a 100 Watt DSB Mobile Transmitter

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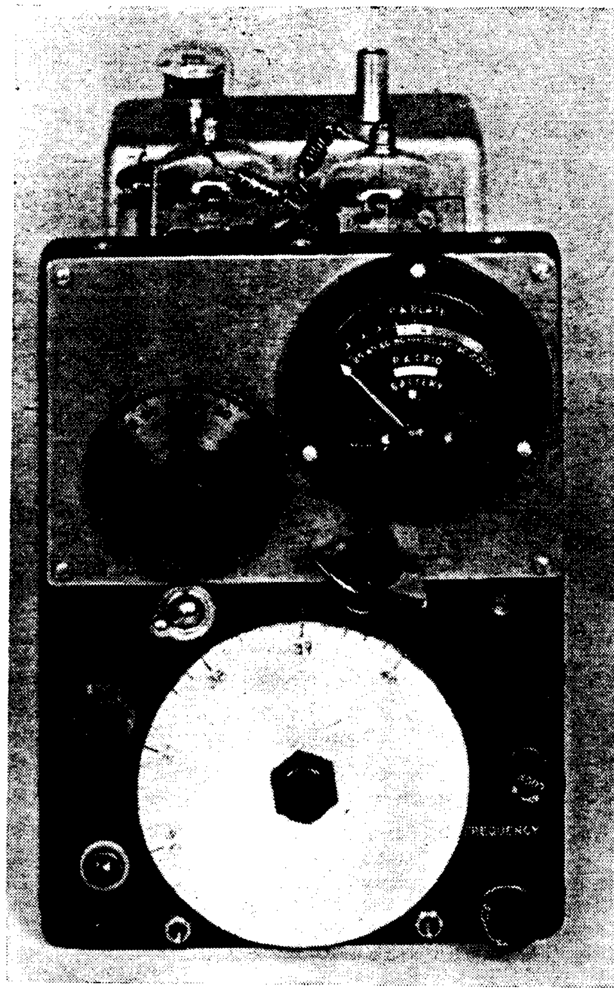


The completed Transmitter

When John Costas, W2CRR, came up with his double sideband suppressed carrier transmitter (CQ, January 1957) we looked over the pros and cons and came to the unbelievable conclusion that here, at last, was the closest approach yet to something for nothing. For the mobile operator fighting QRM and low efficiency antennas, this mode of emission has, in general, all the advantages of SSB but is actually simpler to build and operate than an AM transmitter of equivalent power. Here are the advantages as compared to an AM rig in the same power class:

1. More "talk power."
2. Easier and less expensive to construct.
3. Lower average d-c input power required.
4. No critical or specialized components needed.
5. Instant change to straight AM if desired.

