To save tubes was one object of this design, using tuned radio frequency instead of a superhet circuit. New multivibrator sweep circuits save 3 tubes and simplify construction. Good image reception was demonstrated 35 miles away from the NBC transmitter in New York.

The 10-Tube “R & T” Television

- The television receiver illustrated is one of the lowest cost televisions which can be turned out by the amateur, experimenter or serviceman and yet produce satisfactory and reliable results. This television attachment can be made at a cost of about $50.00 (including 3 7C-13 tubes and 10 amplifier, oscillator, rectifier and detector tubes).

- Choice of Picture Tube. In deciding upon the picture size, the 1" and 2" microscope tubes were considered, but it was decided that the 3" tube was the minimum size which would be tolerable to the viewer. The author has spent enough hours viewing programs on green-screened tubes to be quite sure that nothing other than a white screen will do. Accordingly the RCA Kinescope 9CC-P4 3" CRT tube was chosen as the picture tube and the receiver built around this tube.

- Choice of Sweep: In the technical bulletin which accompanies the 9CC-P4 Kinescope there is given a circuit diagram of a synchronizing pulse amplifier, followed by suitable sweep circuits using type 884 Rectifiers as oscillators and type 626's as amplifiers. A power supply using two 81's is also shown. These circuits are carefully designed and very satisfactory. In the interest of

- The final design of the T.R.F. receiver has the C.R. tube mounted horizontally, as photo below shows.
Receiver

maximum economy, however, the authors experimented with various other sweep circuits and power supplies. It was found that the multivibrator type of sweep circuit using two 685-D tubes as shown in the circuit diagram gave very satisfactory results, and a power supply using one 6L6 tube and using less filtering as shown was found to operate satisfactorily. These tubes are thus eliminated, to the interests of economy, from the number required in this portion of the circuit.

Kinescope Circuit Controls: The constants given in the parts list and the circuit shown here are followed carefully it will be found that the aspect ratio is correct and that the vertical and horizontal oscillator frequencies can be brought into synchronization with the transmitter by using the controls provided. It will also be found that the range of the vertical and horizontal "centering" controls is ample. The chokes shown are essential to preserve linearity of the sweeps and thus prevent compression of the picture at any of its edges. If for any reason it is desired to change the sweep frequency beyond the range of the controls provided, alter the values of C32 and/or C35. To adjust the aspect ratio, alter (Continued on page 475).

Photo at left, below, shows another rear view with C-R tubes removed. Right—A bottom shot.
10-Tube "R & T" Television Receiver

(Continued from page 461)

R36 for the horizontal size or R37 for the vertical size. Potentiometer R34 is the horizontal sweep frequency control, R41 the vertical; Potentiometer R49 is the brilliance control; Potentiometer R46 is the focus control. The brightness or brilliance of the picture is controlled by the grid bias on the video amplifier stage. It will be noted in the Kinescope section of the power supply diagram that the positive is grounded and that the Kinescope cathode is connected in series with the voltage divider resistance chain, thus making the grid more negative than the cathode and so supplying the bias. Some positive potential from the low voltage power supply is put on the centering point where the picture almost fills the screen. The clipping of the sync pulses from the modulation signal is done in the circuit tied to the grid of the sync amplifier. The bias is automatically maintained at a high enough value to keep the tube at "off" for the modulating signal, but low enough so that the sync pulses are amplified by the tube. One half of a 6L6 is used to supply the sync pulse system with detected signal of the correct polarity. It will be noted that this half of the 6L6 is connected in the opposite direction from the one supplying the video amplifier stages. Each half thus supplies the correct polarity of detected signal to its own load. Reversing the picture

controls so as to increase their range. The focus control varies the potential, which is positive with relation to the cathode, on Anode No. 1 in relation to Anode No. 2, which is grounded, and therefore at maximum positive potential with respect to the other electrodes in the Kinescope.

Synchronizing impulses are fed to the sweep from the synchronizing amplifier 1832, pentode through condenser C29 and C29, C30 has a high resistance to the vertical (or low) frequency pulses while C29 lets them through easily. These synchronizing pulses are of the correct polarity and of sufficient strength to trigger the sweeps strongly and hold them in perfect time with the transmitter. The sync amplifier was designed upon to assure a "rock-steady" picture and it certainly does its job. The set holds itself, even when the gain controls are turned down to the

detector would give us a negative image on the kinescope screen, like a photographic film. If one or three video amplifier stages had been used instead of two, it would have been necessary to connect the picture detector in the opposite direction.

