SPECIAL TELEVISION NUMBER

RADIO NEWS AND SHORT WAVE RADIO

SHORT WAVE TIME TABLE

MAY

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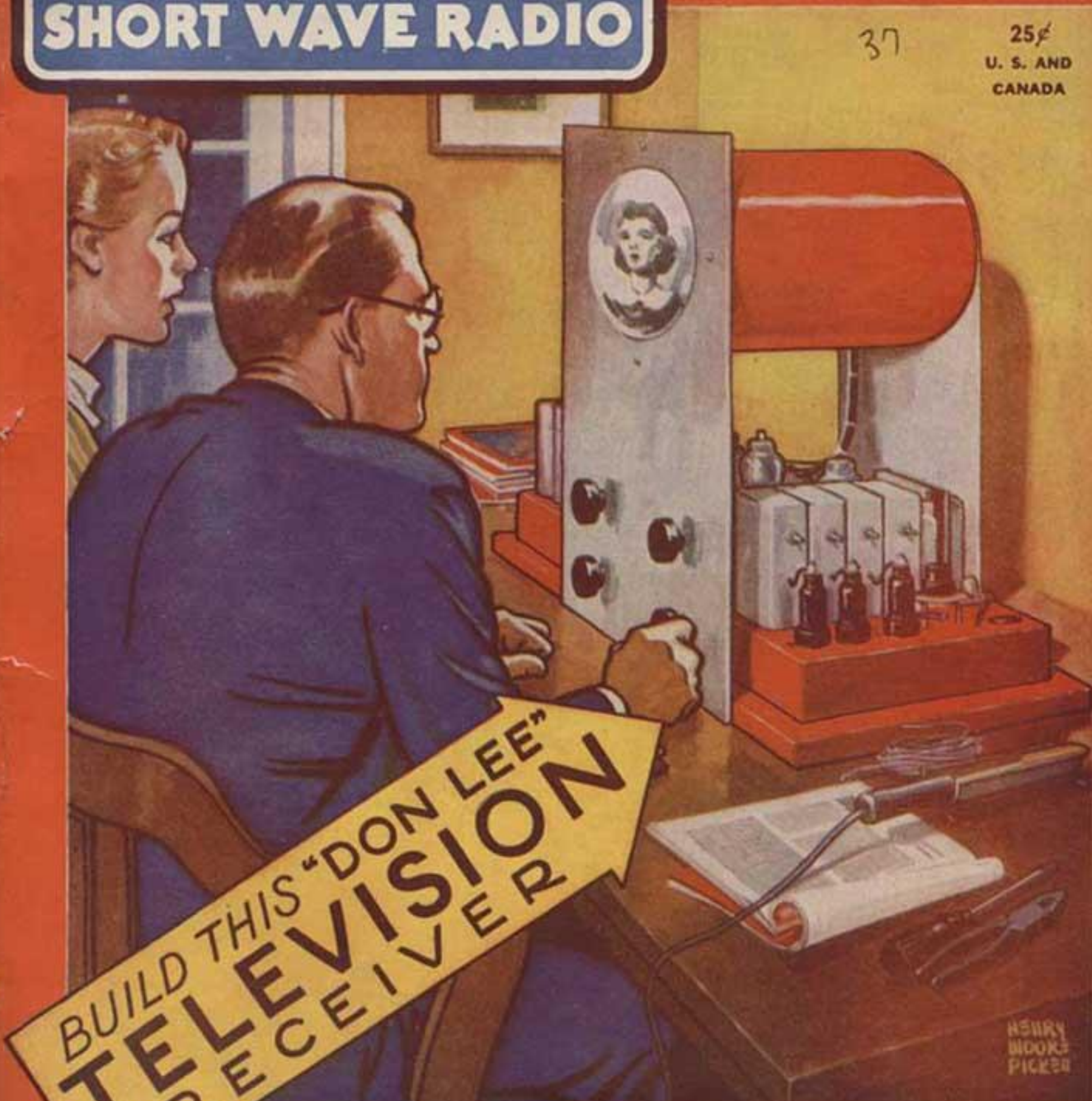

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Radio News

May, 1937

Build This DON LEE TELEVISION *Receiving Set*

Here is the first chance presented to the television experimenter and amateur to build a really modern cathode-ray television receiver from a carefully tested and authorized design and from plans that are complete, so that the builder can make one and know that it is actually workable

By the **Don Lee Television Staff**

IN common with all high-definition television transmissions, a receiver for displaying the images must tune very broadly as compared to the usual communications type receiver used for receiving voice and music transmissions. A high intermediate frequency must be employed in a television receiver and band-pass transformers used to provide sufficient band width. In the "audio" section of the television receiver, abnormally low values of plate resistors must be used and great care exercised to keep the stray capacitance of wiring and components to a minimum.