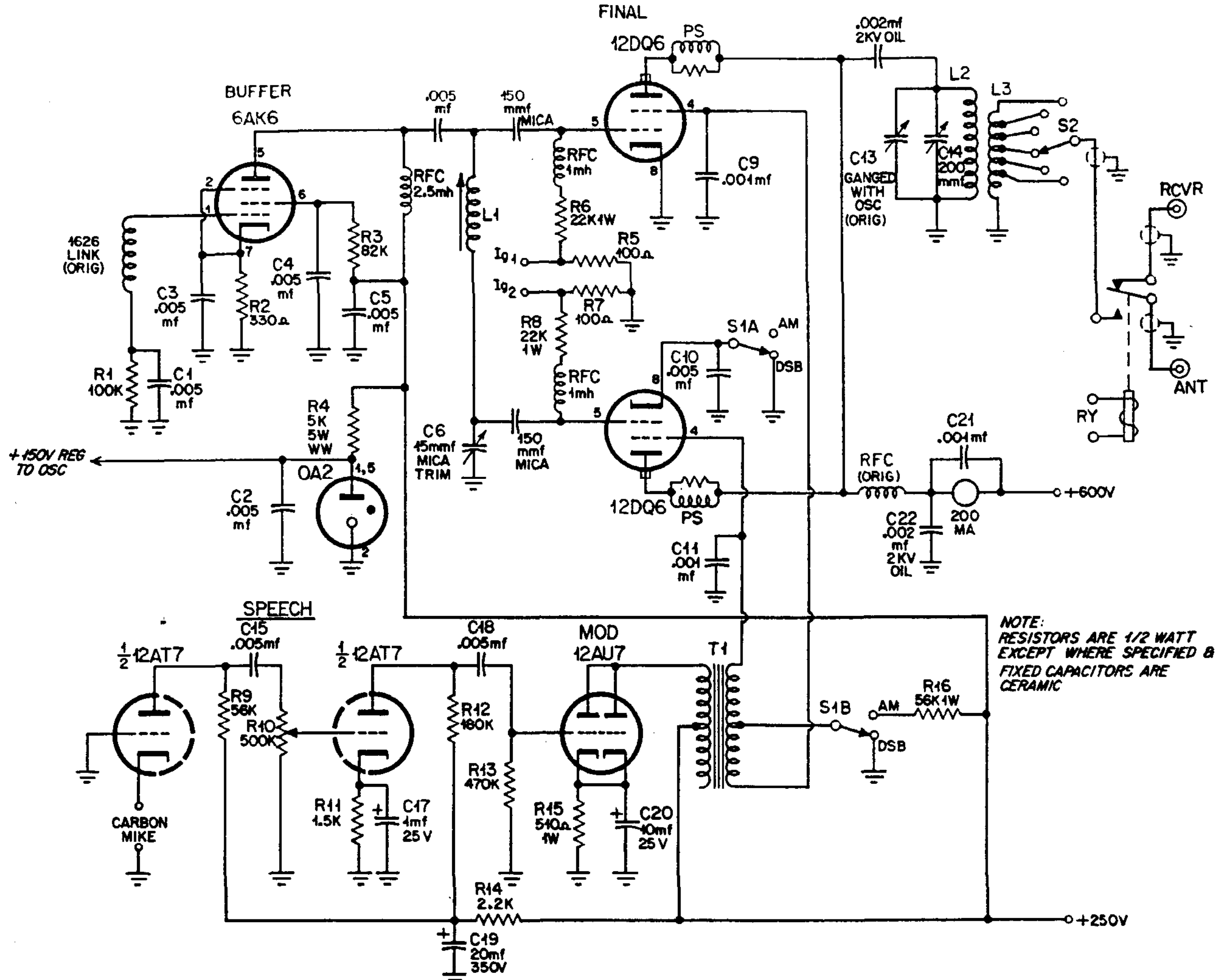
The drawback of the system, if it can be interpreted as such, is that you will now be talking to the SSB men and must therefore be equipped to receive them. Lacking a b.f.o., this can easily be done by using the transmitter VFO for carrier insertion, as will be explained later.

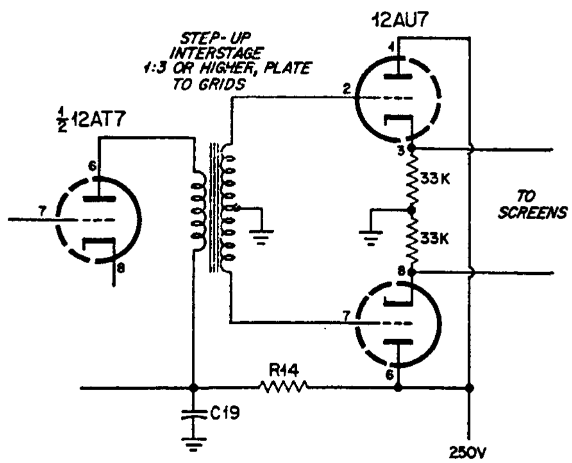
The basic difference between a high level DSB transmitter and a conventional AM rig is in the final amplifier and the method of modulating it. Existing exciters and/or drivers can be used together with conventional speech equipment. This was one of the reasons for using a surplus command transmitter as the heart of the mobile rig to be described. The other reason is that the oscillator circuit in the command transmitter, when suitably isolated, takes a back seat to none in terms of stability. As in SSB, this feature is essential if the station at the other end is going to decipher your carrier-less sidebands.