Getting a Picture: Once the Kinescope is triggered with power, the proper sweep circuits are connected to its deflecting plates and these triggered by suitable synchronizing pulses, a raster sweep pattern will appear on the screen. It will be possible to control the brightness of this raster and to swing it from the center (441) to the horizontal lines of which it is composed in order to have a picture appear; however it will be necessary to supply a modulating voltage to the grid of the Kinescope, which will cause the brightness of the scanning spot to increase or decrease as it moves thus painting a picture for us. This modula
The tube chosen to reproduce this linearity was the 6AU6. This tube was selected because of its high gain and low noise figure, and because it is a direct replacement for the 6AU5 which is commonly used in linearity applications. The 6AU6 was found to be slightly noisier than the 6AU5, but this increase in noise was more than offset by the increased gain of the 6AU6.

The biasing of the 6AU6 was done with a simple DC voltages, with the plate bias set at 100 volts and the grid bias set at -5 volts. This biasing was found to be adequate for the application, and no further adjustments were necessary.

AC Coupling

AC coupling was used in the input and output circuits of the linearity amplifier. This was done to prevent any DC offset from appearing at the output of the amplifier. The AC coupling capacitors were chosen to have a high enough capacitance to block the DC bias voltage, but a low enough capacitance to allow the AC signal to pass through.

The output of the linearity amplifier was coupled to the input of the video amplifier with a 1000 ohm resistor. This resistor was used to match the impedance of the linearity amplifier to the input impedance of the video amplifier.

The video amplifier was a 6AV6, which was chosen because of its high gain and low distortion. The plate bias of the 6AV6 was set at 100 volts and the grid bias was -5 volts. This biasing was found to be adequate for the application, and no further adjustments were necessary.

The output of the video amplifier was coupled to the antenna with a 1000 ohm resistor. This resistor was used to match the impedance of the video amplifier to the input impedance of the antenna.

The antenna was a standard 300 ohm coaxial cable. The RF signal was fed into the antenna at the center conductor and the ground was fed into the shield. The antenna was mounted on a mast with a ground plane to provide a good ground return path.

The output of the antenna was coupled to the receiver with a 1000 ohm resistor. This resistor was used to match the impedance of the antenna to the input impedance of the receiver.

The receiver was a standard 1000 MHz preselector followed by a 10 MHz VFO and a 300 MHz IF amplifier. The 10 MHz VFO was used to set the frequency of the receiver. The 300 MHz IF amplifier was used to amplify the RF signal to a level that could be detected by the detector.

The output of the 300 MHz IF amplifier was coupled to the detector with a 1000 ohm resistor. This resistor was used to match the impedance of the 300 MHz IF amplifier to the input impedance of the detector.

The detector was a standard 10 MHz detector. The detector was used to convert the RF signal to an audio signal that could be heard.

The output of the detector was coupled to the speaker with a 1000 ohm resistor. This resistor was used to match the impedance of the detector to the input impedance of the speaker.

The speaker was a standard 8 ohm speaker. The speaker was used to convert the audio signal to sound that could be heard.
Tiny Tim Receives ‘Em All

(Continued from page 49)

Two of the new 1.4 volt tubes are used, as the diagram shows, and instead of using plugs to coin the coils are switched into circuit as required. The case measures 3 1/4 x 2 1/4 and may be built of aluminum. An insulated antenna terminal is mounted on top of the cabinet next to the carrying handle. As shown in the diagram, a LNS6 tube is used as the regenerative detector, and a 1A5C tube as the audio amplifier. A 1/2 meg. potentiometer, B2, controls the regeneration by varying the screen voltage on the detector. A standard type 4-pole, 5-position band switch is used which leaves room for experimenting with other coils. If the builder only desires to cover three bands, then he may employ a 3-pole, 3-position switch. The set covers from 15 to 35 meters in three bands; the first band covers from 15 to 28 meters, the second from 27 to 48 meters, and the third from 47 to 96 meters.

The tuning condenser has a capacity of 500 pf. and the A.F. coupling choke must be a standard iron core A.F. impedance, or it may comprise a small audio transformer (about three turns ratio) with the primary and secondary windings connected in series. Insulate the phone jack from the metal panel; the protecting fuse, if used, may be of the 2 1/2 volt, 61 ma. type. The A battery drain is very small or about 100 ma. In order to break the “B” battery circuit when the set is not in use, a double-pole, single-throw switch should be used so as to break the “A” and “B” circuits simultaneously. The antenna, about 3 feet long, can be made from three pieces of copper or brass tubing, sliding inside one another, and each piece may be 12” long. One of the new compact type 1.5 volt batteries may be used, with a Gilbert type 45 volt “B” unit—courtesy The Australian Electrical World.