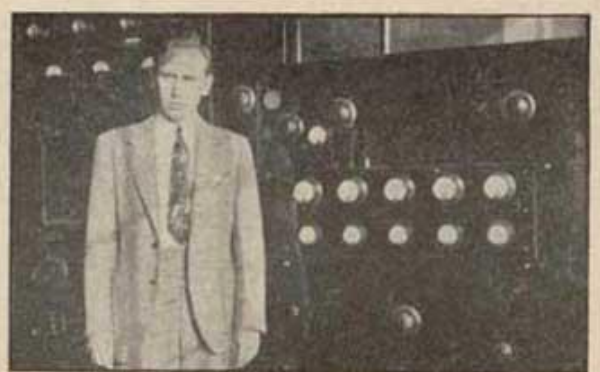
Circuits Given

The diagram of the Don Lee receiver described here in detail is shown in Figure 1. It is of the television superheterodyne type embracing the design features set forth above. The antenna is indicated by the tubing at the upper left, separated in the center and connected to L1. The separate lengths of the tubing should be 63 inches long and ¼ inch or more in diameter. They should be joined mechanically by an insulator 2 or 3 inches long. The leads running from the antenna to L1 indicate a length of 70-ohm cable, known as "EO1," or the rubber-covered parallel pair feeders known as the Lynch "Giant Killer" Cable. It is desirable that the feeder should extend perpendicularly from the antenna for 5 feet or more. The antenna end of the feeder is fanned out for 6 inches and one conductor attached to each 63-inch length of the antenna. The receiver end is brought in through insulating bushings to the 1 to 2-turn coil, L-1.

MOVIE STAR "KNOWS HIS PICTURES"

Robert Montgomery, the popular screen star, said, when he and Mrs. Montgomery witnessed the television demonstration as the guests of Harry R. Lubcke, director of television for the Don Lee Broadcasting System, "I am surprised at the results. . . . The present exhibition is a great advance over one I attended a few years ago."

The first resonant circuit, L2, C1, should be of "high-loss" construction; that is, no effort should be made, as is usually done, to keep the coil away from shielding, or use the best quality variable condenser. The radio-frequency resistance of this circuit *must be considerable* to insure that the high-frequency components of the wide image sideband will not be attenuated. This can be accomplished by using components of ordinary quality or by shunting a fixed resistor across the circuit. The components should be mechanically excellent, but the use of bakelite coil forms, bakelite pieces for coil support, and condenser end plates, is definitely allowable. This circuit, with vacuum tube VT1, com-



THE TELEVISION TRANSMITTER AT W6XAO

Harry R. Lubcke is shown standing in front of the W6XAO television transmitter that operates on 45 megacycles (6⅔ meters) which transmits high-definition images daily in Los Angeles, California.

This article gives all the necessary information for building a complete television cathode-ray receiver. The set is constructed of standard parts and represents a simple combination that can be put together by any amateur or experienced set builder. The design was made, built and tested by the staff of the Don Lee Broadcasting System. The design is a practical one

prises the superheterodyne first detector or converter. This is housed in the first dark shield can shown in the front left of Figure 3. The porcelain lead-through insulator at the left supports coil L1 and provides external binding posts for the incoming feeders. The upper of the two knobs is the tuning control and comprises the shaft and variable condenser C1. This is one of the front-panel knobs. The knob directly below it is the volume control, comprising resistor C7 in the circuit of Figure 1. Behind the first shield is the oscillator shield, and condenser C15 of this circuit is ganged with condenser C1. This is accomplished by an ordinary shaft coupling.

These two shields are preferably made of copper, with as few joints as possible to give good shielding at ultra-high frequencies. They may be chromium, but not cadmium plated, if desirable. Cadmium plating is satisfactory for the chassis in general and aluminum shield cans may be used elsewhere. Copper shield cans with chromium plating are an extra refinement. The remainder of the circuits of the converter VT1 and oscillator VT7 are more or less standard. Oscillator coil L2 is placed over (surrounding) the grounded end of coil L11. No difficulty should be encountered in securing ultra-high-frequency oscillation with this circuit.

Coil condenser combinations C3, L3 and C4, L4 complete the band-pass intermediate-frequency transformers. These should also be of "high-loss" construction. Bakelite coil forms and small wire are specified, while the condensers may have bakelite end insulators, and may be of the mica compression type. The

AN "ACTUAL" PHOTOGRAPH

Unretouched photo of the television image received 3½ miles away from the transmitter under home receiving conditions. The picture was taken with an ordinary Eastman folding pocket Kodak with a comparatively slow lens of F6.3. The subject is a member of the American Legion and a few folds of the American flag show in the background.

