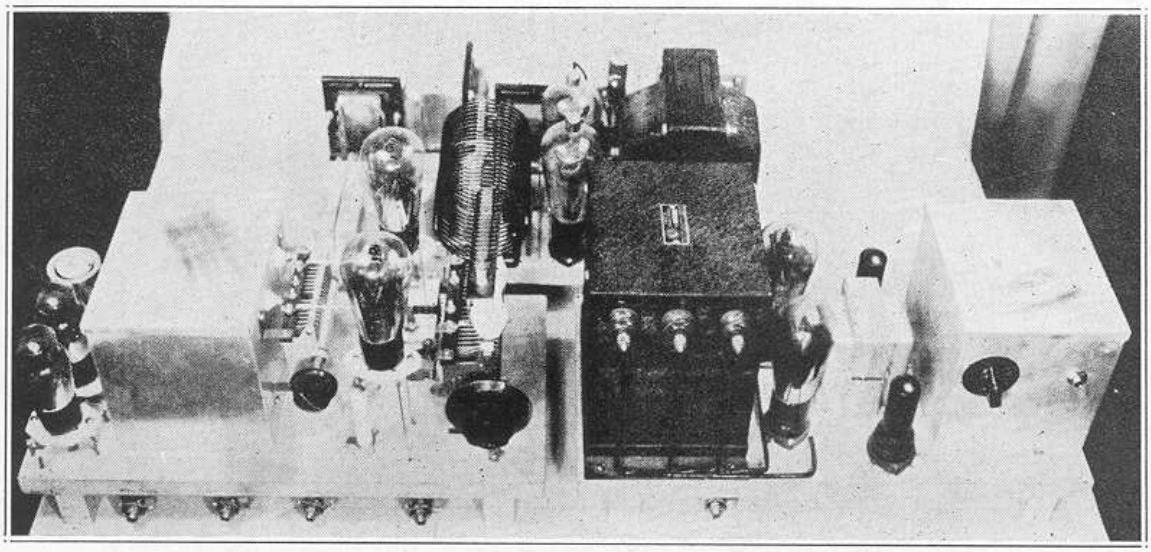
Cascade Modulation in a 210 Transmitter

By Martin A. Brown, W6ABF



The complete 210 transmitter described in the story. The different units should preferably be spaced more than in the photograph; they were placed in this position merely to get them in one picture.

