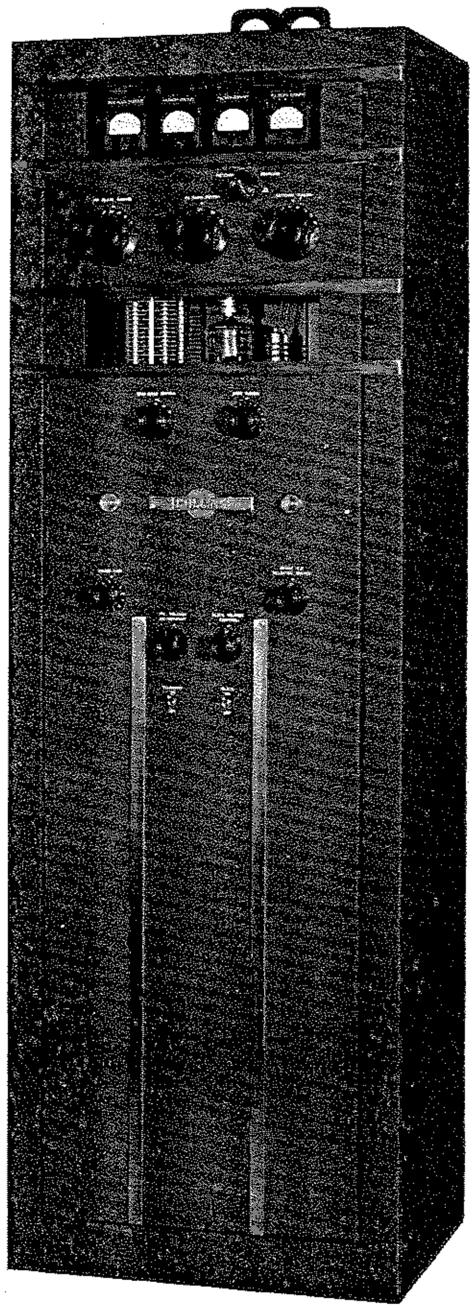
THE COLLINS 30K-1

amateur transmitter



500 watts input on CW, 375 watts input on phone

THE COLLINS 30K-1 AMATEUR TRANSMITTER

500 watts input on CW, 375 watts input on phone

The 30K-1 is for you who want quality and reliability. It combines the desires and dreams of hams with brass in their blood and also those who want only a push-to-talk button. It was designed by engineers to whom CQ is a cherished and friendly sound. Every detail has been worked out carefully to provide efficient, economical operation. Select quality components are used throughout to assure long, trouble-free life.

Versatile and reliable, it is thoroughly engineered for continuous operation. The 30K-1 amply meets the exacting requirements of amateur radio.

These features are for your advantage:

fully metered	speech clipper
PTO* controlled	115 v. a-c power source
smooth, modern styling	3 pairs antenna terminals
	band switching
clean, sharp keying	100% modulation
unit construction	fused primaries

80, 40, 20, 15, 11, 10 meters

BANDSWITCHING

All circuits are bandswitched with the exception of the antenna tuning network. Two separate plug-in coils are supplied for that position—one covers 80 and 40 meters, the other covers 20, 15, 11, and 10 meters.

REMOTE CONTROL

The exciter unit, in a receiver type cabinet, sits on the operating desk right at your finger tips. With PTO* control, you can vary the operating frequency several kilocycles up or down, without retuning the final. A push-to-talk switch can be connected for phone operation.

SPEECH CLIPPER

The audio peak clipping circuit permits running the audio gain at a high level, thus maintaining a high level of modulation. With the circuit set to become operative at 90% modulation, the carrier will not be overmodulated, and the high audio power in the carrier side bands strengthens the signal. Intelligibility is also improved, assisting the QSO during QRM or static. The clipper circuit is followed by a cut-off filter which attenuates all frequencies above 4000 cps.

CIRCUIT PROTECTION

Primary power circuits are well fused. The power amplifier bias circuit includes a plate power relay which opens if bias should fail.

EFFICIENCY

High efficiency is obtained on all bands. The low grid-plate capacity of the 4-125A eliminates the requirement for neutralization and makes the plate to grid reaction very small even on ten meters.

TUBE LINE-UP

1—4-125A r-f power amplifier
1—6SJ7 speech amplifier
1—6SN7 audio amplifier
1—6H6 speech clipper
1—6B4G modulator driver
2—75TH Class B modulators
1—5R4GY bias rectifier
1—5R4GY low voltage rectifier
2—866A high voltage rectifiers

METERS

Modulator plate current, filament voltages, power amplifier grid current, power amplifier plate current, r-f output.

RELAY OPERATION

An extra section is placed on the P. A. grid bandswitch for operating automatically antenna relays, or other control relays.

* The Collins 70E-8A Permeability Tuned Oscillator

CONTROLS

- Plate ON-OFF switch
- Filament ON-OFF switch
- Phone-CW switch
- Audio gain control
- Filament voltage adjustment
- Low voltage-tune-operate switch
- P. A. grid tuning
- P. A. grid bandswitch
- P. A. plate tuning
- P. A. plate bandswitch
- Antenna loading

ANTENNA MATCHING

An antenna impedance matching circuit is incorporated in the output. It efficiently couples the 30K-1 to any antenna or transmission line that approximates an integral number of quarter wave lengths. A separate antenna tank is utilized, thus providing additional harmonic attenuation.

The antenna tank with its swinging link is plug-in. Only two coils are necessary to cover all bands from 80 meters through 10 meters. Either parallel or series tuning may be used, and adjustment is simple. The carrier frequency can be shifted over a considerable range without exceeding the amplifier tube plate dissipation rating.

DIMENSIONS

22″ wide, 16½″ deep, 66½″ high.

FINISH

St. James Gray.

POWER SOURCE

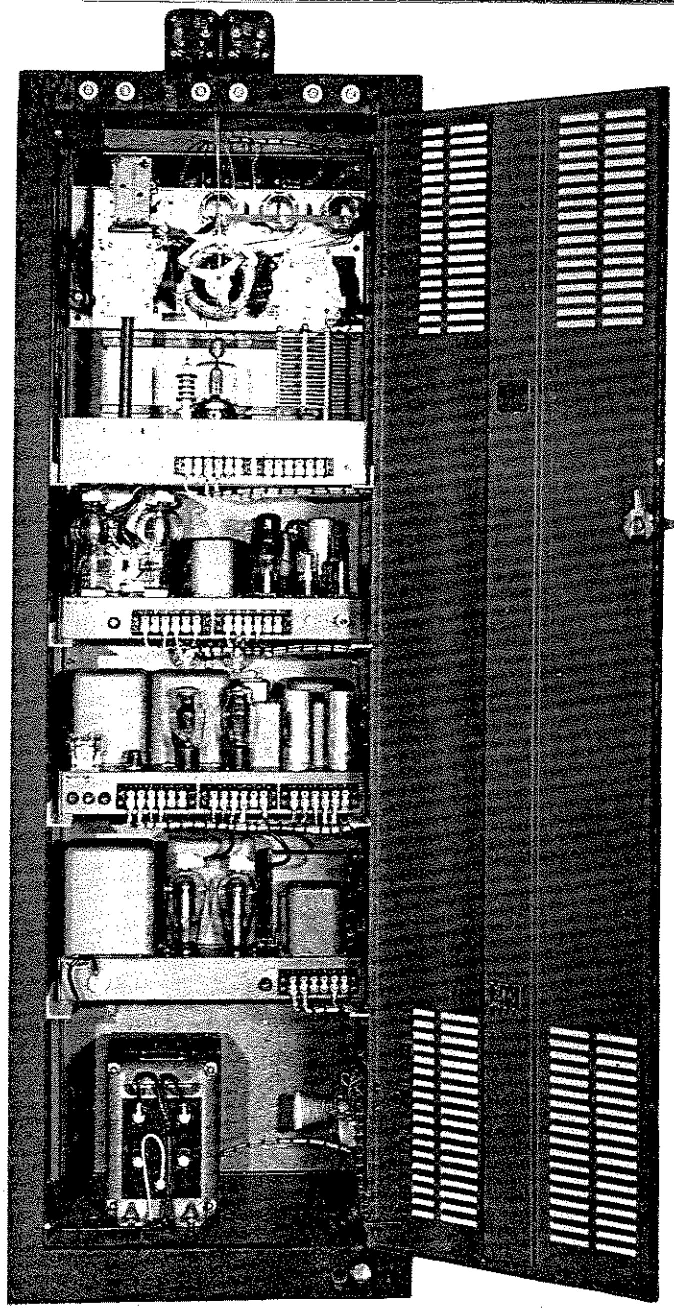
115 volts a-c, 60 cps, single phase.