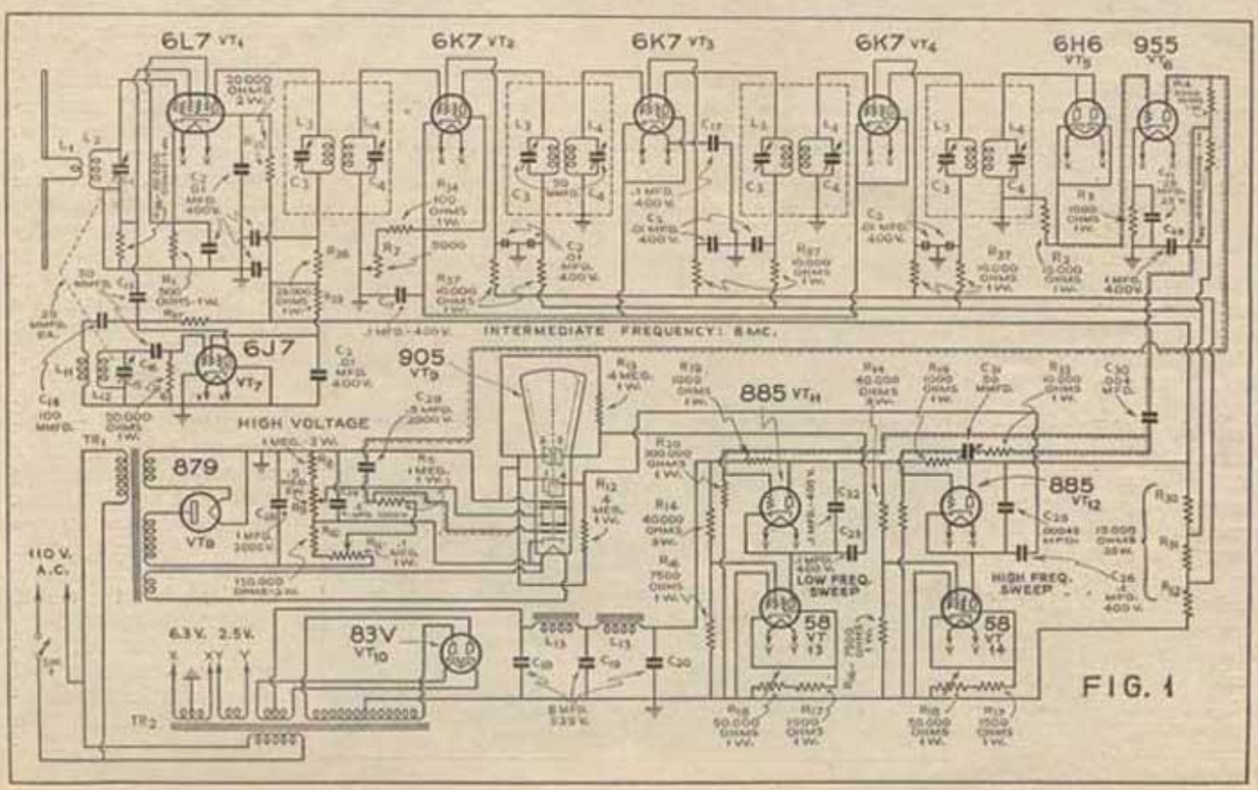
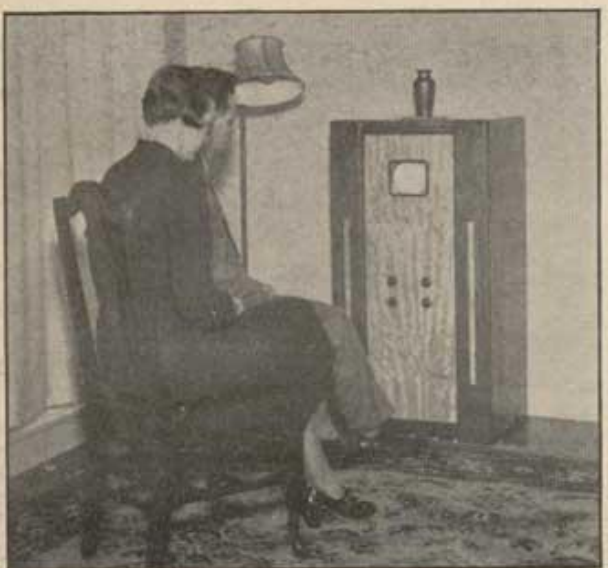
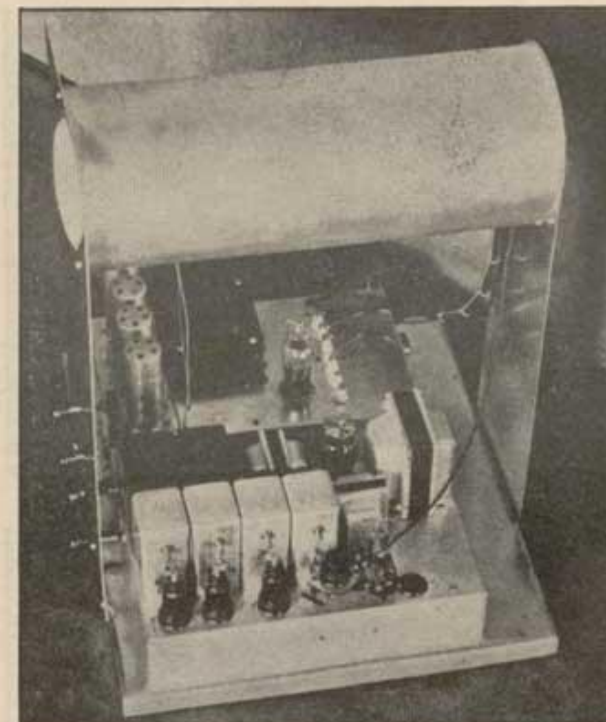


