving one sideband, it sounded the same to them. Then someone would switch to the other sideband and start calling me frantically. "W6TNS— W6TNS, better get that thing off the air, your sideband suppression has gone to pot". Explanations of what I was doing brought interested questions, usually. Occasionally, it brought the conversation to an end! All kidding aside, the SSB operators were not really hostile. They pointed out that DSB has several advantages. First and possibly most important, it eliminates the carrier. The carrier is the biggest troublemaker we have to contend with on the amateur bands, bar none! This "monster" is responsible for all the squawks and whistles that usually spoil a QSO. Elimination of the carrier is the first step in the right direction. Another advantage is that voice control can be utilized to reduce transmission time to a minimum thereby reducing QRM. Sideband also reduces the duty cycle on the final amplifiers and power supplies permitting more power out per dollar invested. 1300 volts, and more, is not uncommon on "low power" tubes such as 6146's and 807's.

Another mis-conception is associated with the balanced modulator circuit shown in fig 1. When this circuit is used on double sideband, we gain a power advantage because the carrier power can now be used in the sidebands. However, since a balanced modulator is simply an electronic switch, only one tube is working at any one time. Because of this, if the plates were amplitude modulated with B-plus on the screens the power output would be the same as if the stage were operated as a DSB balanced modulator. Actually, the power advantage is lost by using a high level balanced modulator. Of course the balanced modulator can be loaded heavier and more plate voltage applied, but all other things being equal the power output of the two amplifiers is the same.

The DX-100

Two possible methods of changing the DX-100 suggested themselves. I might change the final grid or plate circuits to push-pull, thereby making it a balanced modulator or I might build a small balanced modulator to operate external to the rig and run the final as a linear.

Looking over the DX-100 brought several



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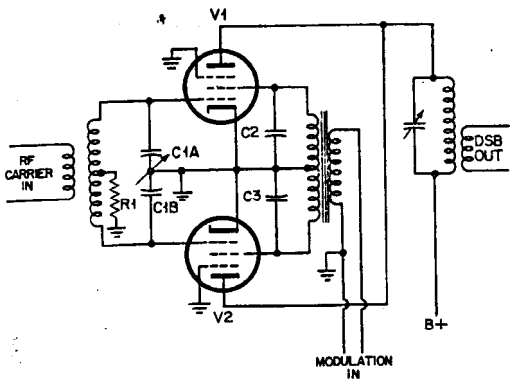


Fig 1. A typical balanced modulator circuit for use at high and low r-f levels.

very interesting factors to light. Converting the final amplifier to push-pull grids involved a major reconstruction job. Leaving the grids the way they were and converting the plate tank to push-pull was out for the same reason. In thinking the problem over, I kept coming back to the obvious fact that in a high level balanced modulator only one tube at a time is working. If both tubes could be made to work at the same time then twice the power could be had. The solution lay in operating the final as a linear and inserting the DSB adaptor (balanced modulator) between the buffer and final amplifier.

A careful study of the circuit showed that the final received two types of bias. First from the bias supply, providing fixed or protective bias. Second, from the application of r.f. It so happens that when the r.f. is removed the fixed bias is close to the amount necessary to operate the 6146's linear. In fact, with no drive to the final, adjustment of the clamp tube to where the plate meter reads 50 ma. places the final in a linear condition since the grid does not draw current, the grid voltage doesn't change, hence the clamp tube wouldn't affect performance. Oh boy! this was it. A couple of miniature tubes between the buffer and final and I would have a 200 watt sideband transmitter. This system would also reduce the TVI that might get out of the transmitter without a low pass filter in use.

Additional Advantages

This type of adaptor can be used to sideband the Johnson Viking, Collins 32-V and B&W as well as any single ended transmitter. Just make sure the final is linear when using the adaptor.

The DX-100 Adaptor

The DSB adaptor for the DX-100 is shown as *fig 2*. When operating on SB the modulators are not used. Audio for modulating the adapter is taken from the speech amplifier. When operating AM the modulators are switched back into operation and the final amplifier is automatically biased to class C by the drive from the buffer stage. In operation r.f. from the DX-100 is connected to J1 and then to the balanced modulators (V1 & 2). Capacitor C2 acts as a balance control for the two tubes. The balanced output is combined in the plate circuit and fed back to the 6146's in the DX-100, via J2. A switch in the screen circuit (S2a) applies B plus voltage to the screens on calibrate (pos. #1), on AM manual (pos. #4), and on AM voice control (pos. #3). Switch S2b applies audio to the balanced modulator screens in the DSB positions. A third section of the same switch turns the DX-100 driver on for frequency spotting and tune-up.