Circuit Details

The command transmitter we used originally tuned 4.0 to 5.3 mc and this range can easily be padded down to cover the 75 meter phone band (as well as the c-w band if desired) by adroit manipulation of the oscillator coil slug and padder capacitor. Using this range command rig has the added advantage of a higher "C" oscillator tank than would be the case if the 3.0 to 4.0 mc transmitter is used. This means better oscillator stability. The original 1626 oscillator is followed by a 6AK6 buffer. It should be emphasized that some form of isolation between the oscillator and final is essential—otherwise the final will pull the oscillator frequency and you will have a novel system of FM plus double sideband less carrier which will not endear you to the fellow at the other end. Since ours was a 12 volt system, the 6AK6 heater is wired in series with the front panel No. 47 pilot lamp thereby conserving .945 watts of d-c. power (You think like this after years of mobiling).

The 6AK6 develops its drive across a low "Q" slug-tuned coil. A look at the schematic will show you how to get away from the nasty chore of center tapping this coil while still ending up with push-pull drive to the final grids. The small mica trimmer at the lower end of the coil compensates for the 6AK6 capacity across the top side of this coil so you will end up with equal grid drive to each final tube. If you want to be different, you can drive the grids in parallel and operate





Above, Schematic of Transmitter. Left, suggested Cathode follower modulator circuit for DSB.

Parts List

- L1—80 turns #28 enam. scramble-wound on ½" dia. slug-tuned coil form.
- L2—30 turns #18 tinned, 1" dia. 2½" long. Air-wound with plastic ribs.
- L3—10 turns #14 tinned, wound around bottom of L2. Space diameter of wire and cement to L2 with 1/16" concentric clearance from L3. Tap every turn.
- S1—DPDT toggle switch.
- S2—Ten position rotary switch.
- T1—Interstage transformer. Turns step-up at least 1:2 modulator plate to screens. See text.
- PS—5 turns #22 tinned wound on 100 ohm 1 watt resistor.
- RY1—12 volt d.c. SPDT relay.

at the same time, is driven negative, so it just sits there and coasts. On the other half of the audio cycle, the second tube works and the first tube rests. In other words, at any given instant, only one final tube is working. The idle tube is still hanging in the circuit, however, and its internal capacity acts as a neutralizing capacitor for the working tube. Eureeeka!! True automatic neutralization!

Obviously, with no audio applied and with zero screen voltage, application of plate voltage will produce very little plate current flow. With the antenna properly coupled, however, modulation will kick the plate current up to a high value. How, then, does one resonate and load the final of this rig, especially in an automobile? Although this question would normally be answered later in the tune-up details, it is mentioned now in order to show the reason for inclusion of the DSB-AM switch. More elaborate versions of this type of transmitter include a built-in tone generator to supply a steady audio modulating signal so the final can be resonated and loaded. This is not for us mobileers! So, you say, how about a steady whistle into the mike?

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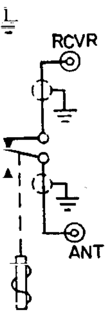