OTHER COLLINS EQUIPMENT FOR AMATEURS

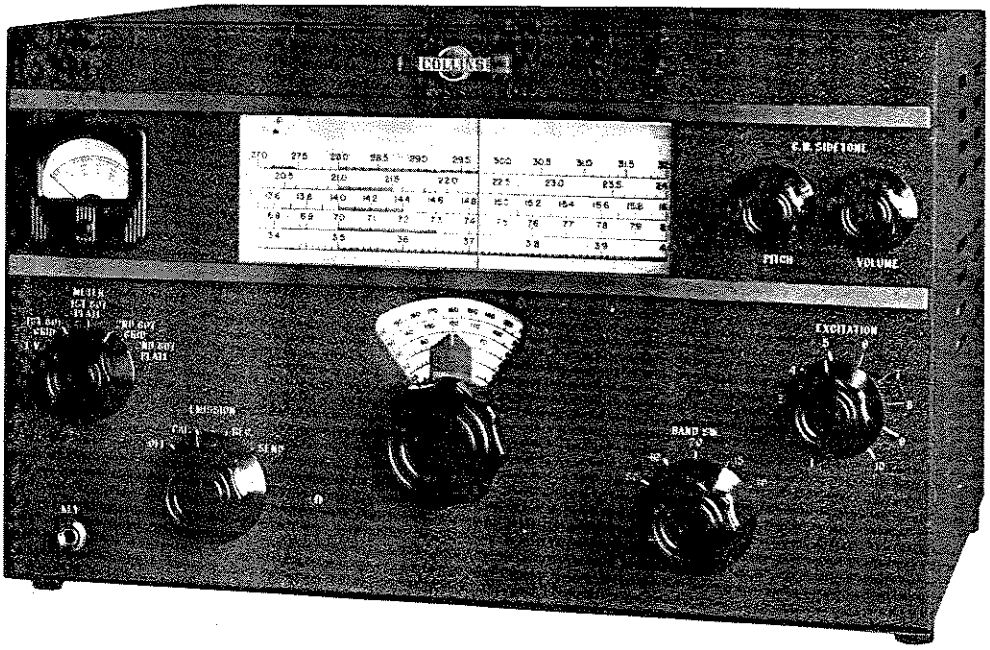
- 32V-1 transmitter—150 watts input on CW, 120 watts on phone, 6 bands, bandswitching, PTO* control, table model.
- 75A-1 receiver—precision calibration, double conversion, extreme stability, high image rejection on all bands.
- 70E-8A PTO*—precision unit, 1600 kc to 2000 kc range, linear tuning.
- 310B-1—v.f.o. all band exciter—40 watts input.
- 310B-3—Same as 310B-1, but with antenna network for use as low power transmitter or exciter.
- 310C-1—80 meter frequency control unit.
- 310C-2—Same as 310C-1, but with power supply.

30K-1

rear view



THE COLLINS 310A-3 EXCITER UNIT



The 310A-3 exciter unit for the 30K-1 has a Collins 70E-8A PTO, and an r-f output of 10 watts. All circuits are ganged together and controlled by a single tuning knob. The slide rule dial gives a rough indication of operating frequency, while the vernier dial provides a direct reading in kilocycles. Both accuracy and stability are very high. The PTO operates in the 160 meter band. The output tube in the exciter is an 807 which is used as a doubler on all bands except 80 meters.

One control bandswitches all circuits simultaneously. The 310A-3 covers the 80, 40, 20, 15, 11, and 10 meter bands. The send-receive switch has four positions—Off, Calibrate, Receive, and Send. In the Calibrate position, the exciter can be tuned to zero beat with a received signal without turning on the transmitter. This switch has extra sections which can be used to operate a transmitter relay and disable a receiver in the Send position.

A c-w sidetone oscillator is controlled at the front panel for pitch and volume. Grid block keying is provided. A keying filter eliminates key clicks. When the key is removed from the jack, the circuit is automatically closed for phone operation. The exciter output is controlled at the front panel and is fed through a 73 ohm coaxial transmission line to a matching circuit associated with the grid coil in the transmitter.

The multi-range panel-mounted meter has a 5-position switch, and indicates the low voltage supply, and the grid and plate currents in the two 807 multiplier stages.

Tube Lineup:
- 1—6SJ7 PTO
- 1—6AG7 buffer amplifier
- 1—6AG7 doubler
- 1—807 multiplier
- 1—807 multiplier
- 1—6SL7GT c-w sidetone oscillator
- 2—VR105 voltage regulators
- 2—VR150 voltage regulators

Dimensions: 17¼″ w, 10½″ h, 12½″ d.

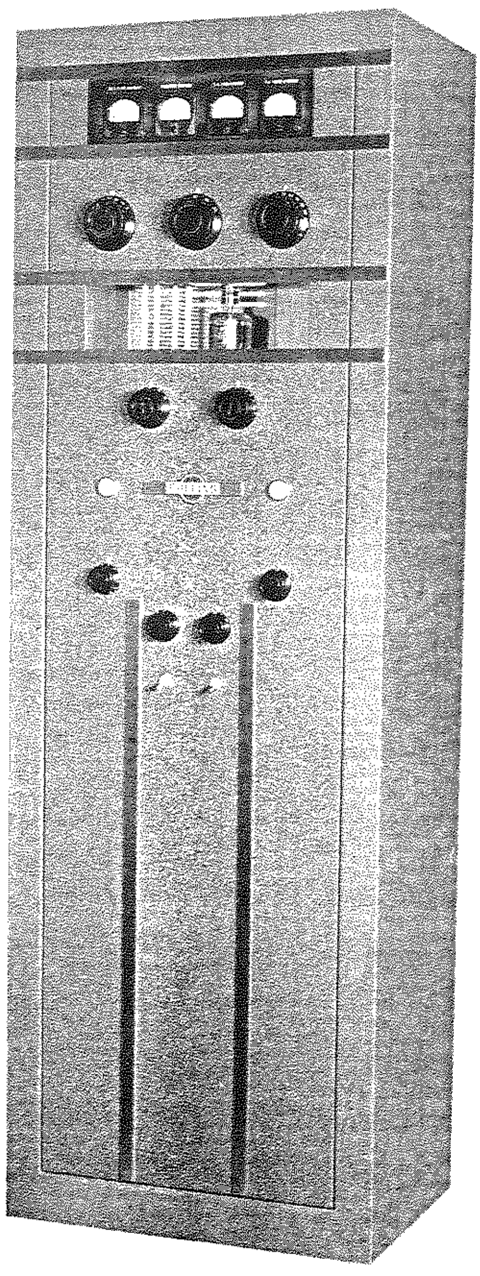
Power Source: 30K-1 power supply.

Net price of 30K-1. complete with 310A-3 Exciter, Tubes. Microphone Cord, R. F. Cable, Power Cable, and Instruction Book................$1,450.00

4M-9-48—P2426—48708—Printed in U.S.A.

THE COLLINS 30K

amateur transmitter



The COLLINS 30K

amateur transmitter

It's here! . . . the NEW Collins ham transmitter! 500 watts input on CW, 375 watts on phone. The 30K combines the desires and dreams of hams with brass in their blood and also those who want only a push-to-talk button. It was designed by engineers to whom CQ is a cherished and friendly sound. Every detail has been worked out carefully to provide efficient, economical operation. Select quality components are used throughout to assure long, trouble-free life.

Versatile and reliable, it is thoroughly engineered for continuous operation. The 30K amply meets the exacting requirements of amateur radio.

Look at these features:

fully metered	speech clipper
push-to-talk	115 v. a-c power source
vfo controlled	3 pairs antenna terminals
smooth, modern styling	band switching
	break-in operation
clean, sharp keying	100% modulation
unit construction	fused primaries
80, 40, 20, 15, 11, 10 meters	

BANDSWITCHING

No coils to change—no storage space required—just turn a knob and you're on a different band. All controls are conveniently and symmetrically located on the front panel. The time you save will count in contests.

REMOTE CONTROL

The exciter unit, in a receiver type cabinet, sits on the operating desk right at your finger tips. With vfo control, you can vary the operating frequency several kilocycles up or down, without retuning the final. A push-to-talk switch can be connected for phone operation.

SPEECH CLIPPER

The audio peak clipping circuit permits running the audio gain at a high level, thus maintaining a high level of modulation. With the circuit set to become operative at 70% modulation, the carrier will not be overmodulated, and the high audio power in the carrier side bands strengthens the signal. Intelligibility is also improved, assisting the QSO during QRM or static. The clipper circuit is followed by a cut-off filter which attenuates all frequencies above 4000 cps.

CIRCUIT PROTECTION

Primary power circuits are well fused. The power amplifier bias circuit includes a plate power relay which opens if bias should fail.