Voice control is accomplished by rectifying a small portion of the modulating voltage in V4b. Control R10 acts to set the trip level and relay hold in time. Relay tube (V3b) is biased to cutoff by resistors R12 and R13. However, when the positive d-c from V4b is applied to the control grid of V3b, the sensitive relay K-1 will trip. This in turn trips relay K2 which turns on the driver and final in the DX-100. Resistor R14 causes current to flow in relay when the front panel switch is turned on for manual operation.

To prevent audio from the speaker, from turning on the transmitter, a small portion is applied to V3a from the speaker matching transformer, T2. This voltage is amplified and rectified in V4a, ½ of a 6AL5. This section of the rectifier produces negative voltage which counteracts the positive voltage created by the voice control circuits.

A filament transformer is included to avoid overburdening the DX-100 filament supply. Note that the filament connections on the 12BY7's are not the same as those of the 12AT7. Plug PL-1 connects to a cable that plugs into the accessory socket on the rear apron of the DX-100. This cable brings all the necessary connections to the adapter, with the exception of the r.f.

Converting the DX-100

Conversion of the DX-100 is simplicity itself. The hardest part is the installation of the coax connectors on the rear apron. Let's do that first. To start, clip the connection between feedthrough insulator and the 6146 grid r.f. choke (Be careful not to damage the choke). Next, drill two ⅝ inch holes behind the 6146's between the rear apron lip and the 6146 subassembly. It may be necessary to file the edge of the connector flange, for it is an extremely close fit. UG-88/U style connectors will work equally as well and mount somewhat easier. Use these, if available. Remove the 47 mmf capacitor that is connected between the grid wire and the ground wire. Extend the ground wire and solder it to the two coax connectors. Connect the center pin of the connector near-