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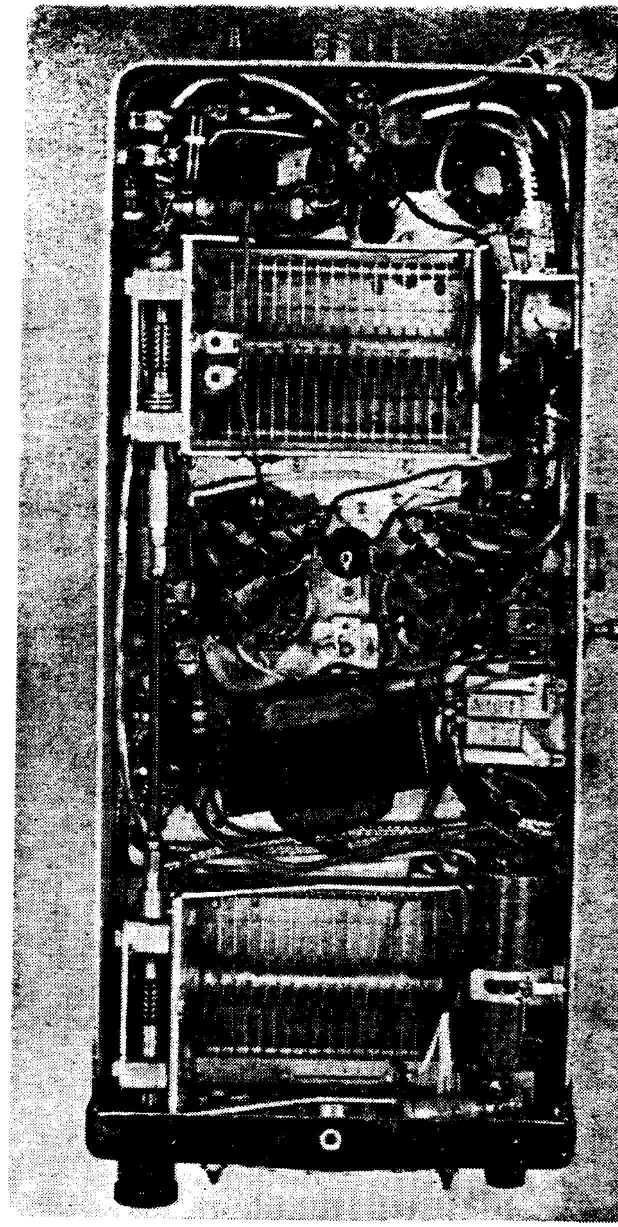
Fine! But unless your whistler is a lot steadier than ours, you'll never find the plate current dip because small variations in whistle level will vary the plate current too much. The answer is the AM-DSB switch which provides two nice features. In the AM position you have a conventional rig with carrier and two sidebands. This you can resonate and load in the usual fashion. You can also use this position to talk to other mobileers or die-hards who refuse to insert carrier for you. Once the rig is tuned up in the AM position, flip the switch to DSB and you are tuned and ready to go with lots of talk power. To put it another way, once you tune up properly on AM, no retuning is necessary when switching to DSB.

In the AM position, the switch performs two functions. First, the cathode of one of the final tubes is opened. This leaves us with a conventional, single-ended class C amplifier. Second, B+ is applied to the remaining tube's screen through the center-tap of the modulation transformer. End result: a screen modulated final! Throwing the switch to the other position restores the rig to DSB. A few minutes with the schematic will make this clear.

The modulation transformer required in this application is not critical except that it should provide a step-up in impedance between the modulator and final screens. A turns ratio step-up of at least one to two (full primary to full secondary) is needed and a step-up of one to four or one to six is much more desireable. With the lower ratios of transformation, more audio power will be needed for a given peak power output. Our transformer was dug out of the junk box and happened to be an interstage push-pull plates to push-pull grids. This was connected in reverse, with the modulator connected to one half of the grid winding to give a step-up of one to two. In general, class "B" driver transformers are not suitable because they step down. However if you can find a class B driver with push-pull plates to push-pull grids, you are in business. Connect it in *reverse*, that is, modulator connected to half the grid winding and screens connected to the plate winding. In our experiments we even tried a small 60 cycle power transformer with modulator connected to the 115 v. primary and screens connected to the center-tapped H.V. secondary. It worked almost as well as the interstage job, too, so don't be afraid to experiment!

Construction

The original 1626 oscillator circuit is left intact and the output coupling link feeding the 1625 grids is reconnected to the buffer grid. The 6AK6 buffer, 12AT7 speech amplifier and 12AU7 are squeezed into the rear apron space formerly occupied by the crystal socket and indicator tube. The OA2 voltage



Bottom view

regulator sits just behind one of the 12DQ6's. No special precautions in construction are required other than the usual one of shielding long audio leads to prevent RF and/or audio feedback. Power is supplied at the rear via a Jones plug while phono connectors are used to antenna connections. The original oscillator dial can be covered with paper and new calibrations inked in, or, it can be replaced with a disc of thin aluminum suitably marked.

Octal sockets are needed for the 12DQ6's, these being secured to a sheet of aluminum which covers the area formerly occupied by the 1625's. Removal of the final padder condenser leaves room for the modulation transformer underneath. As can be seen from the photographs, the original tank coil and antenna roller coil assembly are removed to make room for the meter, antenna coupling switch and final tank tuning capacitor. Naturally, it is not necessary to follow this exact order of construction. Just make your own parts fit the available space! Note also that control circuits are not shown. Your pet ideas are probably better than mine so why complicate the schematic?

