Text-book Series No. 12

TELEVISION & RADIO SETS REPAIR

1970

OVERSEAS TECHNICAL COOPERATION AGENCY

JAPAN

FOREWORD

In order to meet the growing requests for the services of Japanese experts in various fields from developing countrkes, the Overseas Technical Cooperation Agency entrusted with the mission of extending technical cooperation toward those countries by the Government of Japan, is making every possible effort to recruit qualified experts.

However, it understood that one of the major difficulties encountered by the experts in carrying out training, demonstration, research and experiments abroad is the "language barrier" which sometimes resulted in ineffective implementation of the experts assignment project.

Therefore, in order to settle the difficulty and to obtain a good result in the technical guidance by the experts, the Overseas Technical Cooperation Agency has started to publish a series of technical text-books.

This technical text-book on "TELEVISION & RADIO SETS REPAIR" is the translated issue from the Japanese text-book prepared for the vocational training at the Vocational Training Institute by the Ministry of Labour, Government of Japan.

It is hoped that this book will be fully utilized not only by the experts but also by their counterparts and trainees of receipient countries and thereby will serve as an aid to the technical development in the developing countries.

March 1970

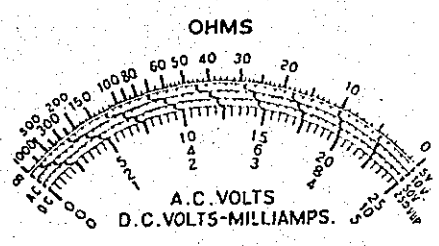
Overseas Technical Cooperation Agency

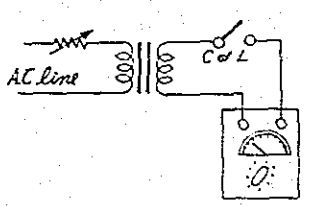
Tokyo, Japan.

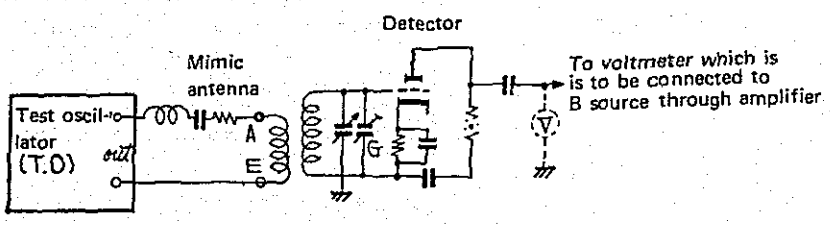
CONTENTS

PART I RADIO

No.	No. 1, Part 1
Title	Handling of circuit tester
Subject	Voltage measurement
Material	
Tool	Circuit tester



No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Reading (1) Read the pointer on the scale according to the range. (2) Read the value right under the thinnest stem of the pointer. (3) Read the value at which the pointer and its image coincide with each other, if a mirror is provided. 2. Zero adjustment (1) The zero adjustment must be conducted with the tester set as specified. (2) Turn the adjusting screw slowly. (3) The zero adjustment must be carried out each time the range switch is changed over, if the tester serves as an ohmmeter. 3. Calibration (1) Examine as to how the indication of tester corresponds to that of a standard meter. (2) Plot indications and prepare a calibration curve. 4. Changeover of range (1) The range switch must be changed over at a guess of a subjective measured value. (2) If the value is uncertain, try the maximum range first.	Figures on the range switch denote full scale values. Example - Tester 10V 50V 100V Standard meter 9.8V 50.3V 105V Examine a given circuit.
2.	Measurement	1. Pay attention not to miss polarities. 2. Adjust the range so that the pointer may come as far to the right as possible or within 2/3 the full scale value. 3. For the circuitry with a high internal resistance, set the voltage range high.	E: Source voltage E': Meter indication $E=E'\left(1+\frac{R}{RV}\right)$ R: Source internal resistance RV: Meter internal resistance Generally, R/RV is much smaller than 1, and is negligible.
Remarks	Measurement of output voltage (anode output voltage)	Block C current with a capacitor of some 0.1 μ F,	E: Meter indication w: Source frequency E_0: Source voltage Z: Meter internal resistance
	Measurement of oscillating voltage	1. Disconnect terminal E from Rg, and provide an ammeter instead in between. Calculate IgRg=eg. 2. It should be noted that the measurement by voltmeter would cause a substantial error.	
	Measurement of zero beat	Measure a point at which the pointer stops swinging.	
	Measurement of capacitance	1. Adjust the source voltage to a correct value. 2. If the capacitance scale is not available, calculate the capacitance according $C = E/w\,(Eo - E)\,Z$.	In the process of activating the oxide film, the leakage current will vary. Also, variation due to temperature change will be noticed.
	Measurement of inductance	1. Correctly adjust the indication source voltage. 2. If inductance scale is not available, calculate according to the following fomula. $L = (Eo - E)Z/wE$	
	Measurement of insulation resistance of electrolytic capacitor	1. Measure leakage current. 2. The reading should be obtained at a point where the pointer ceases from moving. (minimum current) 3. Pay attention to the polarity when measuring on the ohmmeter. (Connect (+) terminal of circuit to (−) terminal of the battery.	