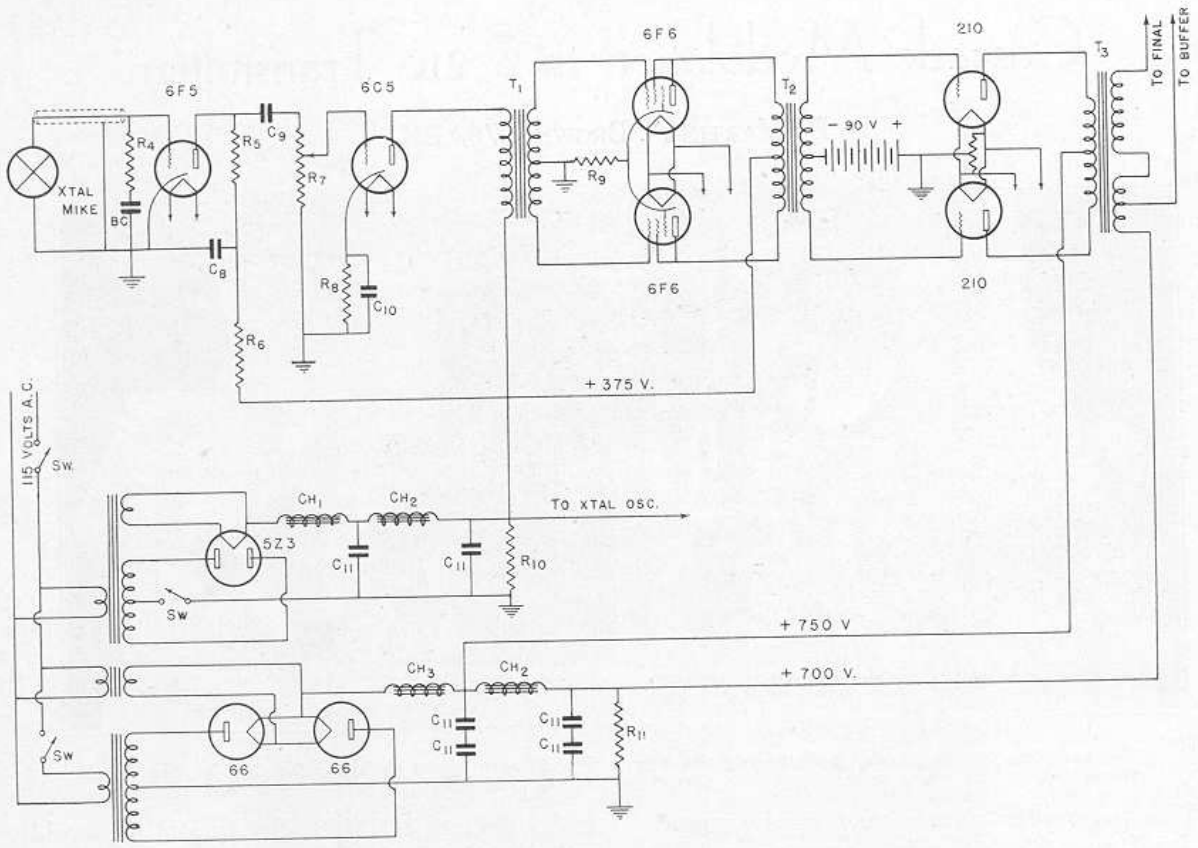
This transmitter gives a very good account of itself on 160, 75, and 20 meters; and is conservatively rated at 75 watts of carrier output. The fidelity and linearity are considerably better than average due to the use of somewhat oversize class B transformers and due to the use of cascade plate modulation, which allows 95% *linear* modulation capability to be more than just an idle dream.

The r.f. portion of the rig is straightforward and was completely described on page 27 of the January, 1936 issue of Radio. The use of parallel 42's as the crystal oscillator allows high oscillator output and a good impedance match to the 210 buffer grid to be obtained without going to link coupling. The use of shielding around the buffer stage is highly desirable as it eliminates all signs of unwanted regeneration from the oscillator and buffer stages. The shield material is cadmium plated furniture steel. The buffer shield box and the preamplifier shield box are exactly the same and are available commercially. Care must be taken to see that the buffer plate tuning condenser and the neutralizing condenser can stand the peak modulation voltage. However, as the buffer is only modulated about 25% on peaks, this voltage is only 25% higher than the unmodulated voltage. The buffer and final amplifier must be very carefully neutralized if good results are to be obtained as all the shielding in the world will not eliminate regenerative feedback through the tube itself.

The Audio Channel

The audio channel is largely standard practice except for the use of the newer metal tubes. If it is desired to use glass tubes no changes in the circuit are necssary. Use a 75 as the first stage in place of the 6F5, a 76 in place of the 6C5, and 42's in place of the 6F6's. As crystal microphones are standard practice these days the audio channel was designed to handle all types of diaphragm type mikes. The total gain is approximately 112 db with the gain wide open and no signs of either audio or r.f. feedback have been experienced.