FIG. 1



THE COMPLETED "SIGHT" RECEIVER

An exclusive photograph of the Don Lee receiver, described in this issue, shown in use in a private residence and used for checking transmitted air programs.

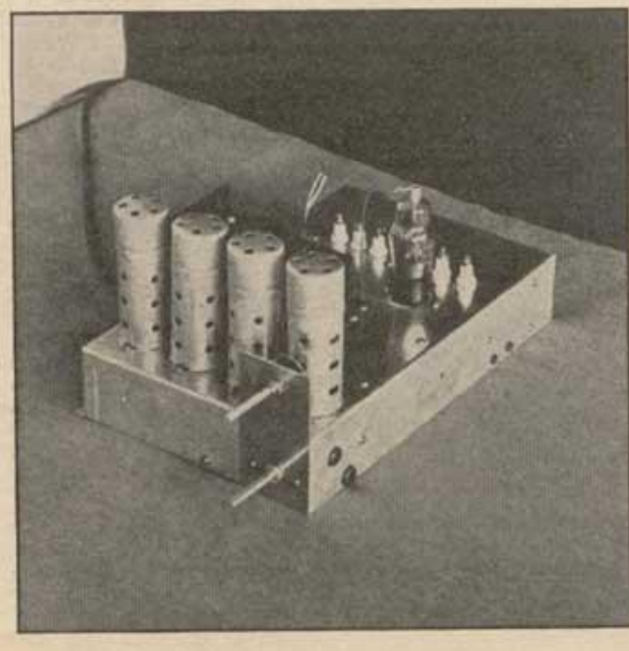


THE COMPLETED CHASSIS

Figure 2. The superheterodyne and low-voltage power supply are shown in the foreground, the sweep circuits and high-voltage power supply are in the background with the shielded cathode-ray tube above.

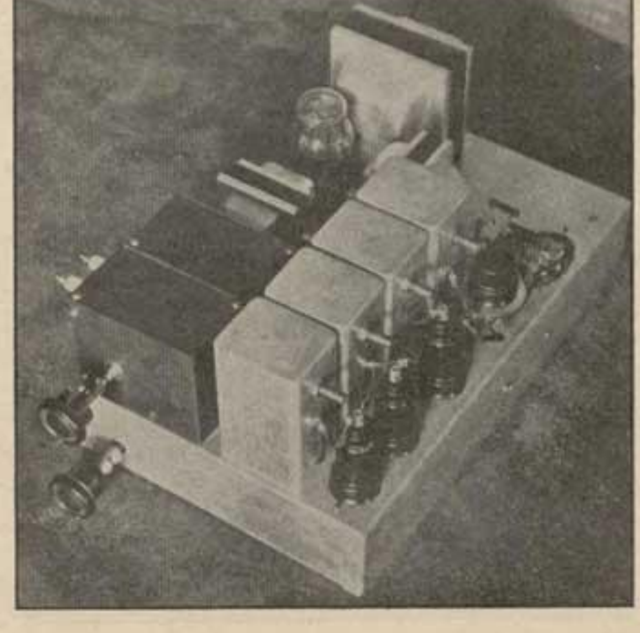
intermediate-frequency transformers are shown as the row of rectangular shield cans down the center of the chassis in Figure 3. The three 6K7 intermediate-frequency vacuum tubes are shown to the right of the several stages. It is not necessary that the arrangement shown be strictly adhered to. Increasing the space between shield cans and placing a tube between each one, or a staggered arrangement of shield cans and tubes is satisfactory. The diagram shows three stages of intermediate-frequency amplification, indicated by tubes VT2, VT3 and VT4, with the associated equipment. This amount of amplification is satisfactory where a moderate or strong signal is available, such as a hillside or unobstructed line of sight location on level ground, using an antenna 25 or more feet above surrounding objects. Where these conditions cannot be met, an additional stage of intermediate-frequency amplification is recommended. The addition is accomplished by merely constructing and installing another tube, VT3, another intermediate-frequency transformer, C3-L3, C4-L4; a socket, shield can, two isolating resistors, R37, and two by-pass condensers, C2. The adjustment of the several condensers, C3-C4, of each stage should be available from the outside, and they should be adjusted to give the best detail while looking at the image.