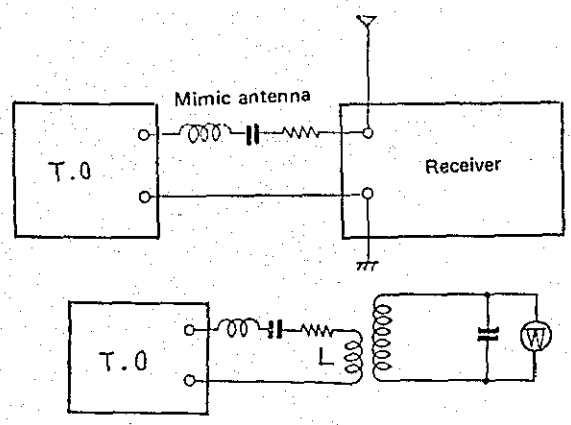


No.	No.2, Part 1
Title	Method of using test oscillator
Subject	Adjustment of tuning circuit
Material	
Tool	Test oscillator, receiver, voltmeter

No.	Sequence	Explanation	Supplementary Notes
1.	Wire as shown above.	For coupling T.O. and tuning circuit, use either a dummy antenna or C of some 100 PF, or R of some 400 ohms.	It is necessary to minimize the variation of circuit constant due to stray capacity and adjusting means.
2.	Set the test oscillator	1. Set to "MOD" band. 2. Correctly adjust the oscillating frequency 3. Adjust the output.	Excess input to the circuit obscures the tuning point.
3.	Obtain a maximum low frequency output.	Turn the dial of T.O. gently, and adjust GT or L to obtain a maximum deflection of the output meter.	For receivers, measurement around 20V of the output voltage is desirable. Excess output lies in the curved section in the vacuum tube characteristics curve, and its variation is hard to detect.
4.	Measure at desired frequencies within the receiving band.	1. Normally at three places. At extra frequencies, if required. 2. 600 kC, 1000 kC and 1400 kC within B.C. band. 3. Adjust Ct for higher frequency range. 4. Adjust L for lower frequency range.	Three places measurement is practically warrantable.
5.	Repeat the measurement	1. 2 – 3 times.	

Remarks

It is advisable to examine the error by means of trimming rod. Especially when two or more turning circuits are to be adjusted, the trimming rod is indispensable.



No.	No. 3, Part 1
Title	Method of using test oscillator
Subject	Measurement of unknown frequency
Material	L, C
Tool	Receiver, test oscillator, valve voltmeter

No.	Sequence	Explanation	Supplementary Notes
1.	Wire as illustrated above.	See connection diagram above.	
2.	Receive a radio frequency		The frequency calibration of test oscillator can be made with respect to radio waves.
3.	Measure zero beat	Turn T.O. dial gently and slowly.	Examine the zero beat as to whether it is the result of interference by fundamental waves.
4.	Read the frequency indication of T.O.		