TUBE LINE-UP

1—4-125A r-f power amplifier
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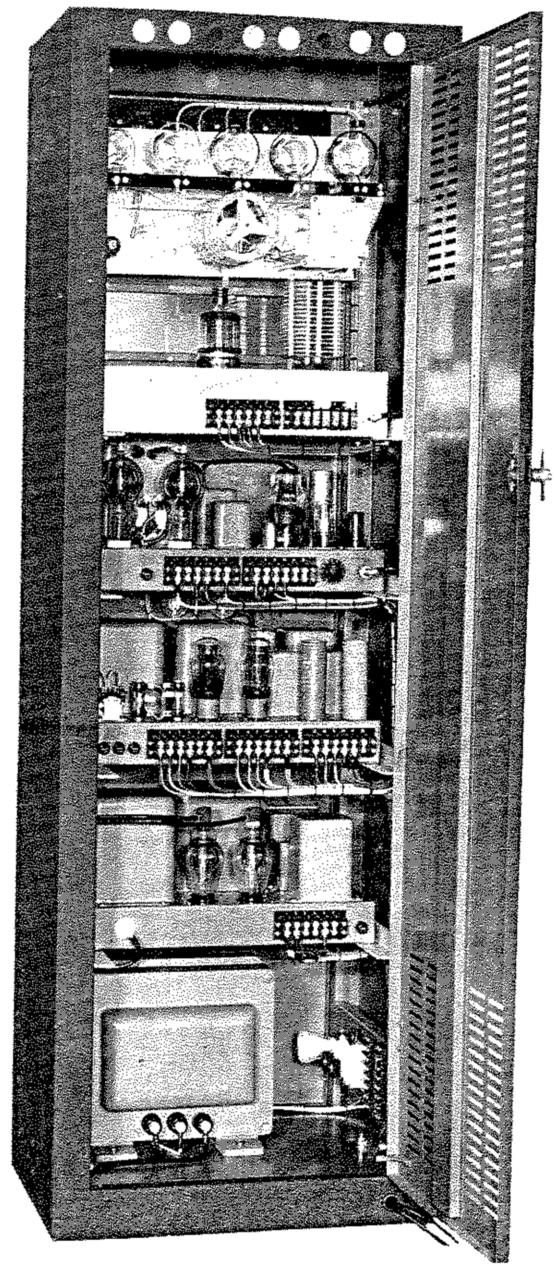
Filament ON-OFF switch
Phone-CW switch
Audio gain control
Filament voltage adjustment
Low voltage-tune-operate switch
P. A. grid tuning
P. A. grid bandswitch
P. A. plate tuning
P. A. plate bandswitch
Antenna loading

30K

rear view



RELAY OPERATION

An extra section is placed on the P. A. grid bandswitch for operating automatically antenna relays, or other control relays.

ANTENNA IMPEDANCE

The transmitter will feed directly into 50 to 72 ohm coaxial or twisted pair feeders balanced or unbalanced. A link coupling to an antenna tuning coil can also be used.

Three pairs of antenna terminals are provided for permanent connection of several antennas if desired. Remote controlled antenna tuning networks will be available for matching the transmission line to various antennas.

EXCITER

A Collins 310A exciter unit is employed with the 30K transmitter. This exciter, designed as a companion unit for the 30K, has accurate calibration and a high stable vfo. Output is on the 80, 40, 20, 15, 11, and 10 meter bands. Frequency is read directly. The 310A sits right on the operating desk.

DIMENSIONS

22″ wide, 16½″ deep, 66½″ high.

FINISH

St. James Gray.

POWER SOURCE

115 volts a-c, 60 cps, single phase.

OTHER COLLINS EQUIPMENT FOR AMATEURS

32V transmitter—150 watts input on CW, 120 watts on phone, 6 bands, bandswitching, v.f.o. control, table model.

75A receiver—precision calibration, double conversion, extreme stability, 50 db image rejection on all bands.

70E-8 v.f.o.—precision unit, 10 volts output, 1600 kc to 2000 kc range, linear tuning.

Designing the Collins 30K

by Warren B. Bruene, W5OLY
7805 Chattington Dr.
Dallas, TX 75248-5307

Forward

The 30K-1, Serial No. 1, was delivered around February 1, 1947 so this article really commemerates the 50th anniversary of this transmitter coming into being.

This February is also an anniversary for me as I got my ham license in February, 1935. My first call was W9TTK. It later became WØTTK and after I moved to Dallas in 1964, it became W5OLY.

I started with Collins in Nov. 1939 and retired from Collins Rockwell in 1984. I continued at Electrospace Systems until 1990 which is a span of over 50 years of full employment in the business.

Collins Radio received a telegram when WWII ended to stop all military production - which was everything. New products were needed. Along with products for other markets, Collins decided to develop three new products for Amateur Radio. These were the 75A receiver, the 30K 375/500 watt ph-CW transmitter and the tabletop 32V transmitter. All were to provide VFO operation using one of the new accurately calibrated and stable permeability tuned oscillators (PTO) developed by Ted Hunter, WØNTI. The design of the 30K and the companion 310A VFO exciter was assigned to me. This was the first complete transmitter for which I was to be the design engineer. For the past few years I had been responsible for the RF versions of the Navy TDH 3 KW Autotune HF transmitters. They used a pair of Eimac 750TL's in the final and a pair of 450TH's in the class B modulator. An 813 was used in the RF driver stage.

Final RF Amplifier Tube Choice For The 30K

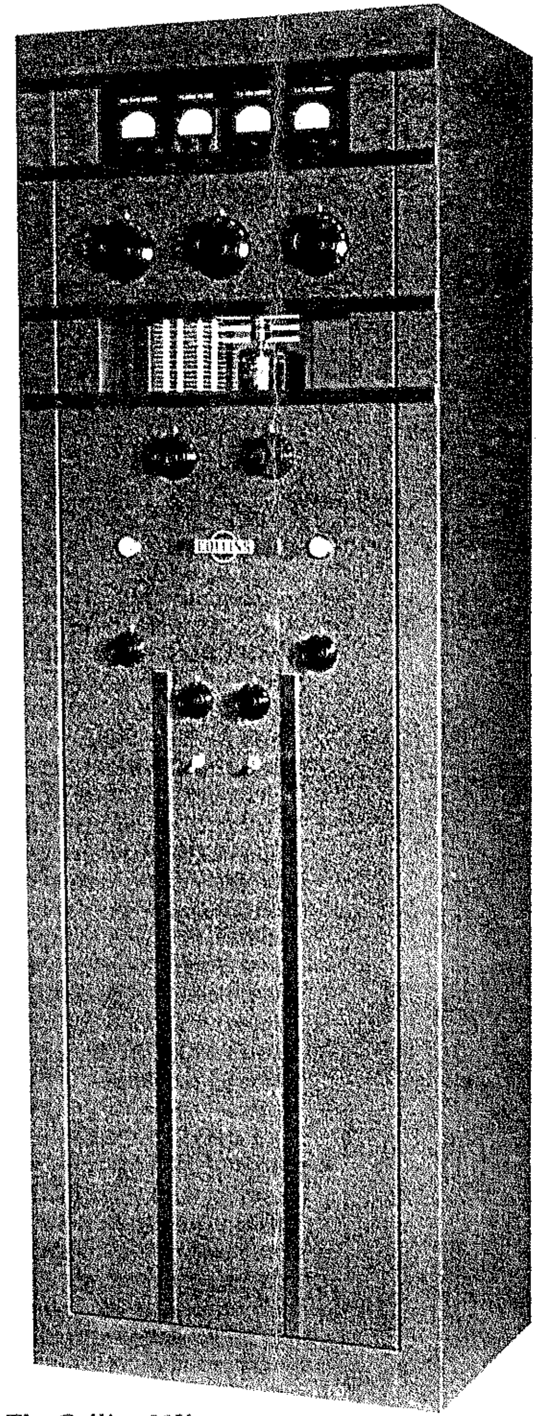
Eimac had recently introduced the 4-125A tetrode which was called a modern replacement for that old workhorse, the 813. We had offered our ideas to Eimac on what features we would like in such a tube. It is compact with shorter internal leads and lower internal capacitances. The data sheet indicated that neutralization probably would not be necessary below 30 MHz. And that cherry red glow of the tantalum plate gives the operator sort of an unexplainable thrill. Furthermore, it added confidence that the circuit was operating as intended because you could "see" that the plate dissipation was correct. You could even resonate the final by tuning for the dullest glow.

A pair of 75T's was a compatible choice for the class B modulator using the same HV DC power supply with a pair of 866A mercury vapor rectifier tubes.

Note: In 1952 the list price of a 4-125A was $30.50, the 75TH's were $13.25 each and the 866A's were $1.95 each.