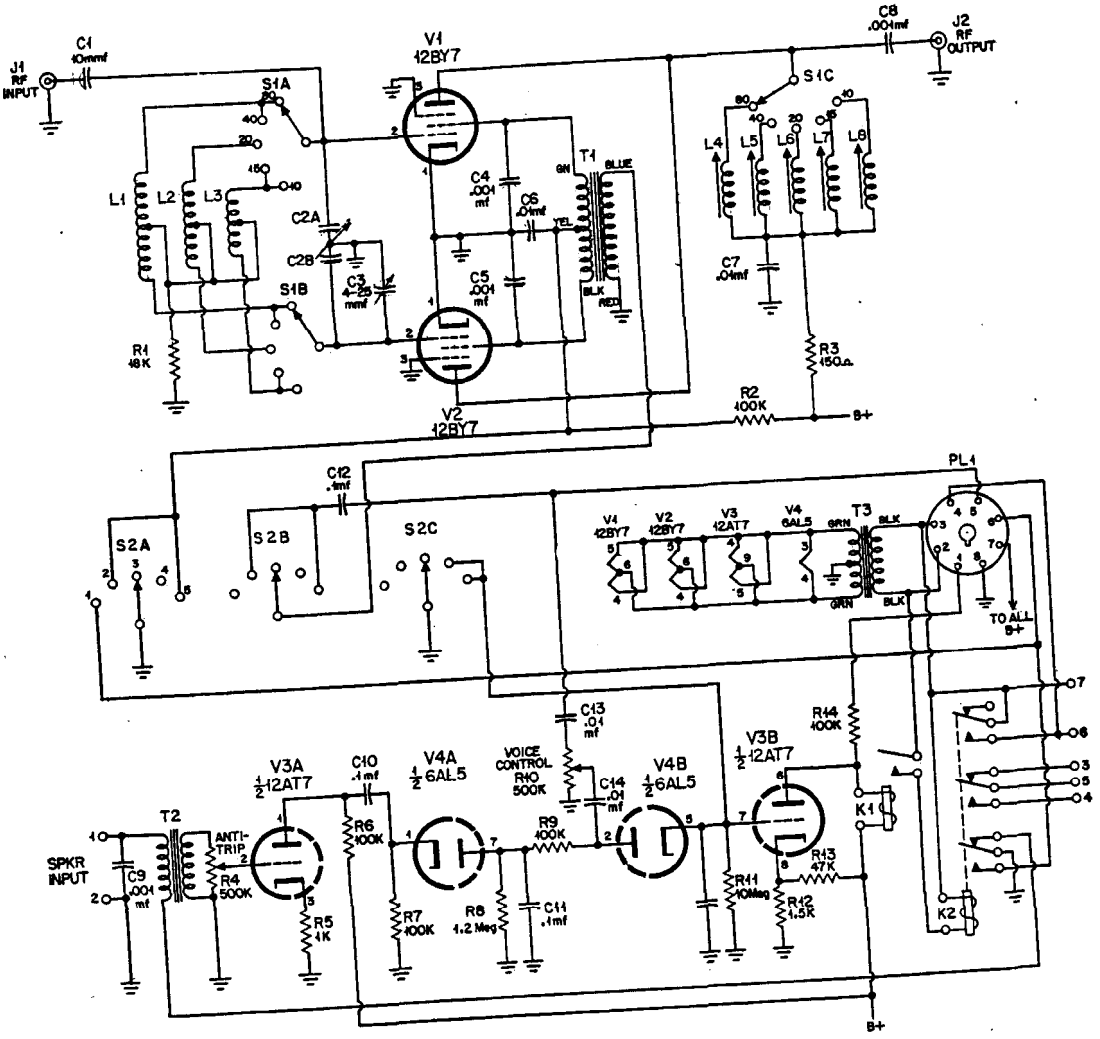


Fig 2. Schematic diagram of the DX-100 double sideband, suppressed carrier adapter. The circles numbered one through seven refer to terminals on the Kulka terminal strip. Terminals six and seven are used for the antenna relay.

Miscellaneous parts:

8 lug barrier terminal strip. 5 x 9½ x 2½ inch chassis (California Chassis A-102) 8 pin plug (Amphenol 86-CP8) 2 foot length of 8 wire cable and connectors (amphenol 78-PF8 and 86-PM8) 3 each 9 pin sockets and one 7 pin socket.

DX-100 adapter parts list

S2—3 pole, 5 position miniature switch (Centralab PA-2007)

T1—Interstage plate to P-P grids (Triad A-31X)

T2—Plate to speaker matching transformer (S-3X)

T3—Filament transformer 110 volts to 6.3 @ 1.2 amps. (Triad F-14X)k

C1—10 mmf disc or silver mica

C2a, b—Dual 365 mmf capacitor (Miller #2112)

C3—25 mmf rotary trimmer (use if padding capacity on C2 is insufficient)

C4, C5, C8, C9—.001 mf 600 volt disc ceramic

C6, C7, C13, C14—.01 mf 600 volt paper

C10, C11, C15—.1 mf 400 volt paper

C12—.1 mf 600 volt paper

J1, J2—Amphenol UHF style connector

K1—Sensitive relay — 5000 ohms (Sigma 4F)

K2—110 volt a-c 3 pole relay (Advance MG/3C/115 va

L1—64 turns #24 ⅝" dia 2" long centertapped, AirDux #532

L2—14 turns #20 ⅝" dia ⅞" long centertapped, AirDux #516

L3—8 turns #16 ½" dia ½" long centertapped, AirDux #416

L4—14.3—31 uh. (Miller #4407)

L5—6.7—15 uh. (Miller #4406)

L6—3.1—6.8 uh. (Miller #4405)

L7—1.5—3.2 uh. (Miller #4404)

L8—0.9—1.6 uh. (Miller #4403)

R1—18K, 2 watt

R2—100K, 2 watt

R3—150 ohms, ½ watt

R4—R10—500K audio taper pot. (Centralab B-60)