VT5 is a diode second detector, the output of which appears at the right-hand end of resistor R2. It will be noted that this (*Turn to page 694*)



THE SWEEP CIRCUITS

Figure 4. The chassis for the sweep circuits and high-voltage power supply are contained on this chassis. The cathode-ray tube adjustments are located on the rear.



THE RECEIVER PROPER

Figure 3. The superheterodyne receiver and low-frequency power supply. The high-frequency circuits are housed in the two darker copper shields and the intermediate-frequency circuits in the four bright cans.

The DX Corner (Broadcast Band)

(Continued from page 669)

in the background. Shifting antennas brought in WFAA on this frequency. Our east antenna brought in WTBO with an R9 signal, while our south antenna would bring it in R6-7, but would bring up WFAA so that we could easily log the latter. Using the west antenna, WTBO dropped to R5 and WFAA to R3, thus providing an opportunity to bring in other signals on this frequency."

Observer Gordon uses a three-stage battery-operated preselector ahead of a Philco '34 seven-tube al-wave receiver. He finds that the preselector gives him a great increase in sensitivity and selectivity. He likewise has a distinct advantage in that there are no power lines or telephone lines within 2½ miles of the house.

Sounds like a close approach to a DX'er's Paradise to us.

Don Lee Television

(Continued from page 651)

resistor has a value of only 15,000 ohms. This resistor in the usual communications type receiver would have a value of perhaps one-half megohm. The low value here used is necessary in order to nullify the reactance of the unavoidable capacitance of the "high" side of the components and the "high" wiring to ground. It will be noted that the lead from R2 to the grid of VT6 is shown as a solid line, with a dotted line adjacent to it. This is to indicate that this lead, as well as others to follow, should be run in a direct manner, and as far away from the chassis as possible, so that its capacitance to ground will be small. The short metal tube in front of the last intermediate-frequency transformer shield can is the diode, and it will be noted that it is above the chassis by 1¾ inches. This is for the purpose of reducing the capacitance of the wire to ground.

Similarly, the acorn triode, VT6, is elevated above the chassis. In this circuit the plate lead to the high end of resistors R4 and R40 and the associated components must all be located as far from grounded objects as possible. Condenser C12 and resistor R5, coupling condenser and grid leak for the cathode-ray tube respectively, can best be located adjacent to the grid terminal of the cathode-ray tube rather than immediately adjacent to VT6. The lead from the junction of resistors R4 and R40 to the synchronizing circuit condensers C30 and C31 and resistor R33, which comprise the synchronizing circuit, and the leads to the grids of the vacuum tubes VT11 and VT12 of the scanning sources should be of low capacitance by being short and by being removed from ground as far as convenient.

The glass tube in the rear of the chassis of Figure 3 is the 83-volt full-wave rectifier. Directly behind it is the power transformer TR2 and the chokes L13, associated with the low-voltage power supply shown in the lower left-hand corner of Figure 1. This power supply operates the television receiver and the two scanning sources.

The simple type of gas triode sweep-circuit oscillator, with a constant-current pentode as a plate resistor, has been used in the interest of simplicity. The high-frequency and low-frequency sweep circuits are alike, except for the value of condensers C22, C25, C23 and C26. Resistors R18 in each circuit vary the frequency. These two controls are front-panel controls, for adjusting the lock-in of both the low and high-frequency sweep circuits.

The components C30, C31 and R33 convey energy from the output of the receiver amplifier through circuits particularly suited to synchronize the low- and high-frequency sources.

Transformer TR1, rectifier tube VT8, condensers C28 and C29 and resistor chain R8, R9, R10, R11, comprise the high-voltage power supply for the cathode-ray tube. This is essentially standard cathode-ray tube practice. However, it is notably different from ordinary receiver tube practice in that the *plate* of the cathode-ray tube is grounded and the heater cathode and grid of the cathode-ray tube are the *high-voltage* leads of the device. These must be treated *with respect* in installation, and *not touched when in operation!* These leads are some 2000 volts "below ground" potential, but whether or not such a lead is "above" or "below" ground potential by a large amount makes no difference in its ability to give a severe shock. It is improbable that there is sufficient energy in the equipment to produce fatal results unless the subject should die of fright. Consequently, if the circuits are accidentally touched, attempt to minimize the effect in the mind, which should tend to put the person in the best condition. (It is to be understood that the Don Lee organization incurs no liability of any kind in connection with such accidents or in any other matter, because of the information furnished herewith. Such information is furnished free for non-commercial use and no patent or other license is granted or may be inferred.)