Features And Objectives

In late August '45 I prepared a list of 23 design features and objectives. It included such things as using a common HV power supply for both the final and the modulator, limit power to the ratings of a pair of 866 mercury vapor rectifier tubes, a smartly styled cabinet, cover 80 through 10 meter bands, speech clipping but should sound good on the air, band switching, inductive RF output coupling, matching to 75-ohm coax or 72-ohm twin lead line and also to



The Collins 30K

tuned Zepp feeders, antenna switch on band switch, push-to-talk, time delay, and blocked grid or suppressor keying for a clean CW signal with no clicks or backwave. By September 10th I had drawn a schematic for a proposed design of the exciter and transmitter and also a drawing for the front panel of the exciter.

Initial Concept For The 310A Exciter

The initial concept was to control the transmitter remotely from the tabletop exciter positioned next to the receiver. The operator would manually set the band-switch on the transmitter and turn ON filament power. Plate power was to be remotely controlled by a switch on the exciter. Grid and plate tuning would be remotely controlled using motors operated by a "raise/lower" switch on the exciter. The speech amplifier would be located in the exciter and an "electric-eye" would be provided to monitor the modulation level. After some thought and consultation with others, it was decided that this much remote control wasn't worth the cost. Eliminating remote tuning just meant that the transmitter should be located within reach of the operator. The audio amplifier was moved to the transmitter and located on the modulator chassis. The electric-eye modulation monitor was eliminated as was a keying monitor and speaker. These changes and simplifications allowed a substantial cost saving.

I was told that Art Collins

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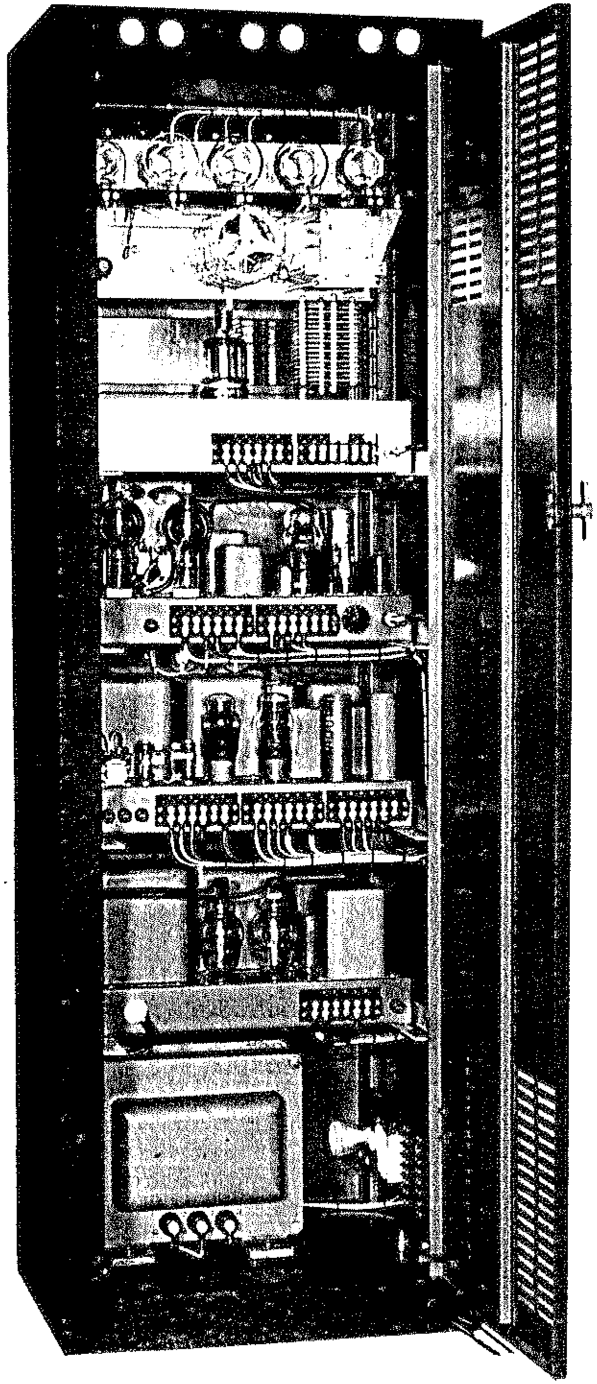
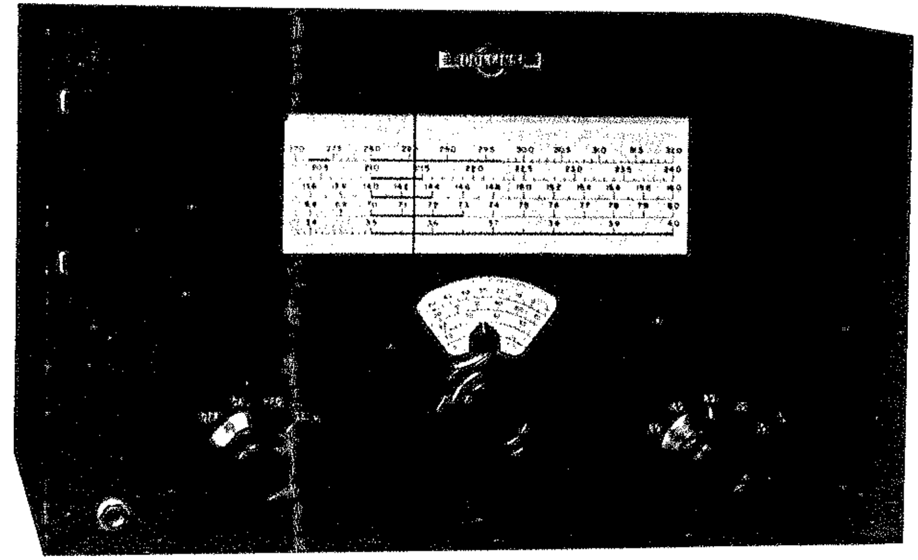


Rear view, showing unit construction and link coupled RF output.

wanted a mixer type exciter but I wasn't told why. I just assumed that it was to achieve frequency accuracy comparable with the 75A receiver which used a crystal oscillator for the first injection, a variable IF, and a PTO for the second injection. It was several years before it finally dawned on me that he must have had SSB in the back of his mind.

My first schematic had a 1.000 MHz crystal oscillator followed by a harmonic generator and triple-tuned selective filters to select the desired harmonic. This was mixed with the output of a 2-3 MHz PTO and amplified by two tuned stages. It was soon realized that the selectivity requirements were quite severe (and expensive) and that some "birdies" were present - such as the 4th harmonic of the crystal frequency on the top edge of the 80 meter band. A simpler and lower cost system was needed. The cost of a separate crystal for each band (like in the 75A) wasn't too appealing either.

I devised a scheme of mixing a 6.0 MHz crystal output with a 1.5-2 MHz PTO. This generated a very accurate and stable frequency covering 7.0-7.5 MHz. The 20, 15, and 10 meter bands would be covered by multiplying this by 2, 3, or 4 respectively. The 80 meter band would be covered by tripling the PTO output to get 3.0-4.5 MHz of which only 3.5-4.0 MHz was used. The buffer/amplifier, following the crystal oscillator, and the amplifier stage following the mixer were keyed for CW. It produced very clean keying with no chirp and no backwave.



The Collins 310A exciter

A production type model was built and put on the air with the 30K. It performed beautifully and I was proud of the relatively simple design, but Art declared it "neither fish nor fowl" meaning it was neither a completely mixer nor a completely multiplier type of exciter. I was then authorized to use the 70E-8 PTO which was being designed into the 32V transmitter for an all multiplier type exciter.

Direct Reading Carrier Frequency Indicator

One objective was a direct reading frequency indicator to take advantage of the frequency accuracy of the PTO. I wanted to provide an analog feel of where you were in the band as well as the ability to read the frequency to an accuracy of 1 KHz. The result was the slide-rule dial calibrated to indicate the frequency to a 100 kHz segment (10 kHz on 80 meters). Only the scale for the band in use was illuminated. The 70E-8 covered 1600-2000 kHz with 16 turns of the shaft. Therefore, one turn of the dial covered 50 kHz on the 80 meter band, 100 kHz on the 40 meter band, 200 kHz on the 20 meter band, 300 kHz on the 15 meter band and 400 kHz on the 10 meter band. This required a separate circular scale for each band. A red pointer with a white indicator mark was moved up and down by the band switch to correctly position the KHz indicator in front of the correct circular scale.

Exciter Tube Lineup

The tube lineup in the 310A was a 6SJ7 in the PTO, 6AG7 isolation amplifier, 6AG7 frequency doubler, 807 frequency multiplier, 807 frequency doubler, two VR105 voltage regulators for the PTO, a 6XGT rectifier for the bias supply and a 5R4GY for the 500 VDC supply. The outputs of the last three stages were bandswitched and tuned with variable capacitors - all ganged to the PTO. The output circuit of the last 807 was link coupled to the 73-ohm

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Designing the Collins 30K from previous page
coax output. The nominal power output was 10 watts.