R5—1K, ½ watt

R6, R7, R9—100K, ½ watt

R8—1.2M, ½ watt

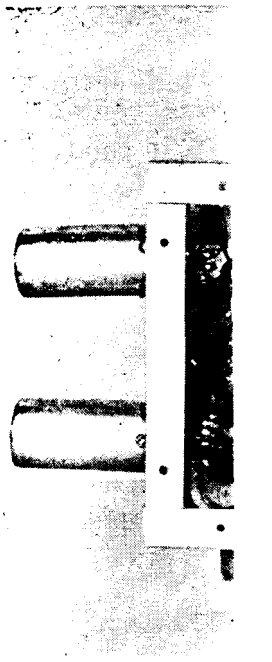
R11—10M, ½ watt

R12—1.5k, ½ watt

R13—47K, 1 watt

R14—100K, 1 watt

S1—3 pole—5 position wafer switch (Three Centralab X switch sections and P-122 index)



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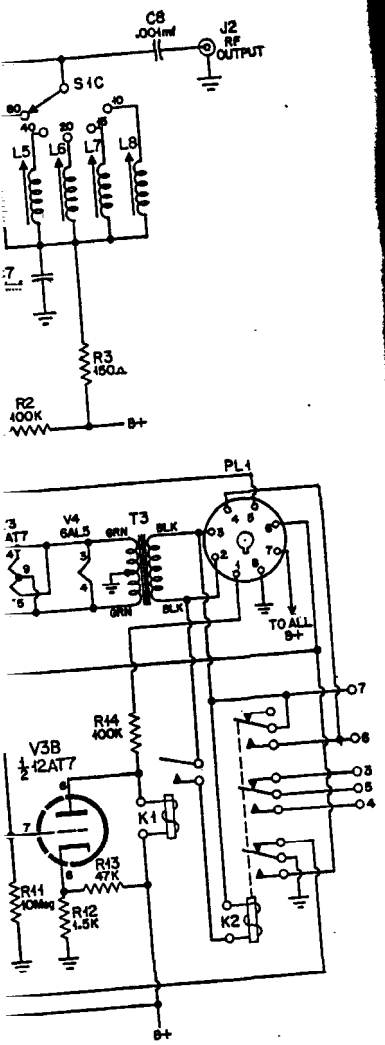

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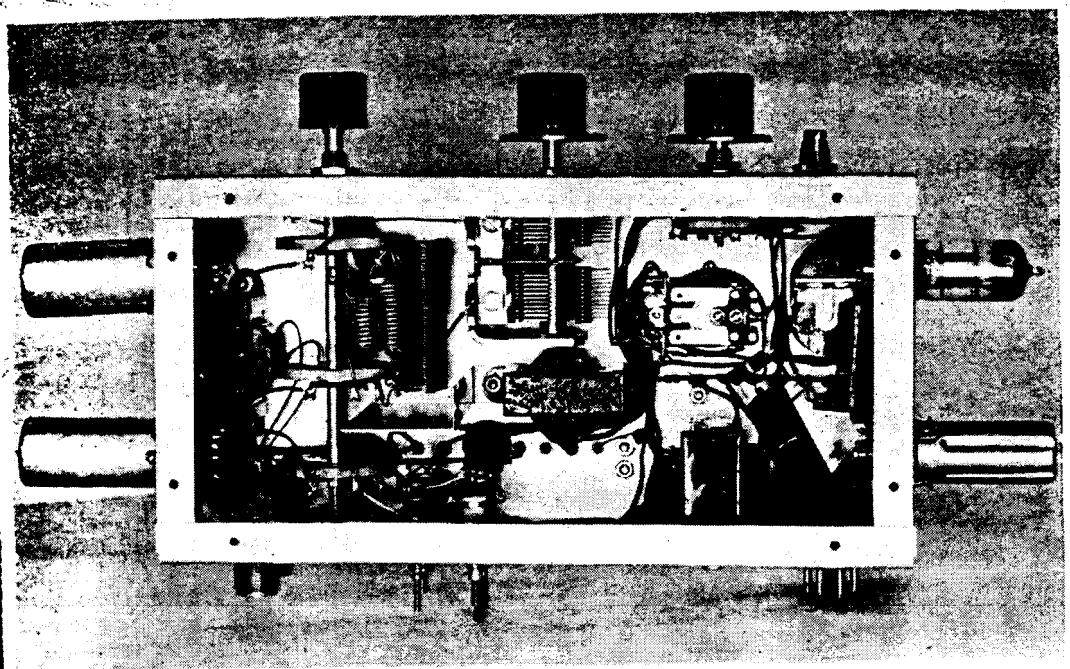


Fig 5. Inside view of the DX-100 adapter. Note the use of tube shields and the plate separating the balanced modulator coils.