Remarks

Test oscillator

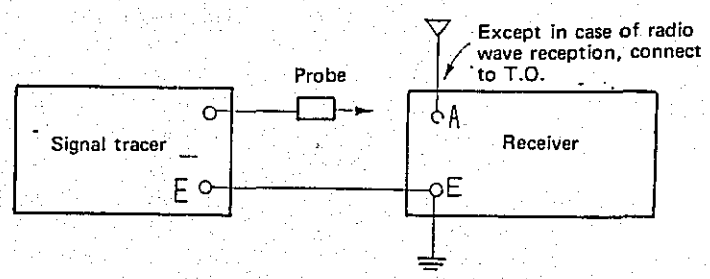
1. Oscillating frequency – Various test oscillators are available ; some capable of adjusting the lowest intermediate frequency and standard broadcasting band, and some others capable of adjusting 100 kC – 30 MC.

2. Modulation frequency and modulation factor – Normally about 40% modulation of a single frequency of either 400 C/S or 1000 C/S. Some changeover type oscillators are able to carry out modulation with an arbitary frequency by mixing a low oscillating frequency at external modulator-output terminal.

3. Output voltage –

   Some 50 μV – 50 mV can be obtained continuously or stepwise.

4. Output impedance – Various output impedances are available. High impedance may be used for test purposes, but low impedances are suitable for standard signal application.



No.	No. 4, Part 1
Title	Method of handling signal tracer
Subject	Trouble-shooting
Material	
Tool	Signal tracer, receiver, T.O.

No.	Sequence	Explanation	Supplementary Notes
1.	Connect as shown above	1. Do not give undue shock on the probe. 2. Connect grounding terminals to each other.	Lock the meter until the vacuum tube is statilized.
2.	Check functions	1. Hum (buzzing sound) will be heard if your finger gets in touch with the probe. 2. Adjust the attenuator.	
3.	Apply the probe to e the antenna.	1. Set the selector switch to "MOD." 2. Voices will be heard under cross-talk. 3. In case of test oscillator connection, modulating sounds will be heard.	If attached to the power unit, ac harmonics will be discriminated.
4.	Connect the probe to the tuning circuit.	1. Tune up so as to clearly hear the receiver.	
5.	Probe the amplifier and detector in the following order : Plate → G of succeeding tube → P (SgG, K) → G. ( ) denotes no signal source.	1. The same station will be detected still. (No substantial change will be noticed on the crystal or diode detector) 2. Normally, signals will not be detected at points where by-pass capacitors are provided. 3. Discriminate noises from signals.	1. Tuning point may sometimes be staggered with stray capacity. 2. Signals may be heard according to the quantitative relationship of by-pass capacitor, C and R. (Mostly in the low frequency circuit). 3. Fault between a given circuit and its prestage is possible if no signal is detected at probable locations in the given circuit.

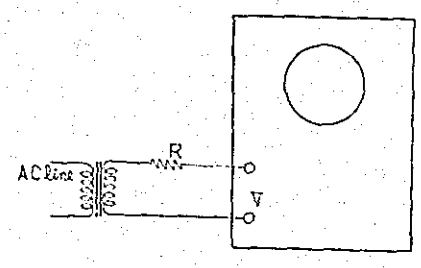
Remarks

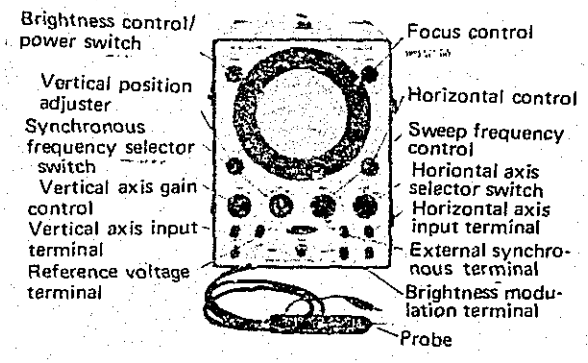
Signal–tracer

1. Application – Trouble-shooting, circuitry adjustment, testing, etc.
2. Outline of construction and features –

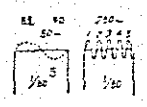
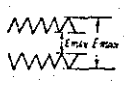
   A detector (amplifier) with a speaker (phone) and an indicating instrument.

   a. Detecting system : Diode detection, grid detection, plate detection, crystal detection.
   b. Meter indication : Carrier type and audio type are available; chargeover to speaker is possible.
   c. Input capacity : Approx. 10 PF.
   d. Input impedance : Approx. – 500 kΩ.
3. One with test oscillator is also made available.