There were several modifications to the 310A which were identified by "dash" numbers up through -3. The 500 VDC power supply was deleted in the 310A-2 and the 500V of plate power was obtained from the 30K. Additions in the 310A-3 were a multimeter, a side-tone oscillator, grid block keying, and an adjustable RF drive control (to the 30K).

The 4-125A Operating Conditions For Phone

The operating conditions chosen for phone were close to those shown on the Eimac data sheet for a DC plate voltage of 2500 volts. The DC screen voltage listed was 350 volts with 210 volts peak audio modulation when the plate was modulated 100%. 100% screen modulation isn't needed because the plate current rises approximately as the 3/2 power of screen voltage.

The screen was made self protecting (from excessive dissipation) by dropping the voltage from 500 VDC to approximately 350 VDC through a 5000 ohm resister. The maximum possible screen dissipation (with no modulation) would occur with the screen at 250 volts drawing 50 mA which is 12.5 watts (when unmodulated). The maximum rated screen dissipation is 20 watts. The 5000 ohm screen dropping resistor provided 500 VDC to 350 VDC with 30 mA of screen current. The screen dropping resistor also makes the screen somewhat self-regulating for variations in RF drive voltage. If the drive is high, there will be more screen current so the screen voltage will drop a little. If the drive is a little low, the screen voltage will rise a little. Also the dropping resistor allows for some self screen modulation. Thus the screen voltage dropping resistor performs several useful functions, it protects the tube and makes the circuit more tolerant of variations in RF drive and also for differences between tubes.

The DC grid voltage is derived from a fixed DC bias voltage plus an additional amount obtained from a grid bias resistor. The fixed part needs to be high enough to keep the plate current cut off in Key-Up when there is no RF drive. The fixed bias voltage required is determined principally by the DC screen voltage which rises to 500 VDC when there is no drive. The characteristic curves for the 4-125A show that the tube would be just barely cut off with -80 volts bias at 350 VDC screen voltage. Cutoff bias with 500V on the screen would be -80*(500/350)^3/2 or -137V. A -145 VDC bias supply is provided for this purpose (this same bias supply provides an adjustable bias for the modulator tubes).

Note: The DC bias voltage is not regulated. If the AC power line voltage varies, a corresponding DC screen voltage variation will result. An unregulated bias supply produces a compensating change in the DC bias voltage.

A 5000 ohm grid leak resistor was provided for the additional bias. The 30K-1 instruction book states that the DC grid current should be 12 to 15 mA. This produces a total DC grid voltage in the range of -205 to -220 VDC.

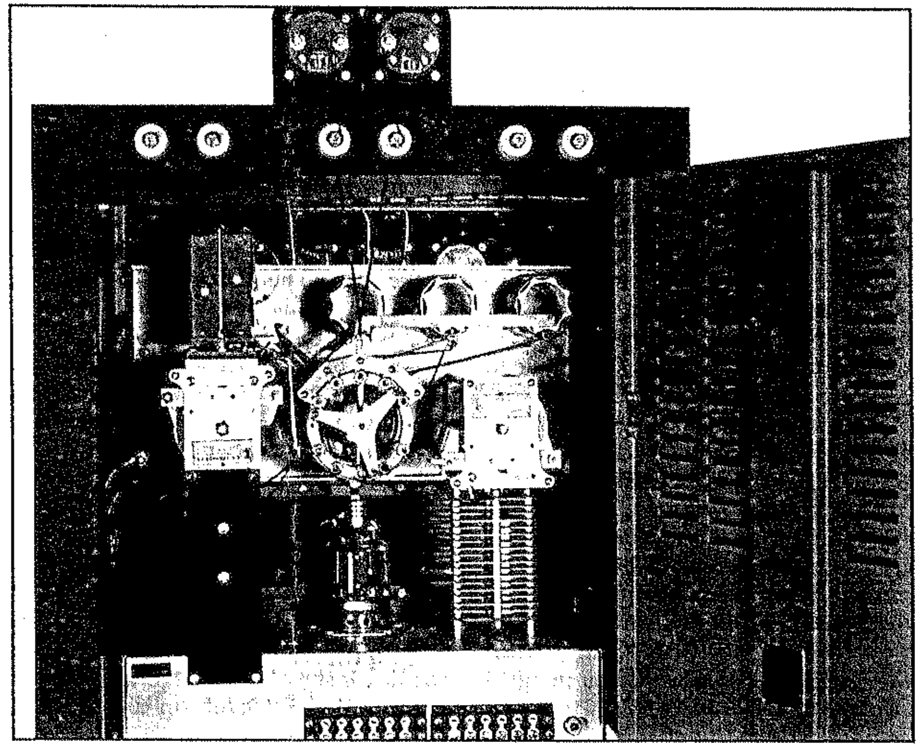
An object of the design was to provide enough self regulation of the screen and bias voltages so that no changes would be required when adjusting the loading from 150 to 200 mA DC plate current for phone and CW respectively. It appears that when loaded for phone, there will be more than 30 mA of screen current which will drop the DC screen voltage a little below 350 VDC. When loaded for CW, the screen current will be less than 30 mA resulting in a DC screen voltage a little higher than 350 VDC. Changing the plate loading causes the DC grid current to vary some also.

RF Grid Circuit Design

All of the Collins transmitters which I had worked on used direct coupling between RF stages, but I had used link coupling in my home brew ham transmitters. Therefore, I started with link coupled coils at both ends of the transmission line between the 310A output and the 4-125A grid circuit. I had trouble getting and maintaining the desired coupling across each ham band (especially 10 meters), and this started my "real" education on the effects of SWR on a coax transmission line. The link coupled circuits which I had used previously were only a foot or so apart, therefore the impedance of such a short length of line made little difference. It makes a lot of difference when the length is 20 feet or so, however.

Directional wattmeters didn't exist yet but the Jones MicroMatch came out about that time. It was designed for measuring SWR on high impedance open wire lines. It wasn't suitable for low power in a coax line. Therefore, I built an SWR meter using the Jones circuit but modified for the 73 ohm coax I was using and for 10 watts of power. It took quite a bit of experimenting before I understood and believed what it was telling me. The matter was complicated by the fact that a variation in coupling across a ham band varied the grid drive and this in turn varied the RF load resistance at the end of the coax. I found it necessary to use direct coupling in the 4-125A grid circuit. I used a tap on the grid tank coils for the 80 and 40 meter bands and a pi circuit on the other bands. The main reason for using the pi circuits was to avoid the need for positioning the tap at a fractional turn.

Apparently there was still quite a bit of SWR on the coax, which caused drive to change with different lengths of coax. This was minimized by designing all couplings to work with a 23.5 ft. length of coax.



Rear view of the 30K1 showing the variable link coupled RF output network.

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Designing the Collins 30K from previous page

Link coupling was kept in the 310A end of the coax. The link coils were wound using bus wire with insulating tubing slipped over the wire. They were wound directly over the 807 tank coils in the 310A to get enough coupling. Their position could be varied a little to adjust the coupling. I added resistance in series with the links to keep the load resistance on the 807 driver more constant across the bands. (In retrospect it probably would have been better to add the "swamping" resistance at the load end of the coax to minimize SWR variation). Apparently this did not keep the grid drive as constant as desired so an EXCITATION control was added to the 310A-3 model which varied the screen voltage to the output 807. A further reason probably was to better accommodate the somewhat different drive requirements for phone and CW.

The effective RF load resistance which the 4-125A grid places across the grid circuit is on the order of 15,000 to 20,000 ohms.

The Plate RF Tank Circuit

The RF plate load resistance for the 4-125A is relatively high, being over 6000 ohms for CW and 7000 ohms for Phone. Shunt feed would present a severe RF plate choke problem in such a high impedance circuit, therefore series plate feed was chosen. The RF voltage across the plate choke is then only the voltage drop across the bypass capacitor from the bottom end of the plate tank coil to ground. This allows a commercial RF choke to be used. Isolation to the RF output circuit was achieved by link coupling which just requires sufficient spacing between the tank coil and the link. The tuning knob for the plate tuning capacitor was isolated by an insulating flexible coupler.

The HV bypass capacitor must be located near the 4-125A where it receives a lot of radiated heat. High voltage mica capacitors were available but they were made using several lower voltage sections connected in series-parallel. These sections were potted in a Bakelite case using wax or tar which would melt when it got too hot. This problem was solved by using an air dielectric capacitor which we could manufacture. We found that the circuit would operate satisfactorily with only 150 pF of capacitance which has 300 ohms of reactance at 3.5 MHz. This could be mounted near the tube with no heat problem. (I originally developed this air capacitor idea in the 3 kw TDH HF transmitters during WWII). The peak RF voltage across this bypass capacitor is about 60 volts at 3.5 MHz and is proportionally lower on the higher frequency bands. The peak voltage on phone will be nearly twice that high but this is no problem for the commercial RF choke selected. The 2nd harmonic voltage across the capacitor is only about 15 volts peak on CW at 3.5 MHz. This is very small compared to the approximately 2150 fundamental peak plate voltage, therefore there is very little RF waveform distortion to impair efficiency.