...est the chassis to the grid wire with a short straight wire. From the other connector, connect a straight length of RG-59/U coaxial cable to the feedthrough insulator. Make good ground connections at each end of the cable to prevent feed-through. This completes the modifications to the 6146's. As a test, connect an 18 inch piece of RG-59/U between the connectors, with mating connectors at each end of the cable. The capacity of this length of cable (approx. 40 mmf) replaces the 47 mmf capacitor and the DX-100 will tune and operate exactly the same as before.

Now let's supply power to the adapter chassis. To avoid drilling any more holes in the rear apron of the DX-100 the present accessory socket can be used. Pin 5 of this socket is empty. Between this point and pin 7 of the 12BY7 speech amplifier connect a length of shielded cable. Ground securely at both ends. It is a little difficult to gain access to the plate pin, but with long nose pliers and a solder gun, it is possible. Pins 6 and 7 of the remote control socket are used with an external modulator. Since we are not concerned with such old fashioned methods of modulating a transmitter, these two wires can be used with the adapter. Locate the other end of the blue wire that connects to pin 7 of the remote control socket (terminal strip G G) and jumper this wire to pin 5 of the 5V4 (B plus tie point). Locate the connection on terminal strip H H that connects to pin 6 of the remote control socket. From this point on the terminal strip, connect a wire to pin 9 of the PHONE-CW switch (N). Last, but not least, spread the shorting prong on key jack O, so that it is no longer a shorting type jack. This completes the modifications to the DX-100. The transmitter will operate exactly the same as before except it is necessary to have a closed key plugged into the jack when checking frequency on c.w.

To check your progress so far, connect the 18 inch coax cable used before to the coax connectors. Switch to 75 and turn up the transmitter normally (drive, final, loading etc.). Now, switch off the final and turn the clamp potentiometer full counter clockwise and remove the 18 inch jumper cable. Turn on the final and *slowly* rotate the clamp adjust control clockwise until the plate meter reads exactly 50 ma. To check for instability, rotate the amplifier tuning knob while observing the plate current. There should be absolutely no movement of the meter, indicating that no r-f is leaking through to the final. A sudden upswing of the meter indicates parasitics. If this should be encountered, a small parasitic choke (similar to that in the 6146 plate circuit) connected between the r-f input connector and the 6146 grids (rather than the wire) will cure it.

Constructing the Adapter

The adapter mounted in its operating position is shown in *fig 3*. Mounting the chassis on the rear panel of the DX-100 is necessary so that the r-f input cable will be short. Since the grid circuit for the 6146's is located inside the adapter chassis, the distance between it and the final should be kept extremely short. The two 12BY7 balanced modulator tubes are

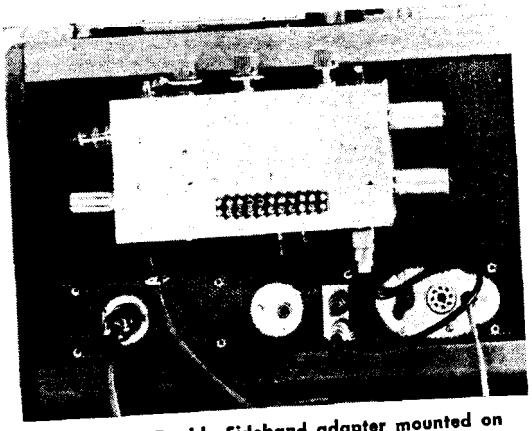


Fig 3. The Double Sideband adapter mounted on the rear of the DX-100 cabinet. The knob and socket are for a VHF adapter that will be described in a future issue.