No.	No. 5, Part 1
Title	Method of using cathode-ray oscilloscope
Subject	Waveform observation
Material	
Tool	

No.	Sequence	Explanation	Supplementary Notes
1.	Develop a spot of light. 	1. Turn on the power switch. 2. Control the brightness. 3. Adjust the focus. 4. Adjust the gain control to minimize the spot. 5. See the figure on the left.	
2.	Sweep with the spot. 	1. Provide a horizontal line as an internal synchronizing signal by adjusting the horizontal gain control. 2. Adjust the brightness.	
3.	Apply vertical inputs. 	1. Adjust the vertical gain control. 2. Adjust by selecting a suitable time axis frequency. 3. See the figure on the left.	1. The lower the time axis frequency, the more the number of pitches. 2. If the horizontal and time axis frequencies coincide with each other, only a single pitch will appear. 3. In case of high time axis frequency, a good number of vertical lines will appear across the screen, representing one frequency to another's ratio.
Remarks	Application  Fig. 1 Fig. 2  Fig. 3  Fig. 4	1. Comparison of input with output. 2. Measurement or adjustment of frequency. a. Apply a known frequency to the time axis. (See Fig. 1). b. Apply unknown input, and measure the number of pitches. (See Fig. 2). c. If unknown frequency voltage and known frequency are applied to the vertical axis and horizontal axis respectively, such a pattern as shown in Fig. 3 will appear. 3. Measurement of modulation factor. Apply a modulated wave on the vertical sweep terminal, and calculate the modulation factor as follows. $\text{Modulation factor} = \frac{\text{Emax} - \text{Emin}}{\text{Emax} + \text{Emin}} \times 100\ \%$	Improper bias voltage distorts half-cycle waveform. Check frequency characteristics and phase characteristics.

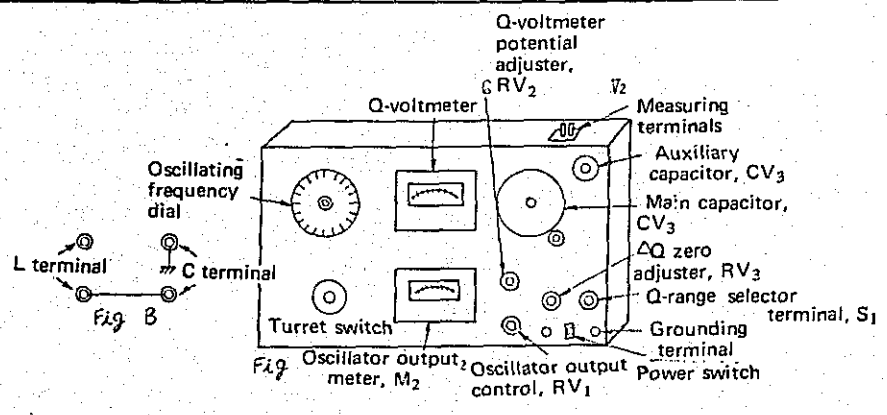


Fig. B

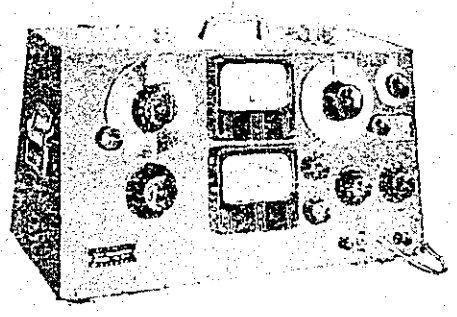
No.	No.6, Part 1
Title	Method of using Q-meter
Subject	Measurement of Q of series-connected coil
Material	Coils
Tool	