A two section plate tuning capacitor was used to reduce the minimum tank circuit capacitance on the higher bands. One section varied from 13-34.5 pF and the other 20-57 pF. The larger section was paralleled with the other only on the 80 meter band.

The Antenna Coupling Circuit

Initially, in the interest of simplification, it was planned to just feed 75 ohm coax or 72 ohm 1 KW twinlead. This was a simple means of feeding dipole antennas. It was thought that putting up a dipole for each band to be used might be preferable to complex tuned antenna coupling circuits. Therefore, the antenna coupling link was just approximately series resonated with a fixed capacitor. Thus the only adjustment was the amount of coupling from the link to the plate tank coil. A separate plate tank coil was provided for each band with its own coupling link. The links were all mounted on an insulating shaft so that the links could be rotated closer to and further from the bottom end of their respective tank coils. It was thought that if resonant feeders or a high impedance transmission line were used the user could build a simple resonant circuit placed on top of the 30K cabinet. It would be link coupled to the plate tank with the variable coupling link in the transmitter. It was soon found, however, that hams wanted an antenna tuning circuit built into the transmitter. Art Collins suggested the circuit which was then designed into the transmitter in January, 1947.

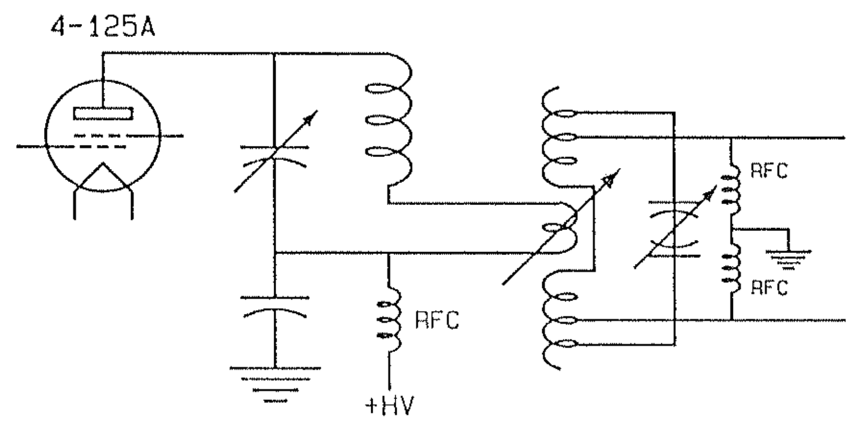

Figure 1. 30K-1 output network

This coupling circuit for the 30K-1 is shown in Figure 1. It took two plug-in antenna tuning coils to cover all bands. One covered the 80 and 40 meter bands and the other covered the 20, 15 and 10 meter bands. There was a swinging link in the center of the antenna coil and this link was in series with the plate tank coil. The antenna coils could be jumpered for either a series or a parallel tuned circuit or for either a parallel or single ended configuration. Usually the parallel configuration was used since most hams were using open wire feeders.

It was found that the bandwidth was greatly increased in the parallel configuration. As the 310A frequency was shifted, the tuning error of the antenna circuit tended to cancel the tuning error in the plate circuit. Large segments of any band could be covered without retuning - a very attractive feature. Other factors which affect this broadbanding are the resonant Q of the antenna and the transmission line length. Most of us didn't understand just how this all tied together back then. Now, this knowledge is in hand but it is rarely used to advantage.

Three pairs of antenna terminals were provided near the top rear side of the 30K cabinet. Two switch sections on the bandswitch were provided which could be jumpered to provide automatic antenna switching when changing bands. Two RF ammeters which could be used to read antenna feeder current were mounted on top of the cabinet .

Equations For Link Coupling

The coefficient of coupling, k, to a link at the middle of a coil is approximately 35%. When just off the end of the coil, it is about 20%. The Q of a parallel

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Designing the Collins 30K from previous page

resonant circuit is the ratio of the equivalent resistance across the circuit divided by the reactance of the capacitance across it.

$$Q = R/X_C$$

Maximum power is coupled into a link when the inductive reactance of the link is equal (in magnitude) to the load resistance across the link, such as 72 ohms. The Q of the tank circuit must be quite high to get adequate coupling to an untuned link. It takes a Q of 50 when k=20% to an optimum link, or a Q of 16 when k=35%.

The k required when two resonant circuits are inductively coupled together is much less. In the above case, just resonating the previously optimum link drops the minimum Q of the plate circuit in half. The required k between two resonant circuits with Q's of Q_1 and Q_2 is:

$$k = (1/ (Q_1 Q_2)^{\wedge}1/2$$

When only part of the inductance of one circuit is inductively coupled to the other, the k required is increased in inverse proportion to the fraction which is inductively coupled.

This is explained in detail in my article "How to Design RF Coupled Circuits" in *Electronics*, May 1952. It also appears in Chapter 18 Radio Transmitters in the 5th Edition of Henny's Radio Engineering Handbook, McGraw Hill, 1959.

The Class B Modulator

The 75TH tubes were chosen for the modulator because they were the right size and could be operated at a DC plate voltage of 2500 - the same as used in the final. The 75TH has a mu of only 20 so it requires a bias voltage of approximately -105 volts DC for the recommended 45 mA modulator idling plate current. The instruction book lists 175 mA plate current for 100% modulation.

We worked with the modulation transformer manufacturer to find a reasonable compromise between tube operating conditions and transformer design limitations. This is a very high impedance circuit therefore capacitances within the transformer greatly affect the high frequency response. We asked for flat response to 4000 Hz and then a rapid drop. The plate-to-plate primary impedance of the final design was 32,000 ohms. Each tube sees a load of one fourth of that or 8000 ohms at the crest of the audio wave. The peak plate voltage swing is 1730 volts at 100% modulation. The peak power output required from the modulator tubes is equal to the DC power input to the final in the carrier, for no modulation condition, which is 375 watts. The modulator tube peak plate current is therefore:

$$i_p = 375/1730 = 0.217A \text{ or } 217 \text{ mA}$$

The modulator tubes do not draw grid current until approximately the 70% modulation level. It rises to approximately 20 mA instantaneous peak at 100% modulation. This places a non-linear load on the 6B4G Class A driver tube which causes the audio distortion to rise from 2% at 70% modulation to 8% at 100% modulation. No attempt was made to reduce this because it just acts as a little "soft" speech clipping which is more of an advantage than a disadvantage.

Audio Amplifier And Speech Clipper

The microphone input was designed for high impedance mics such as Turner's crystal and dynamic mics. It was coupled to the grid of a 6SJ7 through an RF filter.

From the beginning I had planned to include some means of minimizing overmodulation splatter. Articles on splatter suppressors and on speech clipping were starting to appear. A moderate amount of speech clipping, such as 6 to 10 dB, greatly increases sideband power without excessive distortion. A clipped signal will sound louder in the

receiver because the receiver AGC operates from carrier level - not sideband power. We decided to include a speech clipper followed by another gain control to set the clipping level to just below 100% modulation. Thus we could have the advantage of speech clipping plus the avoidance of overmodulation splatter.

The speech clipper used a 6H6 twin diode to clip both the positive and negative peaks. It was followed by a low-pass filter with a 4000 Hz cutoff frequency. The clipper was preceded by one section of a 6SN7 dual triode and followed by the other section. A potentiometer between the 6SN7 and the grid of the 6B4G driver tube designated as the "clipper control" was used to set the clipped output level to a little under 100% modulation. The audio gain control at the input of the first section of the 6SN7 sets the level into the clipper for the desired amount of clipping. Of course, the gain setting depends upon how loud the operator speaks into the mic also.

Art Collins and Roy Olson listened to the 30K over the air at a Olson's residence to assure that it functioned correctly and sounded OK.

I remember building a clipping level monitor into the engineering model using a small cathode ray tube. The audio input to the clipper was applied to the horizontal input and the output of the clipper fed the vertical input. This produced a sloping line at low audio levels where there was no clipping, but continued in a horizontal line in the clipping region. It was interesting to watch but was not seriously considered for production.

High Voltage DC Power Supply

The high voltage DC power supply was rated for 2500 VDC and 300 mA. It employed a conventional single-phase full-wave circuit using a pair of 866A mercury vapor rectifier tubes. A two-section DC filter was used using a 12 Hy filter choke and a 2 mFd filter capacitor in each. In addition, the input choke was tuned to 120 Hz with a 0.10 mFd capacitor. At that time it was common practice to use a swinging choke in the first section whose inductance varied from 25 Hy, with just bleeder current load, down to 5 Hy at full load current. Collins engineers had been using the tuned choke idea for several years because it reduced hum better and had better transient response to a varying load such as the keyed final.