Figure 4 shows the sweep-circuit, high-voltage, power-supply chassis, with gas triodes and accompanying pentode resistor tubes shown in alignment at the front end of the chassis. Behind them is transformer TR1, rectifier VT8 and porcelain lead-through insulators, which carry the high voltage to the cathode-ray tube. Condensers C28 and C29 are below the chassis. Resistors R18 are shown on the small panel at the front right of the chassis. On the rear of the chassis are located controls R9 and R11, which control the focus and intensity of the cathode-ray tube respectively.

Figure 2 shows the completed receiver. The curving black lead in the foreground, from receiver to the rear of the cathode-ray tube shield, is the output "high" lead which goes to the grid of the cathode-ray tube. The cable leads in the rear which also enter the rear of the cathode-ray tube shield are the cathode-ray voltage supply leads. It is desirable that the cathode-ray tube be mechanically, electromagnetically and electrostatically shielded. To accomplish this, a piece of 6- or 7-inch diameter stove-pipe is suitable for a 5-inch diameter tube. In the receiver constructed, this shield, the two supporting panels and the bottom shelf were cadmium plated. This presents a pleasing appearance, regardless of the lowly origin of the stove-pipe.

The mechanical arrangements shown in the photographs do not have to be rigidly followed. Several rules of construction must be observed, however, and these are given herewith. Most important: power transformers and chokes should not be located closer than one foot from the cathode-ray tube, particularly if near the rear end thereof. If located closer, the stray magnetic field from these devices deflects the electron beam directly by the mechanism of the electromagnetic deflection and an irregular vertical margin is found on both sides of the blank field of view of the cathode-ray tube, even if all signal circuit leads are disconnected therefrom. If it is desired that the tube and chassis be close together, the transformers must be located at the front of the tube near the fluorescent screen. All components may be located on one large chassis if these precautions are followed. Another allowable arrangement consists of locating the receiver and scanning sources on an upper chassis and the two power supplies on a lower, the latter being placed below the former in the cabinet.

Also, it is not necessary that metal vacuum tubes be employed. The corresponding glass types are suitable. *It is important that an acorn triode be used for VT6, however!* Another acorn triode connected as a diode may be used for VT5, if desired.

In connecting the cathode-ray, tube-deflection plates, the numbers on the diagram when viewed from the front of the cabinet are: (1) right rear; (2) lower front; (3) upper front; (4) left rear. When this arrangement is observed, the picture will appear right side up and printing will read from left to right.

The receiver is put into operation in the following manner: All connections having been made and checked, the power circuit is turned on by SW1. After about a one-minute warm-up period, a rectangle of light should appear on the cathode-ray tube screen. This should be adjusted by resistor R11 until it is of average brilliancy. If the resistor R11 is adjusted too much in one direction the rectangle of light will be extinguished; if too far the other direction it will be very bright and unsuited for displaying the television image. The neutral or blank screen should be of half-brilliancy so that the black portions of the picture will extinguish the cathode-ray spot and the bright portions carry it to full brilliancy. The resistor R9 controls the focus of the tube, and this should be adjusted until the scanning lines are most clearly seen.

With no signal being received, there should be no variation of intensity over the screen, except for a very slight darkening at the top, which is permissible. Any traveling or stationary variations of intensity having several dark and light horizontal portions, indicate the presence of alternating current hum. This might come from improper circuit connections or conditions in the high-voltage rectifier for the cathode-ray tube; hum in the output of the radio receiver or improper connection of the cathode and heater of the cathode-ray tube. It is usually found that connecting the cathode to one side of the heater gives less hum in the field than connecting to the other side. Whether or not the hum comes from the television receiver can be checked by removing the connection to condenser C12. If the horizontal variations of intensity disappear, the hum is in the receiver. As previously mentioned, irregularity of the vertical sides of the beam usually indicates deflection of the cathode-ray beam directly by transformers or magnetic field. This must be cured by further separation between these units and the cathode-ray tube. This type of interference might occasionally produce residual intensity variations of the field of view and give rise to the horizontal variations of intensity which are characteristic of power supply hum. A slight amount of such variation can be tolerated, since the incoming signal is much stronger and the variation is not seen, when an image is being received. When the receiver is properly constructed and adjusted, however, all hum will be removed.

After making the above adjustments without a television signal, the next step is to tune in the test signal of W6XAO. When this is properly received, it appears as 38 parallel horizontal bars in the field of view. In order to receive the signal, the several condensers C3, C4 of the intermediate-frequency transformers must be aligned. If necessary at the start, headphones (with a series blocking condenser) can be shunted from the plate of VT6 to ground and the weak signal, which will probably be received in any event, brought to maximum intensity by such adjustment, and the separate tuning condensers C1 and C15, which are best left free of each other in this preliminary adjustment. The intermediate frequency is 8000 kilocycles and the oscillator operates 8000 kilocycles above the incoming frequency. Its condenser, C15, will consequently be at a smaller capacitance than condenser C1 to bring this about. The setscrews of the coupling between C1 and C15 may be tightened when maximum signal is secured.