No.	Sequence	Explanation	supplementary Notes
1.	Preparations	1. Ground the grounding terminal of the case. 2. Connect a coil to the terminal L. 3. Set the turret switch to a desired frequency range. 4. Set oscillating frequency to a desired frequency. 5. Set the Q-range switch to "MEDIUM" (or to "RIGHT" if not available). 6. Turn on the power switch. 7. Make sure that the Q-meter and coil are out of tune. (8.9 turn the main capacitor CV_2 to lock). 8. Turn Q-voltmeter zero adjuster to zero. 9. Change over Q-range switch and adjust zero adjuster to zero. 10. Check as to whether zero point is settled in each range. 11. Turn RV_1 to adjust M_2 index to a specified value. (Meter may be inscribed with a red mark).	1. (1) Zero adjustment of Q-meter is impossible. (2) Leads should be short yet thick as possible. (3) The low voltage terminal of core and shield should be connected to a low potential terminal. (Auxiliary coil is connected internally) (4) In 10 – 20 sec., each part will become active, and in 5 min., all will be settled.
2.	Tuning	1. Set the auxiliary capacitor CV_3 to zero. 2. Obtain a maximum deflection by turning main capacitor CV_2.	If tuning is impossible for want of capacitance, add a suitable high Q-capacitor to terminal C. (See Fig. B)
3.	Reading	1. The reading on the Q-scale 2 shows Q value. 2. The sum of the capacitance of main capacitor CV_2 and that of auxiliary capacitor CV_3 represents the tuning capacitance.	Effective series resistance $Rs = \frac{1.59 \times 10^8}{fcQ}$ .... Ω

Remarks

Industance, stray capacity and effective series resistance can be measured by the method explained above.

The effective series resistance can be calculated according to the following formula. $Rs = \frac{1.59 \times 10^8}{fcQ}$



	No.	No. 7, Part 1
	Title	Setting up parts of usual RF receiver kit
	Subject	Wiring and cautions on part arrangement
	Material	Receiver kit, soldering rods, paste
	Tool	Screw drivers (large, small), socket-headed wrench, hand-operated drill, file, soldering iron, reamer, spanner.

No.	Sequence	Explanation	supplementary Notes
1.	Arrangement	Adjust parts so that they may be least subject to magnetic and electrostatic interference or coupling.	
2.	Machining the chassis	1, Carry out as marked off. 2. Pay attention not to cut more than necessary.	
3.	Soldering sockets and lugs, etc.	Clean excessive paste away.	
4.	Fitting parts  	1. Begin with such light parts as those which are little susceptible to damages; socket, shield case, electrolytic capacitor, fuse holder, regenerative capacitor, variable capacitor, transformers, coils, dials, terminals. 2. Bolting to conform to the instructions on the left. 3. Arrange the dial to make the drum, pulleys and driving shaft lie in the same place.	

Remarks

No.	No.8, Part 1
Title	Wiring usual RF radio
Subject	Wiring work
Material	Usual RF receiver kit, soldering rod, paste, emery paper, tinned copper wire, empire tube.
Tool	Soldering iron, pincers, nippers, long-nosed side cutting pliers.

No.	Sequence	Explanation	Supplementary Notes
1.	Check parts with the wiring diagram	1. Tabulate parts by ratings. 2. Prepare parts just needed.	For correct wiring.
2.	Grounding bus	Turned wire.	
3.	Heaters	Twist heater leads, and ground either one.	For the prevention of electromagnetic induction.
4.	B-source		
5.	B-circuit	Wire in order of B-source, output tube, detective tube and RF amplifier, starting from the B-source.	
6.	Grid circuit	1. Completely isolate from the plate circuit. 2. Position the coupling capacitor as far from the grounded place as possible.	Connect the inside of the capacitor to the grid.
7.	Cathode circuit	Test the leads of R and C.	
8.	RF circuit	1. Make the turning circuit leads as short as possible. 2. Never fail to ground the shielding piece of the variable capacitor to the contact piece. 3. Make sure that VR is so arranged as to increase volume when turned clockwise.	Influence of Q on selectivity and gain.
9.	Power cord	1. Connect one lead to the switch leading to the primary of the power transformer. 2. Connect another lead to the fuse holder leading to the primary of the power transformer. 3. Set the cord inside the chassis by a suitable means or by knotting.	
10.	Detective circuit (Grid detection)	1. Arrange the grid leads as short as possible. 2. Minimize the leads of regenerative circuit.	Oscillation by positive feedback; connection of regenerative coil.

Remarks

Color codes :

Red – Circuits to be connected to plate. Orange – Circuits to be connected to grids other than control grid.