If desired, the sides may use a larger size wiring coil so as to bring in the broadcast stations, and this coil may comprise 125 turns of No. 28 wire for the grid coil, and 28 turns of No. 18 for the tickler. Use a 100146 pf. tuning capacitor for this B.C. coil. Wound on 1/4” dia. form.

Correction Notice

In the last issue accompanying the article on “A.B.C. Wave Power Station” on page 499, all the September issue, the values of Resistors R1 and R2 were given as 300,000 ohms (1/2 watt each). This is incorrect: The right values are 395,000 ohms (1/2 watt each).
10-Tube "R & T"

Television Receiver

This second article describes the sound section, details of the aligning procedure, improvements in the R.F. circuits, details of the low and high voltage power supplies, etc.

- TAKING up the description of the R & T television attachment from where it was terminated in the last issue, we find that the radio frequency amplifiers, low voltage power supply, sound section and antenna installation remain to be considered.

The design of radio frequency amplifiers of suitable characteristics for use in television, and which can be readily switched from station to station, is not practical. None of the manufacturers of television sets or kits has placed on the market a T.R.F. receiver for this reason. In England, however, where the London station was the only one in operation (since shut down because of war crisis and no others were likely to be put in operation) many T.R.F. receivers were on the market in the lower price ranges. Since the builders of the television described in this series are unlikely to be lavish in its expenses it was decided that the use of plug-in coils would be a possible solution of the problem. You will, we hope, not consider the plug-in coils a hardship, since using them enables you to hold down the cost of the outfit by making use of homemade coils. It would be difficult to make suitable coils in the case of a super-lux but it's

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Associate Member, A.I.E.E.

Assisted by Jerriar Haddad

easy with a tuned radio frequency set.

The de-coupling R-C filters shown in plate and screen circuits are of great importance. The tendency of R.F. amplifiers to oscillate when operated at these high frequencies with such high gain pentodes as the 1852 type tube is positively amazing. This tendency, even at high settings of the gain controls, is absent in this design. If the experimenter should decide to change the mechanical layout, he must be sure to keep the various R.F. coils as “un-coupled” as possible. Keep the coils far apart and at right-angles to each other. Both stages of R.F. have tuned plate circuits, as this increases the gain far above anything which was found possible with plate resistors. As a matter of fact, it was found possible to sacrifice some of the gain by putting resistors across the tuned circuits, thus increasing the band of frequencies they pass (don't forget the television video carrier, plus modulation, is 4 mc. in width) and therefore the detail on the picture. The value of this broadening resistor is not critical; the value specified worked fine at 35 miles ari-line from the transmitter. It might be possible to improve the range somewhat by not using any resistor in this position thus increasing the sensitivity; the tendency to oscillate would be increased, however, so watch it. A still lower value of resistance in localities having high signal strength might be used with a slight improvement in picture detail. The first stage has tuned input for maximum efficiency, due to better impedance matching to antenna circuits. The second stage uses a grid resistor input. This arrangement was found to operate as well as tuned input, at the same time reducing the number of tuned circuits and the chances for feed-back. It was found desirable to use a separate gain control on each stage, because in this way they can be adjusted independently. Using the same control for both involves the use of a complex decoupling network, and

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10-Tube "R & T" Television Receiver
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power supplies

The low-voltage power supply is conventional except that it is somewhat better filtered. Hum spots are exception at levels which would be inaudible in a sound receiver. The best parts are used here because the voltage fluctuating is due to the fluctuating load imposed by the scan. A power supply having poor regulation would cause a darkening of portions of the picture and also give it ragged edges. Looking at the high voltage supply for a moment, this type of supply, in which the positive is grounded, is standard oscillating group practice, but using a well filtered will introduce hum in the picture. Grounder the negative instead will reduce this tendency. If you have trouble on this source, be careful before you make the change. I have not tried this out and shall not predict just what additional changes might be needed in the rest of the set. A few are obvious, but I would not expect anyone missing even one, and so will not make any recommendations in this section except caution.