With the 250 volts applied (hold off with the 600 volts) and the oscillator perking at 3.9 mc, peak the buffer coil while measuring grid current at either of the final grid jacks. A check of both grid currents will probably show that one is higher than the other. Observe the higher current and adjust the mica grid trimmer to reduce this to a value approximately equal to the lower current. Repeak the buffer coil for maximum and again check both currents. If they are still not equal, repeat the above juggling process until they are. Once this is done, no further adjustment of drive is required to cover the phone band. With the values of grid resistors shown, the grid current should run between 1½ to 2½ ma. per tube when the final is loaded. Somewhat better cross-over characteristics are obtained on a bow-tie scope pattern with the lower value grid current but this is not a really critical parameter. The amount of grid drive can be adjusted by selecting various 6AK6 screen dropping resistors. If the drive is adjusted for 2½ ma. with the buffer coil peaked at 3.9 mc a drop of about ½ ma. will occur at the band ends. If the grid currents drop off much more than this, the "Q" of the buffer coil is probably too high and this can be corrected by resistance loading with a one watt resistor of the order of 10K to 68K.

With grid drive adjusted and balanced, apply 600 volts to the final and throw the DSB-AM switch to AM. Resonate and load the final in the usual manner. 80 ma. in this position is plenty and this represents 48 watts input to the single screen modulated final. Flipping the switch to DSB should drop the plate current to around 20 ma. and speech should kick this up to around 150 ma. or more. When the audio gain control is set to produce this amount of peak current on DSB you will find that changing over to the AM position will result in over-modulation. This can be corrected, naturally, by backing off audio gain, or, if you are as lazy as the average mobileer, you can just back away from the mike slightly.

Operation

DSB is used in the same manner as SSB, so by all means arrange things for push-to-talk so the voice-controlled stations don't have to wait for you to fumble around with switches. Instant receiver recovery is necessary and you may need an extra set of relay contacts to short out the B+ that lingers in the filter condensers of the exciter when the button is released.

In the QSO's we have had with SSB stations, none realized that both sidebands were being transmitted until we spilled the beans. Reports on speech quality were uniformly good and some glowing comments were received on the stability of the signal under mobile conditions. Signal strength reports were generally one or two "S" units higher than we used to get with the 60 watt AM rig. Perhaps the one frustrating feature of DSB or SSB mobile is the round-table with three, four, or more stations involved. This requires a prodigious memory for calls and handles plus log-keeping ability, while still maintaining the car on an even keel!

Receiving

If you are using a converter-BC receiver combination in the car, SSB and DSB can be copied by using the transmitter VFO for carrier insertion. This method has several important advantages. First, no modification of the existing receiving arrangement is needed. Second, the front-end stability of the receiver is not important because the demodulation process depends only on the stability of the transmitted signal you are receiving plus the stability of the local injection signal. This is not the case when an internal BFO at i.f. frequency is used to supply carrier. Finally, the scheme guarantees that you will always be on frequency with the other station. The level of injection signal supplied by the transmitter VFO will depend on many factors such as the amount of coupling between receiver and transmitter, nature of antenna changeover relay, etc. We run both VFO and buffer to supply sufficient injection signal to the receiver. If there is a choice, use the higher level of injection. You may have to crank the receiver volume control up higher than in normal AM operation but you will end up with almost distortionless demodulation.

Circuit Variations

Because of the simplicity of the basic DSB system, many variations are possible, both in the r.f. and audio sections. One suggested audio variation is the use of cathode followers as modulators, thus eliminating the need for a modulation transformer. Unfortunately, cathode followers have a voltage gain of less than unity, therefore, in order to obtain sufficient voltage swing at the cathodes, high driving voltages are required at the grid. This calls for a step-up input transformer of the same characteristics as needed at the modulator so you're back at the starting point. The other disadvantage of the cathode follower scheme is that a small positive voltage appears at the screens of the final tubes which raises the resting current to around 45 ma. This is on the ragged edge of the plate dissipation rating for the final tubes. Nevertheless, our experiments indicated that cathode followers have distinct possibilities.

Triodes with grid modulation can also be used in the final. Or, if desired, the DSB signal can be generated at low level and followed by a high power linear, as in SSB. Go to it . . . the possibilities are endless! ■