With an untuned input choke, there is a minimum "critical" inductance required to prevent the power supply from starting to act like a capacitor input filter. When this happens, it causes the no-load voltage to rise resulting in poorer regulation.

The maximum load resistance is just that of the bleeder resistance (100,000 ohms) when the final is keyed OFF. The value of critical inductance in a single-phase full-wave rectifier circuit is:

$$L_C = R/1130 = 100{,}000/1130 = 88 \text{ Hy}$$

Instead of an 88 Hy choke we tuned the 12 Hy input choke to 120 Hz to achieve the same result and with a much shorter transient time-constant. The choke is rated for 12 Hy at full load current of 300 mA. The inductance of this choke is approximately 18 Hy when passing just the bleeder current of 25 mA. Therefore it takes a capacitor of only 0.1 mFd to tune it to 120 Hz using 60 Hz primary power. (It must be tuned to 100 Hz when using 50 Hz primary power which requires an 0.15 mFd capacitor). The best value can be found experimentally by measuring the DC output voltage using different values of tuning capacitance. The best value produces the lowest DC output voltage.

The transient voltage across the choke may be up to double the DC output voltage. That is one reason why this

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capacitor has a DC voltage rating of 5000 volts. The second reason is that there is a high value of 120 Hz current circulating in the resonant circuit. This creates a significant amount of heating. It has been our experience that a paper dielectric filter capacitor with a DC voltage rating of twice the DC power supply output voltage is sufficient. Plastic film capacitors available now heat less.

Tuning Resistor

There is a LV-TUNE-OP control on the 30K-1. In the LV position, only the low voltage and bias supplies are energized. In the TUNE position the HV power supply is energized but with a 660 watt conical heater element connected in series with the 115 VAC primary winding. This reduces the 2500 volts so the 4-125A will not overheat before the operator can resonate it. Once resonated, the switch is turned to the OP, operate position, which shorts the tune resistor.

LV Power Supply

A single 500 VDC power supply provides all of the low voltage DC power requirements including the 4-125A screen, the audio amplifiers and the later versions of the 310A exciter. It uses a 5R4GY rectifier tube.

Bias Supply

The -145 VDC bias supply furnishes the fixed bias for the 4-125A and an adjustable voltage of approximately -105 VDC for the 75TH modulator tubes. It also provides -60 VDC for bias voltages in the 310A-2/3 and a DC voltage to energize the HV power supply relay. A 5R4GY rectifier tube is used.

Cabinet And Mechanical Layout

It was standard practice at Collins to unitize the cabinet layout by circuit function. This was done so that new transmitter models could be created by redesigning only one or two units. Each unit was usually built on a standard width chassis and mounted one above another in a steel cabinet. I chose a chassis width of 17 inches which was the standard width of chassis used in rack-and-panel construction. The chassis would be supported on rails screwed to the sides of the cabinet. A cabinet height of 66-1/2 inches was chosen so that the meters would be at eye level to an operator standing in front of the transmitter. The welded steel cabinet was designed for simplicity and strength. The St. James wrinkle paint was the standard paint used for most Collins equipment at that time. It was a pleasing greenish-gray neutral color which would be less objectionable to XYLs than black.

Ample space was provided around the chassis for convection air currents to remove heat. Slots in the rear door provided air entry and a 7 x 11 inch cutout in the roof allowed hot air to exit. A metal plate was mounted 1 inch below the roof to keep fingers out, to collect dust and to contain stray RF better.

Note: This transmitter generated no TVI when originally designed because there was no TV!

The meters had to be mounted behind a glass panel because they were located at high voltage points in the circuit. Another glass window was provided so the operator could see the color of the 4-125A plate. This gives the operator confidence that everything is operating OK. Trim strips were used to add some style and provide a family resemblance to the pre-WWII 30J transmitters. The controls were located near the circuits they controlled and/or to provide symmetry. Large pilot lights were chosen just for looks.

Testing And Development

A lab technician, Ken Everhardt, WØEIT, was assigned to the project to assemble and wire the equipment and assist with testing and development. Some of the changes made during development were discussed above. I had wanted to include a time-delay to prevent energizing the 2500 VDC power

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Dear ER

I greatly enjoyed Ken Greenberg's "Memories of Allied Radio" in the January 1997 issue of ER. I too grew up with the "bible" always close at hand.

However, Ken's article suggests the greatest electronic catalog is no longer with us. In fact, the Allied Electronics, Inc. (An Avnet Company) catalog is very much alive and well. I've been ordering from it for several recent years and found very important things for my, shall we say, older radios.

Tube sockets, octal and 11 pin plugs and covers, high voltage transformers and filter chokes, and even a microphone connector for my Johnson Viking. Yes tubes, though a bit expensive, are there. And, of course, all the high voltage caps you can imagine. The only things I found wanting are air variable caps.

So, my pitch is, ER readers need to know the Allied catalog is available, their inventory exceptional, and their service excellent in 1997.

Allied Electronics, Inc. 1-800-433-5700.

Charles D. Barton NZ5M

Editor's Note: Up until receiving the above letter I was under the impression that the old Allied Radio Company had no connection whatsoever to Allied Electronics. I guess I was wrong. Mostly out of curiousity, I called their 800 number and requested their latest catalog. I had not seen one for several years and was surprised to see that it has grown to over 1000 pages. And it does indeed contain a lot of stuff that vintage restorers/repairers need. I suggest it as another good parts source.

Dear ER

A footnote to my article Recompensating Old Oscillators to Minimize Drift (ER Oct. 96, pg. 9) suggested a ceramic trimmer capacitor for temperature compensation. Unfortunately, this type of trimmer gives small 200 Hz wavers, and is poor for CW. I've located a stable capacitor manufactured by XICON Passive Components, namely the Class 1 Ceramic Disc (CD series). In particular the SL code (approximately N330, or -330 ppm/C) is available off-the-shelf from Mouser. I've used the CD 1000S5-022K in my Valiant's 7 MHz VFO with good results (this is a 22 pF, 1 kV, N330 +500,-500 capacitor). The temperature coefficients can vary 500 ppm/C, so it might be wise to obtain several in case one does not have adequate negative coefficient.. If this does not make you happy, then check with XICOM Passive Components, telephone (800) 628-0544, about those temperature coefficients that are available by special order.

Robert Burger, WB6VMI

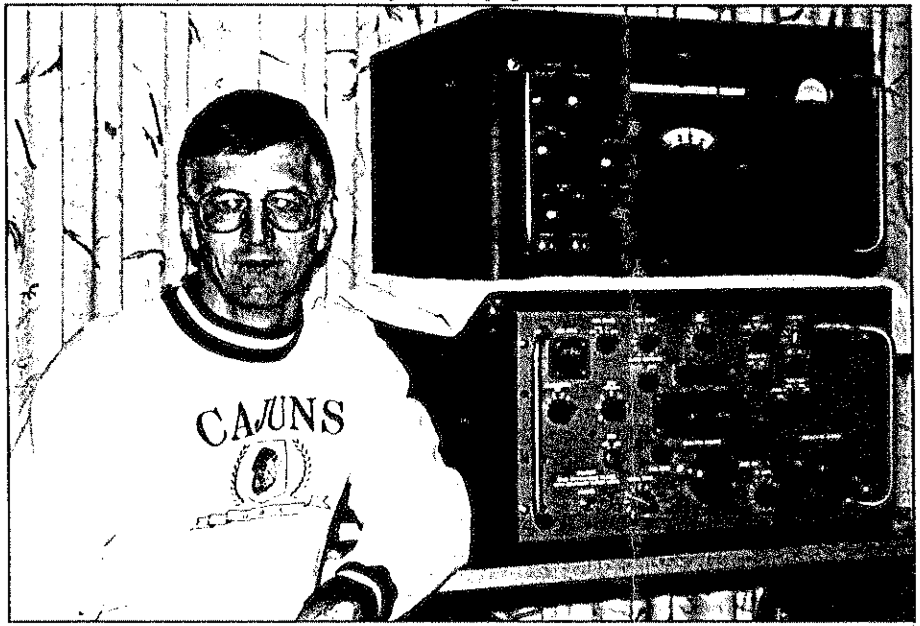
Dear ER

I want to express my support for the December 1996 article by Carl, WB1EYE, on the 5 watt "cake pan" transmitter. In view of the letters of complaint I have seen in OST regarding authors that sell their project, I wanted to counter the same type of letter that you might receive as ER editor. In my humble opinion, ER cannot just be a magazine which has articles about commercially built tube type equipment. I think it is a great idea to have articles that encourage building using tube type equipment. In these days when some (including myself) may not have the time to hunt around for parts, I welcome the ability to buy a complete kit of parts (or even the finished product) from the author of the article. If someone thinks that the kit price is too high, then they can go buy the parts elsewhere. Just don't deny everyone the ability to make that choice by not publishing the article.