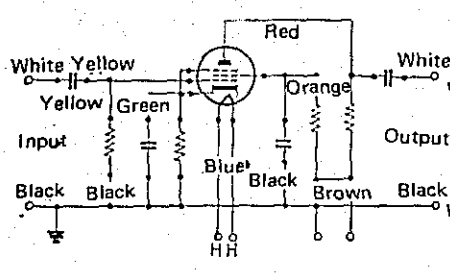
Green – Circuits to be connected to cathode.

Blue – Circuits to be connected to filaments. Yellow – Circuits to be connected to control grid.

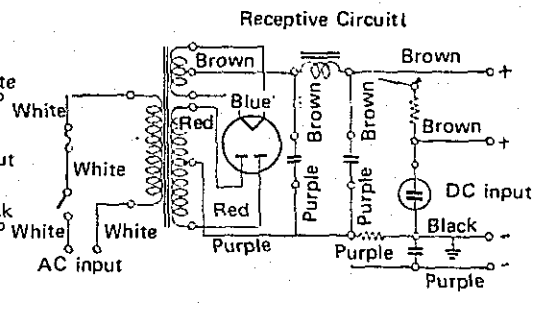
Purple – Negative circuits. Brown – Positive circuits. Black – Grounding circuits.

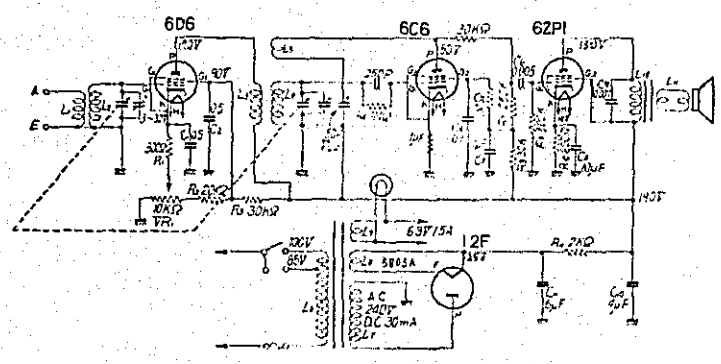
White – Power circuits other than ac, positive ac, positive and negative; auxiliary circuits; positive and negative low voltage circuits; flyback circuits; signal input circuits; output circuits; control circuits.

Audio Amplifier Circuit



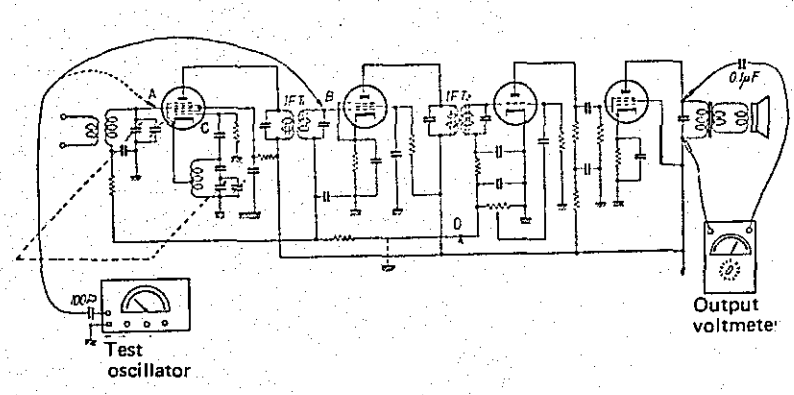
Receptive Circuit



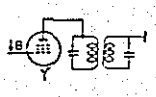
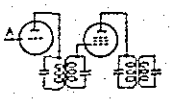


No.	No.9, Part 1
Title	Adjustment of usual RF receiver (grid detection)
Subject	Inspection and adjustment of circuit
Material	Usual RF receiver
Tool	Circuit tester, adjusting rod, test oscillator