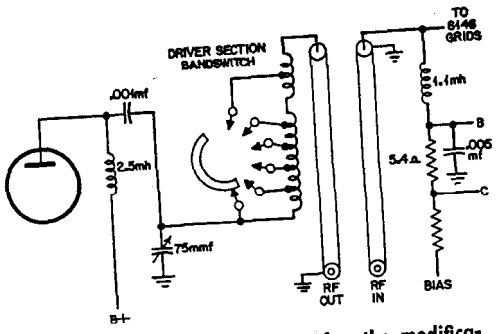


Fig 4. The 6146 grid circuitry after the modifications described in the text

mounted on the side of the chassis above the connectors. Across the back of the chassis a Kulka terminal strip was mounted for connecting to the antenna relay, receiver speaker. In addition, the spare relay contacts were connected to this strip for operating additional circuits such as on the air lights etc. At the left side of the bottom of the chassis, an 8 pin plug was mounted for the power cable. The voice control tubes were mounted on the left end of the chassis.

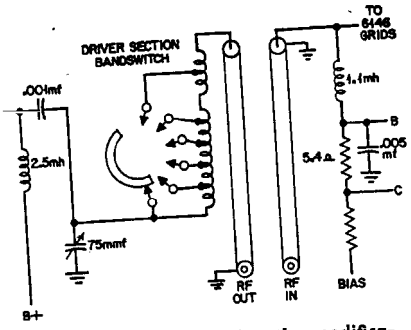
Fig 4 shows the interior construction of the adapter chassis. A dual 365 mmf variable capacitor is used for the balanced modulator tuning capacitor. To the left of this capacitor the band switch is located. The transformer between the 12BY7's is the driver transformer, T1. The filament transformer can be found in the lower right hand corner of the chassis and the speaker matching transformer is approximately in the center of the chassis. A small aluminum shield plate was mounted between the balanced modulator grid coil and the plate tank coil to minimize the r-f feed through. Front panel controls include the band switch, carrier balance, function switch, voice control trip level and the anti-trip level control.

The adapter was constructed by drilling all holes, wiring the balanced modulator circuitry next, then the front panel controls and the voice control circuitry and the relays. No chassis layout is given for the photos are almost self explanatory. No difficulty should develop duplicating the unit if the same general layout is used.

Adjusting the Adapter

In addition to the 18 inch cable you made earlier, prepare a 5 inch piece of RG-59/U to connect the output of the adapter to the input of the DX-100. The 18 inch length will be used to connect the r-f out of the DX-100 to the input of the adapter. Set the DX-100 on 75 meters, tune the DRIVER knob to its usual position for 75 and turn up the excitation control to its normal setting. Tune the balanced modulator grid and plate coils for maximum grid drive. (not to exceed 8 ma.!) Now, switch from position 1 (tune up) to position 2 (DSB—voice control). Carefully adjust the balanced modulator tuning for a sudden dip in the grid current. Since the balanced modulators are level sensitive, it may be necessary to adjust the drive up or down to obtain a null in the carrier. To obtain the exact center of the null, use the receiver "S" meter or turn on the final amplifier and adjust for minimum plate current. Turn off the final amplifier and touch a neon bulb to the r-f output jack on the adapter. The bulb should not light until you turn up the AUDIO GAIN control on the DX-100 and whistle into the microphone. This should cause the lamp to glow and if you talk loud enough, the meter on the front panel of the DX-100 will indicate grid current flow. Incidentally, the 12AT7 tube should be removed from the adapter so that the final will not be turned on. (Now I tell you, after you have been electrocuted!).

The 6146's are to be used as linear amplifiers and therefore, an oscilloscope should be coupled near the dummy load during the following steps. The Heath OL-1 makes a fine scope for this purpose because of its small size. The vertical deflection jack at the rear of the scope should be coupled near the dummy load for r-f pickup. The Heath O-11 also makes an excellent scope for checking 75 meter DSB equipment for low level r-f energy can be fed through the scope amplifiers because of the wide band response. Since the DX-100 uses a combination of fixed bias and signal bias for the 6146 control grids, it is not necessary to change the biasing circuit. The normal fixed bias runs around 60 volts which is only slightly high for class AB_1 operation. However, because of the 2.2K resistor in series with the bias supply, the 6146's should never be allowed to draw grid



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current. This will develop an additional bias voltage which makes the stage very non-linear. Connect an audio oscillator to the mike jack (or whistle, if you have a steady whistler) and adjust the AMPLIFIER tuning and LOADING until the best sine wave presentation appears. This will occur at about 250 ma. plate current. The author has kicked the 6146's up to 300 ma. by very heavy loading of the final but this is not recommended, especially when using an audio oscillator. The shorter duty cycle of the voice is much easier on the final than the steady tone.