If fewer bars than 38 are received, the low-frequency scanning source is operating at *too high* a frequency and if more than 38 are received, it is operating at *too low* a frequency. The proper frequency is 24 cycles per second. The high-frequency source must operate 7200 cycles per second. With the low-frequency source properly adjusted, this is the point where the individual scanning lines just begin to merge into a solid field for the typical 5-inch cathode-ray tube.

The next step is to receive an image. With the high-frequency source "off" frequency, as it probably will be in this first adjustment, a great number of small black and white dots and dashes will undoubtedly be received. Vary the high frequency, adjusting knob R18 until this closes up to a single image. This is identified by a black bar at the right of the field of view and a single orderly representation of an image across the field of view. Preliminary to securing this adjustment, one or more images may appear slanting one way or the other, depending upon whether the source is adjusted to too high or too low a frequency. After proper high-frequency adjustment, it is possible that the image will be moving up or down. This is remedied by adjusting the low-frequency resistor, R18, until the image becomes stationary. Proper adjustment of both of these knobs should now make the image lock in step and continue to be displayed without further interruptions. It will be found with these simple types of sweep circuits that the natural frequency of the sources may tend to vary during the first few moments of receiver operation. Consequently, a few moments' warm-up period is needed. If the receiver signal is not sufficient to fully modulate the cathode-ray tube, the synchronization may not be secure and steps should be taken to increase the signal strength.

To bring the detail in the image to a maximum, the several intermediate-frequency condensers, C3, C4 should now be adjusted while examining the picture. The condensers C1 and C15 should also be checked as to over-all tuning adjustment and relation between the two as determined by the setting of the coupling.

If insufficient signal is secured, the addition of one or even two more intermediate-frequency stages is indicated. This is not difficult, because these stages are of low gain compared to the usual communications type, intermediate-frequency stage. For instance, the gain of the three stages, when properly constructed and adjusted for wide band pass, may not be more than one or two high-gain stages as used in usual short-wave or broadcast reception. The use of

(*Turn to page 697*)

Don Lee Television

(*Continued from page 695*)

a directional antenna is an excellent way to increase the signal strength and decrease the interference from automobiles or other sources, if this is required. This is accomplished by placing a parasitic reflector, consisting of one piece of ¼-inch diameter copper tubing, 11 feet long, 4 feet away from the antenna and on the side directly opposite to the television station from which it is desired to receive. This reflector is not connected to the antenna or any other metallic object in any way. It does not attenuate signals in a range of about 160 degrees in the direction toward the station to which it is aimed, but does reduce signals coming from the rear 200 degrees.

The ordinary 5-inch-size cathode-ray tube has been chosen for this receiver because of its low cost and availability. It is possible to employ any size tube with the receiver. The 1-inch or 3-inch sizes are not recommended, however, because the focus of the spot is not sufficiently fine to secure the proper detail in the present high-definition television images. For a larger cathode-ray tube, symmetrical push-pull amplifiers should be added to the scanning sources, if a plated type anode on the conical side of the tube is employed in its construction. It is understood that large-size tubes (without this feature)are available, that mercury-vapor, gas triode tubes can be used to give large scanning-source outputs without amplification (*DuMont*).

The confidential Don Lee television receivers, as used for demonstrations, differ materially from the design of this particular receiver. However, this unit has been constructed and adjusted according to the above directions by the Don Lee organization and also by a number of individual constructors in Southern California who already have receivers in operation.

It is felt that such constructors as can assemble a receiver of this type will not have difficulty in modifying or improving it in the future to keep pace with the forward march of the television art.