No.	Sequence	Explanation	Supplementary Notes
1.	Checking of wiring	1. Check for errors with the wiring diagram. (Electrodes of tubes)	Check speaker wiring.
2.	Conduction test	1. Between insulated point (B contact) and ground. 2. Between interconnections. 3. Recording of resistance values.	
3.	Plug in tubes	1. Plug in tubes other than rectifier tube, and check their igniting conditions. 2. If no abnormalities are found, put the rectifier tube in.	
4.	Voltage vs current test	1. Carry out test and record the results, starting from the power circuit.	1. The current is calculated from voltage drop. 2. If the rectifier tube alone is put, the electrolytic capacitor may be broken by excessive peak voltage. 3. Clicking sound will become louder as the testing point goes far and far away from the output tube.
5.	Function checking of low frequency circuit	1. Check for source hums. 2. Detect oscillating sounds by lightly attaching your finger on the detector tube grid.	
6.	Connecting test oscillator to supply modulated waves	1. Turn the radio at 1400 kC, and obtain a maximum sensitivity by adjusting the trimmer snug. (Insert the adjusting rod gently into the coil.) 2. Turn at 600 kC, and obtain a maximum sensitivity. 3. The output meter should indicate around 20 V. 4. Minimize the capacitance of the regenerative capacitor. 5. Repeat steps 1, 2 and 5.	When the output is larger than 20V reducing of input is effective for the prevention of current saturation.
7.	Checking of effects of regeneration	1. Turn the regenerative capacitor to examine the effects on the sensitivity increase. 2. If a sudden increase is noticed, add series resistance.	
8.	Checking of volume control	The volume control should cover a warrantable range, and should muffle the signal at the extreme counterclockwise end.	
Remarks			

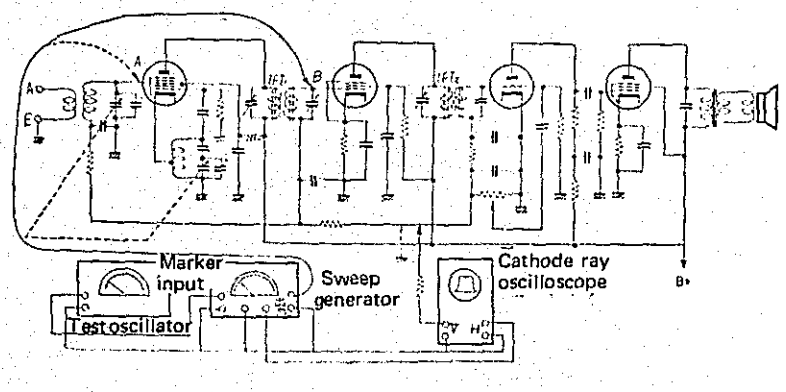


No.	No. 10, Part 1
Title	Adjustment of superheterodyne receiver (I.F.T.)
Subject	Adjustment of I.F.T. by means of test oscillator
Material	
Tool	Test oscillator, output meter or circuit tester, trimming rod

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Ground the A.V.C. circuit (Point D). 2. Stop the oscillator (Point C). 3. Connect the output motor to the plate of the output tube. (Fig.) 4. Turn VR to the clockwise end. 5. Connect the test oscillator, set it at 455 KC to give modulated waves.	1. Obtain output proportionate to input. 2. Prevention of beat interference. 3. Set the test at A.C 50V range. 4. Reduce the output.
2.	Adjustment of $I.F.T_2$ 	1. Apply oscillating output to point B. 2. Obtain the maximum output by trimming the secondary adjusting screw. 3. Obtain the maximum output by trimming the primary adjusting screw. 4. Repeat steps 2 and 3. 5. The output voltage of 20 – 30 V is preferable. If the output voltage exceeds that value, decrease the oscillator output.	Readjustment of the staggering of the turning frequency due to change of coupling factor.
3.	Adjustment of $I.F.T_1$ 	1. Turn down the oscillator output further, and apply it to point A. 2. Begin with the secondary, just as in the case of $I.F.T_2$.	If oscillation is caused by large gains, reduce Esg or increase bias resistance.
4.	Removing E from A.V.C. circuit	Check for abnormalities.	

Remarks

1. In the superheterodyne receiver, the workmanship of the adjustment of I.E.T. has an important bearing on the sensitivity selectivity and fidelity of the receiver.
2. Another method of adjustment using a sweep generator is also commonly employed.