I will look forward to other articles that encourage building, especially the ones that Carl alluded to in his article (the N2ZAB tube type receiver; a screen modulated AM transmitter).

Dick Bean, K1HC

R-388 US Military Contract List from previous page



The author with his two of his favorite receivers: R-388, top; R-390A, bottom.

me by an owner, so it can be inferred that at least that many were made under each contract. A high s.n. of "0" means that from various pieces of documentation this is a known contract, but no examples surfaced in my survey.

Compiling an R-388 contract list is like counting stars; there is a finite number out there, but each time you count, the number gets higher. It would appear that Uncle Sam placed many orders of small numbers. Interestingly enough, the R-388 orders go out well beyond the dates of availability of the new R-390 and R-390A. Perhaps this was for reasons of economy or ease of use.

According to the information available, all R-388's were made by Collins.

Not shown in the list below is a contract for R-388A's (same radio, but with mechanical filters, equivalent to the Collins 51J-4), NObsr-69046. I don't have any serial number data for this contract, however civilian serial numbers as high as 7000 have been contributed. There were likely some radios made for government agencies other than the military.

Future installments will cover the R-389, R-390, R-391, R-392, and R-725.

Any info on these rigs contributed now would make the future installments all the more complete. ER

R-388 US Military Contract List

NObsr-49132 (AN/URR-23A) 91
NObsr-52527 (AN/URR-23A) 180
19624-PHILA-50 976
1908-PHILA-51 355
3096-PHILA-51 8
3131-PHILA-51 919
3155-PH-51 1379
3164-PH-51 153
3167-PHILA-51 491
3357-PHILA-52 1672
3362-PHILA-52 109
3469-PHILA-52 20
3470-PHILA-52 1449
25635-PHILA-53-36 2193
25067-PH-54-55 363
21318-PH-56 88
30951-PH-56 0
30951-PHILA-57 0
37003-PC-62 171
Total of high serial numbers 10617

Designing the Collins 30K from page 14

supply before the 866A mercury vapor rectifiers had time to warm up. I tried a scheme of connecting the filament of a 12H6 twin diode in series with the bleeder of the bias supply and operating a relay from current passed by the diodes. The 5R4GY bias rectifier had to warm up before the 12H6 started to warm up which gave a 22 second delay. It would also provide protection from bias supply failure. The use of the 12H6 for extra delay was discarded to save cost, most of which was due to the need for a 300 mA bias supply instead of 75 mA. This deletion reduced the delay to approximately 5 seconds which meant that the operator had to be the "30 sec. timer".

The Boonton Q-Meter was a very important RF test instrument. We could use it to measure coil inductance and Q, capacitance, and coefficient of coupling between coils. A neon bulb on the end of an insulating rod was also very helpful. We used it to search out parasitic circuits. HF caused a pink glow, a LF parasite caused a yellow glow and a violet glow indicated a VHF parasitic oscillation. We could follow the resonant circuit path by moving the bulb along the circuit path where the color was strongest.

Models 30K-2, 3, 4, and 5

These were all intended for commercial service. There were some users who wanted to be able to communicate between different locations independently of the telephone system. One example was the Corps of Engineers who controlled the water flow through dams. All they needed was a day and a night frequency. These transmitters were crystal controlled with two sets of tuned circuits. Relays were used to switch the tuned circuits from one frequency to the other. They used single-ended pi-networks for the RF output networks. As I remember, most of the differences between models were related to methods of remote operation.

Concluding Remarks

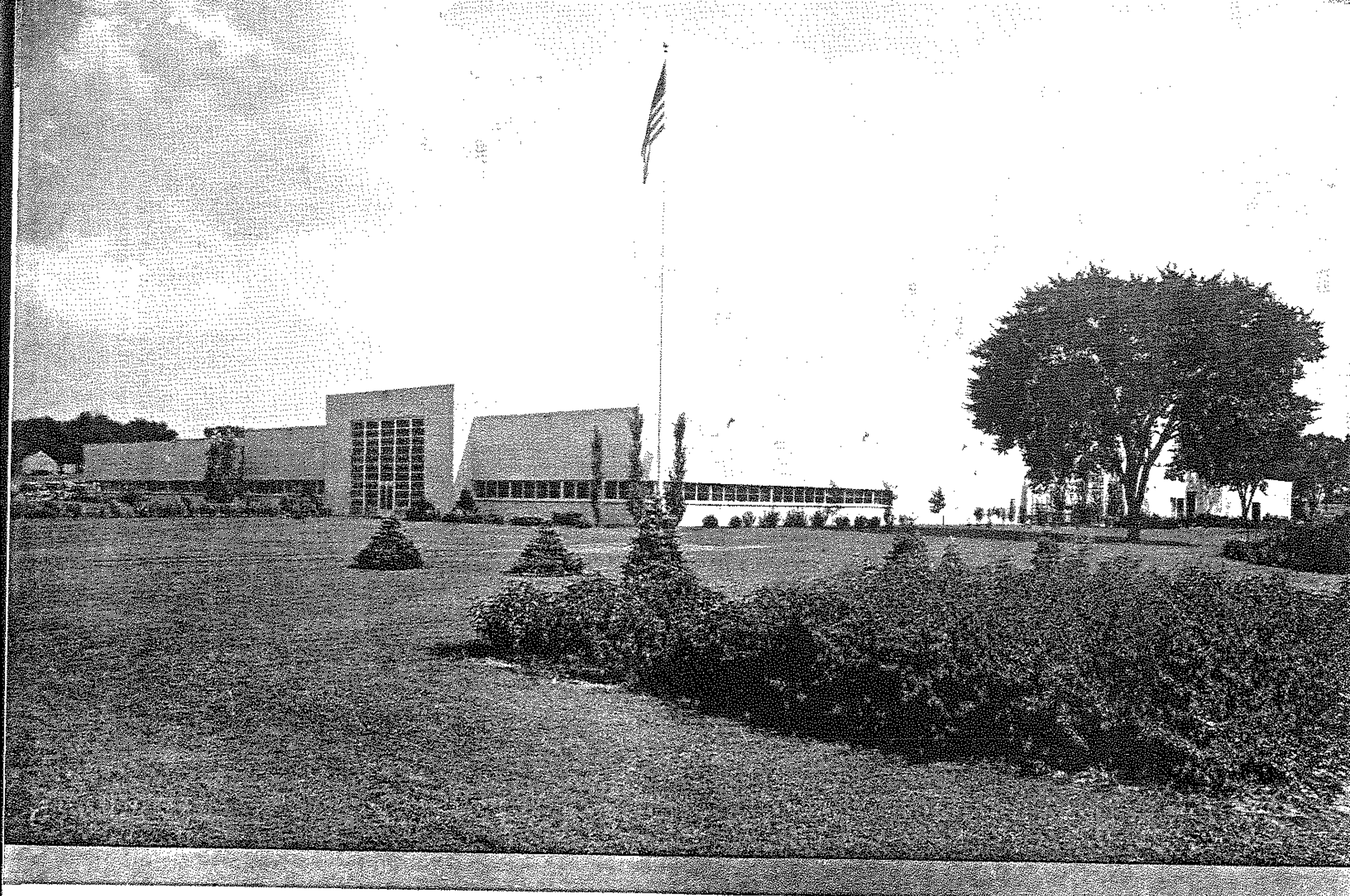
It was fun working on the development of this transmitter. The Company allowed us quite a bit of freedom to use ingenuity in our designs. Most of the engineers at Collins were hams and they frequently stopped by to see how it was coming. I had lots of free advice. My office mate was Lou Couillard who was developing the 75A receiver at the same time. A color photograph of the 30K in the laboratory appeared on the cover of the November issue of *RADIO NEWS*. Clyde Hendrix, WØHBG, came to Cedar Rapids to personally take delivery of serials No. 1 of the 75A and the 30K with the 310A exciter. Years earlier he had purchased a Collins 30FXB when the company was just getting started. ER

A 1927 TNT Oscillator from page 33

tude of RTTY signals. My final score showed 30 valid exchanges and two QSO's with fellows who were simply curious. I think the chirpy, raspy TNT signal was a success. Several people commented on it - N2EZ said it was the lousiest signal on the band! Hooray! Halfway through the contest, I loosened the antenna coupling slightly, dropping the output to 2.5 watts. This seemed to steady the signal a bit. I feel that the project was a complete success except for one thing - I didn't receive a single OO (official observer) notice! Maybe next year I'll short out the filter choke! ER

References

1. ER #82, Feb. 1996
2. ER #83, March 1996
3. Old-Timer's Bulletin, Antique Wireless Ass'n, Dec. 1987



The Collins main plant in Cedar Rapids is a modern, completely air and light controlled structure, containing 150,000 square feet of floor space. It is designed for the most efficient office, engineering and manufacturing use. The Collins management, organization and equipment are devoted entirely to the designing and production of radio communication equipment.

7M 8-46 Printed in U.S.A.