Note that the first stage uses fixed battery bias rather than cathode bias. This has been found desirable in order to minimize hum pick-up and also to minimize motorboating. The bias battery consists of one cell of a fountain pen type of flashlight battery mounted inside of the shield can. These cells sell for a nickel apiece and a cathode resistor and its large by-pass condenser are eliminated by use of one. This cell should last at least a year as there is normally no load on it. Note that the bias voltage appears across the crystal microphone. It has been found that about one and a half volts across a crystal microphone eliminates the pecul-



The Power Supplies and Audio System

C_8—0.5 μfd. paper tubular
C_9—.006 μfd. mica
C_{10}—10 μfd. 25 volt electrolytic
C_{11}—8 μfd. 525 volt electrolytics
R_4—5 megs., 1 watt
R_5—250,000 ohms, 1 watt
R_6—50,000 ohms, 1 watt
R_7—1 meg. tapered potentiometer
R_8—2500 ohms, 1 watt
R_9—750 ohms, 10 watts
R_{10}—40,000 ohms, 25 watts
R_{11}—100,000 ohms, 25 watts
CH_1—200 ma. swinging choke
CH_2—250 ma. smoothing choke
CH_3—350 ma. 5-25 hy. swinging choke
T_1—2:1 push-pull input
T_2—45's to Class B 210's
T_3—Class B output for 800's, 830's, etc. (Must have several taps and be designed to carry secondary current)
T_4—400-0-400 volts, 5 volts, and 6.3 volts, b. c. l. transformer
T_5—2.5 volt, 10 amps., 5000 volt insulation
T_6—950-0-950 volts, 300 ma. Filament transformer for 10's —7.5 volts, 6.5 amps.

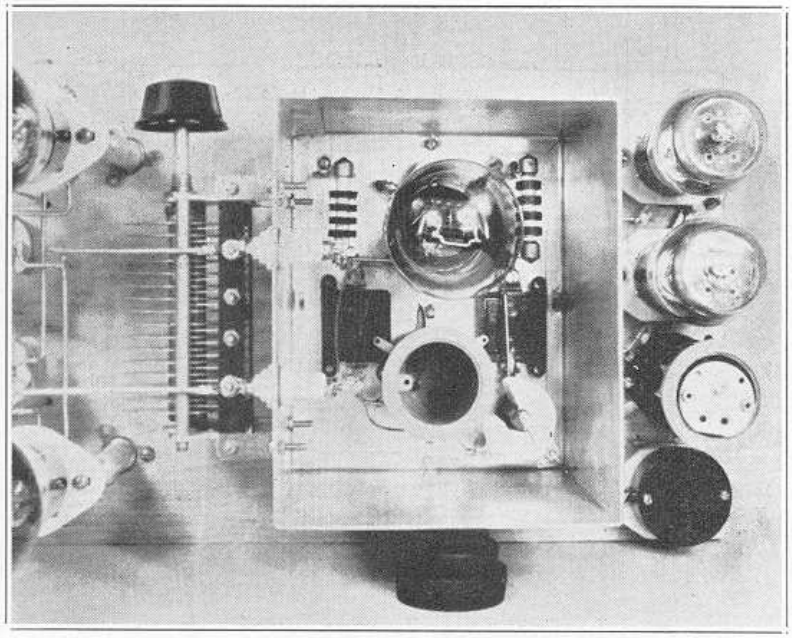
iar rushing background noise made by some makes of crystal microphones when subjected to a strong r.f. field.* Note that the mike jack is of the shielded type.

The audio gain control is located in the grid of the second stage where it belongs in order to eliminate noise. The second stage uses a 6C5 with normal cathode bias and is transformer coupled to the push-pull driver stage which uses triode-connected 6F6's. This stage has more than enough output to drive the class B 210's to better than 60 watts of audio output.

It must be emphasized that class B input and output transformers are a poor place to economize in a phone transmitter. Both the class B input and output are made for class B RK18's or 800 tubes. These transformers list for only a very few dollars more than the 210 types and the turns ratios are almost exactly the same. In this particular transmitter only $2.50 net could have been saved by using the smaller class B transformers and the truly high quality of this rig was much more than worth the difference.