List of Parts

R1—500-ohm, 1 watt, Morrill or equal.
R2—15,000-ohm, 1 watt, Morrill or equal
R3—1000-ohm, 1-watt carbon
R4—5000-ohm, 1 watt, Morrill or equal
R5—1-megohm, 1 watt, Morrill or equal
R6—50,000-ohm, 1-watt carbon
R7—5000-ohm, 4-watt potentiometer, wire-wound
R8—1-megohm, 3-watt carbon
R9—0.5-megohm, 1-watt potentiometer
R10—150,000-ohm, 2-watt carbon
R11—0.1-megohm, 1-watt potentiometer
R12—4-megohm, 1-watt carbon
R13—4-megohm, 1-watt carbon
R14—400,000-ohm, 3-watt (need 2)
R16—75000-ohm, 1-watt carbon (need 2)
R17—1500 ohm 1 watt carbon (need 2)
R18—50,000-ohm, 1-watt potentiometer (need 2)
R19—1000-ohm, 1-watt carbon (need 2)
R20—300,000-ohm, 1-watt carbon (need 2)
R30—2500-ohm, 10-watt, wirewound
R31, R32—15,000-ohm, 25-watt, vitreous enamel, adjustable
R33—10,000-ohm, 1-watt carbon
R34—100-ohm, 1-watt carbon
R35—20,000-ohm, 2-watt carbon
R36—50,000-ohm, 1-watt carbon
R37—10,000-ohm, 1 watt, Morrill or equal (need 7)
R38—25,000-ohm, 1 watt, Morrill or equal
R39—25,000-ohm, 1 watt, Morrill or equal
R40—10,000-ohm, 1 watt
L1—1 turn No. 14 enamel, 1" diameter
L2—6 turns No. 14 enamel, 1" diameter, spaced to make coil 1" long
L3-L4—23 turns No. 30 enamel per coil, wound solid on ½" bakelite form (outside diameter). Coils ¼" long spaced 1/16" apart
L11—5 turns No. 14 enamel, ¾" diameter, ¾" long
L12—3 turns No. 14 enamel 1" diameter spaced to make coil ½" long
L13—Inca D-22 or equal 20-henry choke (need 2 or 1 double one)
C1—25-mmfd. variable, isolantite insulation
C2—.01-mfd., 400-volt paper (12 needed)
C3—50-mmfd. midget variable (bakelite ends satisfactory or mica compression type may be used)
C4—ditto
C11—25-mfd. electrolytic condenser, 25 w.v.
C12—.01-mfd. mica, 2500-volt
C13—50-mmfd. mica, 500-volt
C14—100-mmfd., 500-volt mica
C15—25-mmfd. variable, isolantite insulation
C16—50-mmfd. mica, 500 volt
C17—0.1 mfd. paper, 400-volt (2 needed)
C18, C19, C20—3-section electrolytic, 8 mfd. per section, 525-volt peak
C22—0.1 mfd. paper, 400 w.v.
C23—1-mfd. paper, 400 w.v. (2 needed)

(*Turn to page* 704)

the short-wave transmitter of WMC operating under the call letters WABG. The operator aboard the *Sequoyah* in turn reported the information of the 263 stranded persons to WMC. The broadcasting station flashed the report to the Army Engineers headquarters. From engineers' headquarters back over WMC went instructions to other government steamers in the vicinity of the island on how to conduct the evacuation of the stranded persons. All lives were saved.

Five meters also contributed its service to emergency work. Many amateurs in the flood area were equipped with low-powered transmitters and receivers that easily could be operated from batteries. Many of them had transceivers and duplex transmitters-receivers. These were installed on Coast Guard boats, at Red Cross relief stations and other places in the flood area. They supplied reliable short-distance communication without causing interference on other bands. They made it possible to direct the operations of rescue crews in boats without making it necessary for them to touch shore each time a job was done. They enabled the boat crews to request help when their facilities were inadequate to effect the rescue of large stranded groups. It is now quite apparent that the 5-meter band is an extremely important one for local operation between mobile units in time of national emergencies such as this.

Both amateurs and broadcasting stations again did a remarkable piece of emergency communication work. All those who took part deserve tremendous credit. Undoubtedly, had it not been for their work, thousands would have lost their lives and a great disaster might have been tremendously more disastrous.

Don Lee Television

(Continued from page 697)

C25—.00043-mfd., including stray wiring capacity mica condenser
C26—0.1-mfd. paper, 400 w.v.
C28—1-mfd., 2000 w.v., Pyranol or equal
C29—0.5-mfd., 2000 w.v., Pyranol or equal
C30—.004-mfd., 300-volt mica
C31—50-mmfd. midget, set at 20 mmfd.
SW1—S.P.S.T. toggle switch, 110-volt
VT1—6L7 first detector
VT2—6K7 first i.f. amplifier
VT3—6K7 second i.f. amplifier
VT4—6K7 third i.f. amplifier
VT5—6H6 diode second detector
VT6—955 acorn television ("audio") amplifier
VT7—6J7 oscillator
VT8—879 half-wave rectifier, high-voltage
VT9—905 cathode-ray tube, 5" screen
VT10—83-V full-wave rectifier
VT11, VT12—885
VT13, VT14—58
TR1—Inca B-7 or equal, sec. 1200 r.m.s
TR2—Inca C-66 or equal, sec. 750 r.m.s.

TELEVISION SCHEDULE

THE Don Lee television transmitter W6XAO is located at 7th and Bixel Streets in downtown Los Angeles, and operates on the ultra-high frequency of 45,000 kilocycles (which corresponds to 6 2/3 meters). Image transmissions are made daily except Sunday. The evening schedule starts at 6:30 p.m. and continues to 7:15 p.m. or later. The daytime programs observe the following schedule: Monday, 9-10 a.m.; Tuesday, 10-11 a.m.; Wednesday, 11-12 a.m.; Thursday, 12-1 p.m.; Friday, 1-2 p.m.; Saturday, 2-3 p.m.

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