Antennas

Many antennas were tried at Monmouth Beach, N. J., where the author has a summer bungalow; indoor, simple dipoles aimed in all directions both low and high, the dipoles with reflector both low and high. It was found that the difference between one antenna and another was seldom startling. A simple dipole, low down and outdoors, was a little better than the same one indoors. Turning it laterally to the difference except in a very narrow beam at its side spots. Raising it a few feet, the 2500 ft. antenna worked very well. (It was shown in the photo last month.) Raising it to 45 feet made little difference in signal strength, but did reduce the already acceptable amount of automobile ignition interferences somewhat. Adding a reflector to it further improved the signal-to-noise ratio. With the antenna, the interference from strobe lights was entirely eliminated except for the infrangible traffic passing directly in front of the bungalow or parked in front of it while making deliveries.

"Sound" Section

Now for the sound section. This was, believe it or not, one of the biggest headaches in designing the set. The design presented herewith should not give anyone any headaches, however, as it is not critical. We started our experimental work by getting on the wrong track right away. Since this was a television set at heart, we figured on trying to use an ultra-short wave converter as the sound section and feed this into the antenna and ground posts of a standard broadcast receiver. This method had worked well in connection with the article "Television Experiments with a Servicing Oscilloscope," which appeared in Radio-Craft, August, September, 1939. But putting the converter on the same chassis as the radio set proved to be a horse of a different color. It didn't work out at all, because the oscillation in the converter caused upon getting mixed in with the picture, creating some very beautiful patterns but making simultaneous operation out of the question. The sound worked well alone but was useless because it obliterated the picture. We decided to try one stage of F.C.E., followed by a detector, this to go to the phono input connections on a standard broadcast receiver. We used the same R.F. circuit which had earned out on the vision end and a triode detector circuit suggested by amateur C. E. Sharpe of nearby Portsmith, N. J. This worked immediately and the addition of an R.C. filter in the detector plate circuit took the last "bug" out of it. The diagram and parts list are self-explanatory. Radio-croons 652 and 615 are used, the 1852 as F.C.E. amp., the 605 as bias type detector. The sensitivity and selectivity proved more than adequate. The addition of an conventional A.F. stage and speaker would take the whole basket out of the television attachment class and make it a complete television. The Bidyn, Tech. Television Club is building the sound section, complete with A.F. to go with the silent telly set assembled last year, and we'll be able to report on it as soon how it worked soon. The coil information is found in an accompanying diagram.

The B voltage and other voltages are obtained from the low-voltage power supply of the video set—the reason it must be able to "rive," without complaining or suffering, large voltage regulation. The mounting of the parts of the sound section is shown in the accompanying photographs and drawings. If the layout is changed, take care not to get the sound section too near the scan oscillators, as there is a tendency for these to cause noise in the audio. If the complete sound section is made, take care not to mount the loud-speaker near the 1852 vision R.F. tubes, as they are somewhat microphonic and you will produce broad bands of varying width which will move down your picture. It is preferable to mount the speaker in a separate box.

Since the frequencies which television transmission use are in the ultra-high frequency spectrum, the behavior of newly constructed receivers is likely to be erratic and unpredictable. The specifications which are given her are essentially for coils and those used lumped constants are, therefore, likely to be incorrect when the same circuit is used by another person. A few words of advice gleaned from practical experience will help you in "shooting" the trouble. If either the sound or video does not, at work properly and it is found, after very careful rechecking of the wiring and measurement of the various voltages, that no signal comes through, the best thing to do is to use a good Signal Generator, like the Supreme Model 582 shown in the photograph, as a source of "rule" signal. The use of the signal generator eliminates the antenna, lead-in and television transmitter as possible sources of trouble; it also provides, in many locations, a stronger signal than is available from the antenna. Set the generator so that one of its harmonics falls on what is approxi.
mately the television frequency.

The signal generator is used on the third or fourth harmonic. When operated in the wide-open output position it supplies enough output to permit you to tune each stage and section of the receiver. One of the photos shows the bar pattern obtained on the kinescope screen from the signal generator set at 15 MHz, whose third harmonic is 45.25 and with the 400 cycle modulation cut in. Another photo shows pattern obtained without modulation but with signal generator tuned. 5% off frequency. Since even 1% is a lot at these high frequencies, it is best to calibrate or make a mark on the scale of the signal generator at the exact point, by operating it near a television which is properly tuned to W2XBS and adjusting it in until the bar pattern is strongest. This was found necessary. A single stage R.F. amplifier in conjunction with the signal generator will help a lot, too, because you want plenty of output in lining up a new set, so that you can get something through no matter how badly off time you start out. This R.F. amplifier is to be described in an article at a later date.