Battery bias was used on the 210 modulators because batteries are quite cheap now and a set will last from six months to a year in this transmitter. Four 46's or 59's could have been used for modulators but they require much more grid driving power and the author sincerely believes that they are actually not capable of as good quality as the 210's. Class AB 250's could have been used to give 60 watts from four tubes; but tube, transformer, and power

*This practice is not recommended by the manufacturers, but does not seem to hurt the microphone. Higher voltage across it might damage it, but 1½ volts seem to do no apparent harm.



Many requests were received to show the interior of the buffer shield-can by amateurs building the r.f. portion from the article in January "RADIO". Here it is.

supply costs would have been considerably higher.

Note that the plate voltage supply to the 210 buffer stage is obtained from a tap on the class B output transformer secondary in order to apply cascade modulation. This tap is not critical in location. About 25% up (in turns) from the cold end of the class B secondary will be about right in most cases.

Only about 5% of the modulator output is dissipated in the buffer stage during 100% modulation of the final.

The power supply is standard practice. The 350 volt supply operates the speech channel and the crystal stage. The 750 volt supply operates the rest of the rig. A pair of 66's were used in place of some of the smaller rectifiers which have, on occasion, "gotten by" on 750 volts. However, 66's are now quite inexpensive; so there would be little saving in the use of smaller rectifiers. Also it pays to play it safe on rectifiers as a rectifier short usually means other blown equipment.

Note that the modulators take their plate voltage *ahead* of the smoothing choke in the high voltage power supply. This improves voltage regulation and also reduces the amount of filtering necessary, which reduces the cost. Practically no carrier noise is added through this procedure as the modulators are in push-pull and thus require somewhat less filtering than a single-ended class A modulator for the same transmitter.

The total cost for the parts in this transmitter came to less than $100, using the best available components. This included batteries, tubes, crystal, and microphone.

The breadboards are of the new RADIO standard type and are 17 inches wide by 8¾ inches deep. They fit nicely behind a relay rack and are easy to work on, in addition to being inexpensive.

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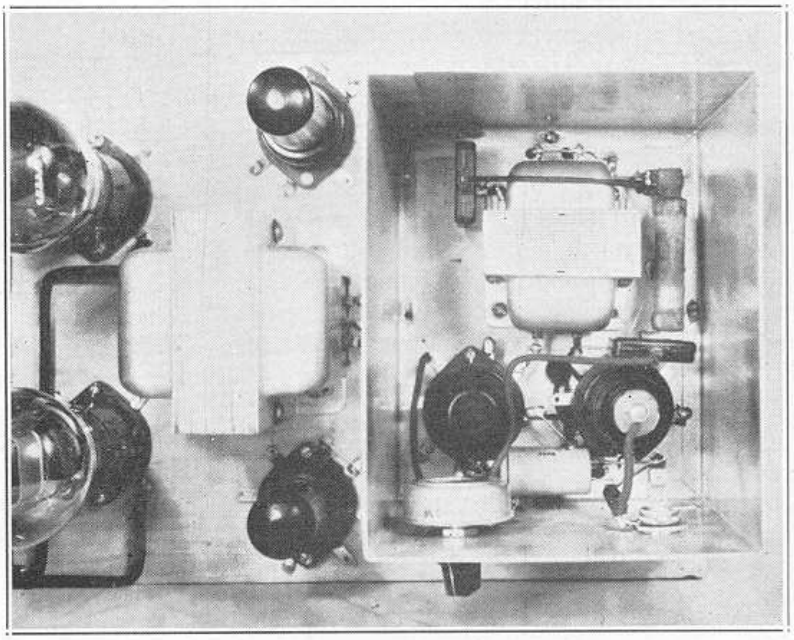
Breaking Glass

Make a small notch by means of a file on the edge of the glass, then heat the end of an iron rod red hot and apply the iron to the notch, drawing it slowly along the surface of the glass in any direction desired, and a crack will follow the direction.—*W6DOB.*



Looking down into the "front end" of the speech system.