Once you are familar with the operating conditions, operation is quite simple. When talking into the microphone watch the grid current meter. It may "twitch" a little, but never hit the modulation hard enough for it to read up-scale. Leaving the scope connected at all times is strongly recommended. Do not pay too much attention to the plate current meter, rather watch the scope trace. Any sign of flat topped waveforms is to be avoided. If the final is not loaded heavy enough, or if you draw grid current, modulation distortion will result.

Another word of caution. Instability cannot be tolerated. When the final is on, it is usually necessary to have the bottom cover on the chassis. The author had quite a battle with r-f in the hamshack, until a better ground system was installed. A sudden rise in grid or plate current when the DRIVER or AMPLIFIER knobs are adjusted indicates that something is "taking off". In some cases, it may be necessary to "swamp" the output coils in the adapter with a 10K resistor. In any event, do not put the DX-100 on the air until you sure the final is "tame" or pink tickets will be your reward!

By changing the function switch to position 4 or 5, manual control of AM or DSB is possible by using the PLATE switch on the front panel. Voice control on AM is available by switching the function switch to position 3.

Voice control by itself may be obtained by omitting V1, V2, S1, S2, T1 and the associated components. The only change in the installation instructions given earlier is to wire the connection to switch N to terminal 7 rather than terminal 9. It is not necessary to spread the contact on the KEY jack or to install the coaxial connectors.

Conclusion

The author feels that the DSB system should be considered a "stepping stone" to full single sideband operation. Once you get the feel of this type of operation you will undoubtedly want to add an audio phase shift system to get rid of the unwanted sideband. Sideband generators such as the Barker and Williamson 51SB may be easily connected to the DX-100 for single sideband operation. ■

Stolen, as usual, from

AUTOCALL

The bulletin of the
Washington, D. C. Mobile Radio Club

Last month's answers: #1. The batting order is: Green, Jones, Brown, White, Becker, Anderson, Black, Gray, and Smith. #2 Puzzler can be worked by checking with a math book. The formula for the intersection of two cylinders of the same size at right angles is 16 times the radius cubed divided by three. Or you can have at it with calculus, if you remember your calculus.

Now let's get you dithered up for this month. Puzzler #1 is a snap, just to get you thinking you are smart. It is a modulation transformer with two identical secondaries. Under given conditions the impedance of either secondary is 5000 ohms. What is the resultant impedance if: a) the secondaries are connected in parallel? b) In series?

Puzzler #2. Bill, John, Henry and Joe have to catch the 6 o'clock train.

1) Bill's watch is ten minutes fast but he thinks it is five minutes slow.
2) John's watch is ten minutes slow but he thinks it is ten minutes fast.
3) Joe's watch is five minutes slow but he thinks it is ten minutes fast.
4) Henry's watch is five minutes fast but he thinks it is ten minutes slow.

Each arrives to catch the train according to his belief of time. Who loses?

Puzzler #3. From W3VDL: A ham spends $75.20 in buying two types of tubes. Type A costs $3.70 each and type B costs $2.30 each. How many of each did he buy? (A solution is possible; the answer does not have to be found by trial and error.)

We'll try to remember to put some of the answers in next month so you won't chew your finger nails down.

OHIO

Saturday, April 6, at the Dayton Biltmore Hotel Dayton—the Dayton Amateur Radio Association will sponsor its annual Hamvention. This get together is one of the most widely attended, largest and finest held anywhere. The day long program will again feature outstanding speakers on all phases of Ham Radio. Several excellent forums will be held throughout the day for DX'ers, novices, V.H.F., etc. Bring the XYL's as a fine program has been prepared for them. Many fine prizes will be given during the day. As in the past the Grand Banquet will terminate the affair. Plan now to be one of the more than 2000 which attend annually. Tickets are $5.50 in advance, including the Grand Banquet, up to and including April 3rd—after this date $6.00. Reservations, more information, and an attractive brochure may be obtained from D.A.R.A., P.O. Box 426, Dayton, Ohio.