The coils for the tuned circuits should be re-ground, adding a turn and then, if not successful, taking a turn off the original specified number. If the trouble has not yet been found, it may be that the distributed constants of one tuned circuit are different from those in the following or preceding circuits. Suspecting this, add a turn to the coil whose circuit leads are shortest and/or take a turn off the coil whose circuit leads are longest. Care should be taken, in deciding upon the correct number of turns, that the trimmer condenser setting for the maximum signal does not fall on either the all-in or all-out position of the trimmer. If the procedure outlined above is followed patiently it will be found that you have, more than likely, corrected the trouble.

In designing the video receiver herein described, a well considered guess was made as to the number of turns to put on the coils. From experience we found that six turns was exactly right for our particular layout. Since the sound carrier frequency is higher than that of the video (40.75 mc, as compared with 45.25 mc, one turn less was used on the coil of the sound section of the set. This, too, was found to be correct but it was much more difficult to line up the sound section trimmers, because of the comparative narrowness of the audio modulated carrier and due to the great selectivity of the circuits. Careful tuning, however, was all it took to get this section working.

If the builder will take care to have all of his tuned circuits the same distance from the tubes and have his wiring of such R.F. stage as nearly identical as possible, the problems discussed above will be greatly simplified.

The R-C filters provided for the purpose of coupling the various stages from their power supplies should be enough to prevent any circuit from breaking into self-oscillation; should oscillation be found to take place, however, due to changes in layout, etc., coil shielding may be used. The shielded, found unnecessary in our layout, must be as large as possible and identical for each coil. The only remaining "out" of oscillation still persists is to decrease the gain of the stage in question by increasing the cathode resistor, or by introducing degeneration by returning the cathode bypass condenser to the tap on the bias resistor. The tap should be approximately 10% of the way down from the cathode, with the bottom end of the condenser grounded.

The sound unit was designed with no gain controls because the volume can be controlled on the sound receiver which is used in conjunction with this "telly" attachment.

If the signal is much too strong, increase the value of the bias resistor in the sound R.F. stage. A shielded cable should be used from the sound unit 6J5 Ratiotrons to the audio amplifier, which may be the phono end of any broadcast receiver. If care is taken in adjustment and construction, high fidelity sound programs will result. If, instead of feeding the output to an audio amplifier, the builder uses a sealed contained set, the least troublesome line-up to follow the 6J5 Ratiotrons would be a 6CS triode driver followed by a 6F8 pentode power amplifier, the author believes.

Resin core solder should be used, and all connections wiped clean. Flux should never be allowed to stay on a connection as it causes corrosion and also a high resistance ground at high frequencies.

An oscilloscope can be used in conjunction with the signal generator if desired, though this is not necessary because, provided your low frequency work is O.K., the kinescope will serve to indicate circuit conditions very well. The oscilloscope is most valuable in the low frequency end of the set, testing the scan oscillator, tracing down hum, etc.

Final setting of the trimmer should always be made on the test pattern and sound. You want the setting that gives you the best picture and clearest sound. Of course we all have "thugs" like SCA, Philco, Du Mont and others, we would not suggest lining up on the signal—but under the circumstances we found it the only way to get the best out of the set.

I wish to acknowledge again the good work of Jerrier Huddal, who did all the (Continued on opposite page)
construction work, and Andy Tait, who put up the final antenna. I also want to express my appreciation to radio amateur C. E. Sharpe for his suggestion on the detector and to Engineer Harry Zion for his suggestions.

Parts List—Sound Section

CORNELL-DUBILIER (Condensers)
4—0.01 mf, type DT6S1 (paper); C1, C4, C5, C10
3—25 mf, type DT6P25 (paper); C6, C8, C9
1—0.001 mf, type 5W-371 (mica); C7

HAMMARLUND MFG. CO.
2—25 mmf, air damping condensers, type APC25; C2, C3

INTERNATIONAL RESISTANCE CO.
(Resistors)
1—160 ohm, type BT-1; R1
1—5,000 ohm, type BT-1; R2
1—60,000 ohm, type BT-1; R3

Coil Data
L1, L2—5 turns of No. 14 wire on 3/8" dia. form, spaced one (wire) diameter (No. of turns varies with hook-up).

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