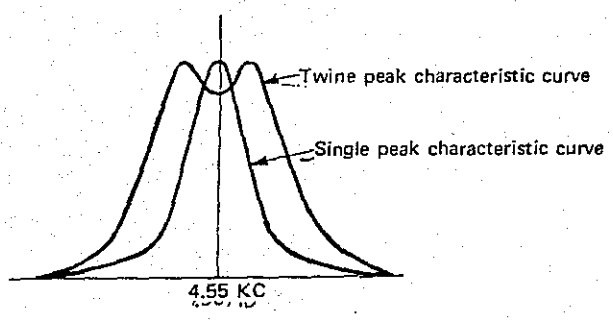


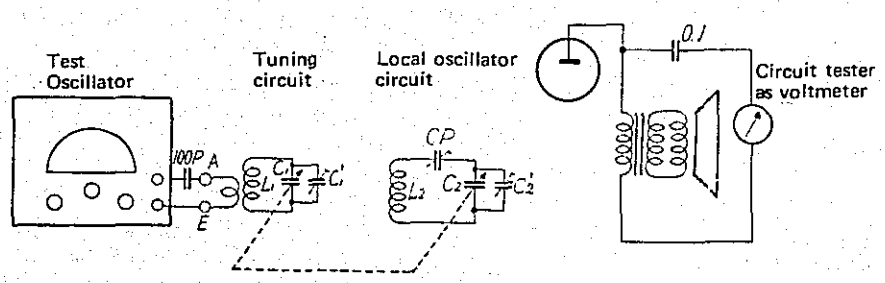
No.	No. 11, Part 1
Title	Adjustment of super heterodyne receiver (I.F.T.)
Subject	Adjustment of I.F.T. by means of sweep generator
Material	
Tool	Sweep generator, test oscillator, oscilloscope, adjusting rod.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Arrange the connection as illustrated above. 2. Set the sweep output as little as possible. 3. Generator as large a waveform as possible.	Use a test oscillator as a marker.
2.	Adjustment of I.F.T_2	1. Supply sweep output to point B. 2. Center the waveform at 455 kC. 3. Adjust so that the curve may become symmetrical with reference to ordinate. (The adjustment should be repeated; beginning with the secondary and then the primary)	
3.	Adjustment of I.F.T_2	1. Set the sweep output at point A. 2. Carry out the adjustment according to the step 2 above, starting from the secondary.	

Remarks

Patterns on oscilloscope screen



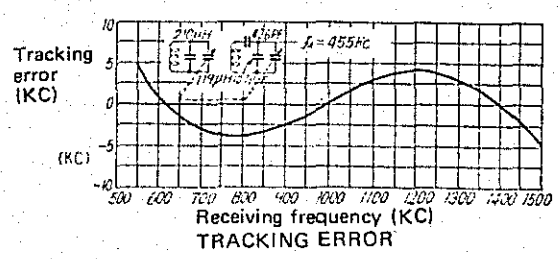


No.	No. 12, Part 1
Title	Adjustment of super heterodyne receiver (3-point adjustment)
Subject	Tracking
Material	Receiver
Tool	Test oscillator, circuit tester, adjusting rod

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect as illustrated. 2. Ground the A.V.C. circuit. 3. Turn down the test oscillator output. 4. Make the receiver output maximum.	Set the circuit tester to A.C 50V range.
2	Adjustment at 1400 kC	1. Make the test oscillator generator 1400 KC. 2. Tune the receiver dial at 1400 KC. 3. Obtain a maximum sensitivity by adjusting C'_1 and C'_2.	3a. Insert the dust core end of the adjusting rod into the coil; if output is increased, it involves a lack of inductance. If output is increased by the insertion of the ring end of the adjusting rod, the induction is considered to be excessive.
3.	Adjustment at 600 kC	1. Make the test oscillator oscillate at 600 KC. 2. Set the receiver dial at 600 KC. 3. Obtain a maximum signal by adjusting CP. 4. Repeat the above steps to minimize error.	3b. CP effects are dominant in lower frequency range, whereas C_2 effects are adverse in a higher range. 3c. L_2 affects the entire range.
4.	Adjustment at 1000 kC	1. Oscillate the test oscillator at 1000 KC. 2. Set the dial of the receiver at 1000 KC. 3. Adjust C'_1 and C'_2 to obtain a maximum gain. 4. If outputs at three points are different from each other, adjust cuts of the end plates of C'_1 and C'_2. 5. Repeat the above steps.	

Remarks

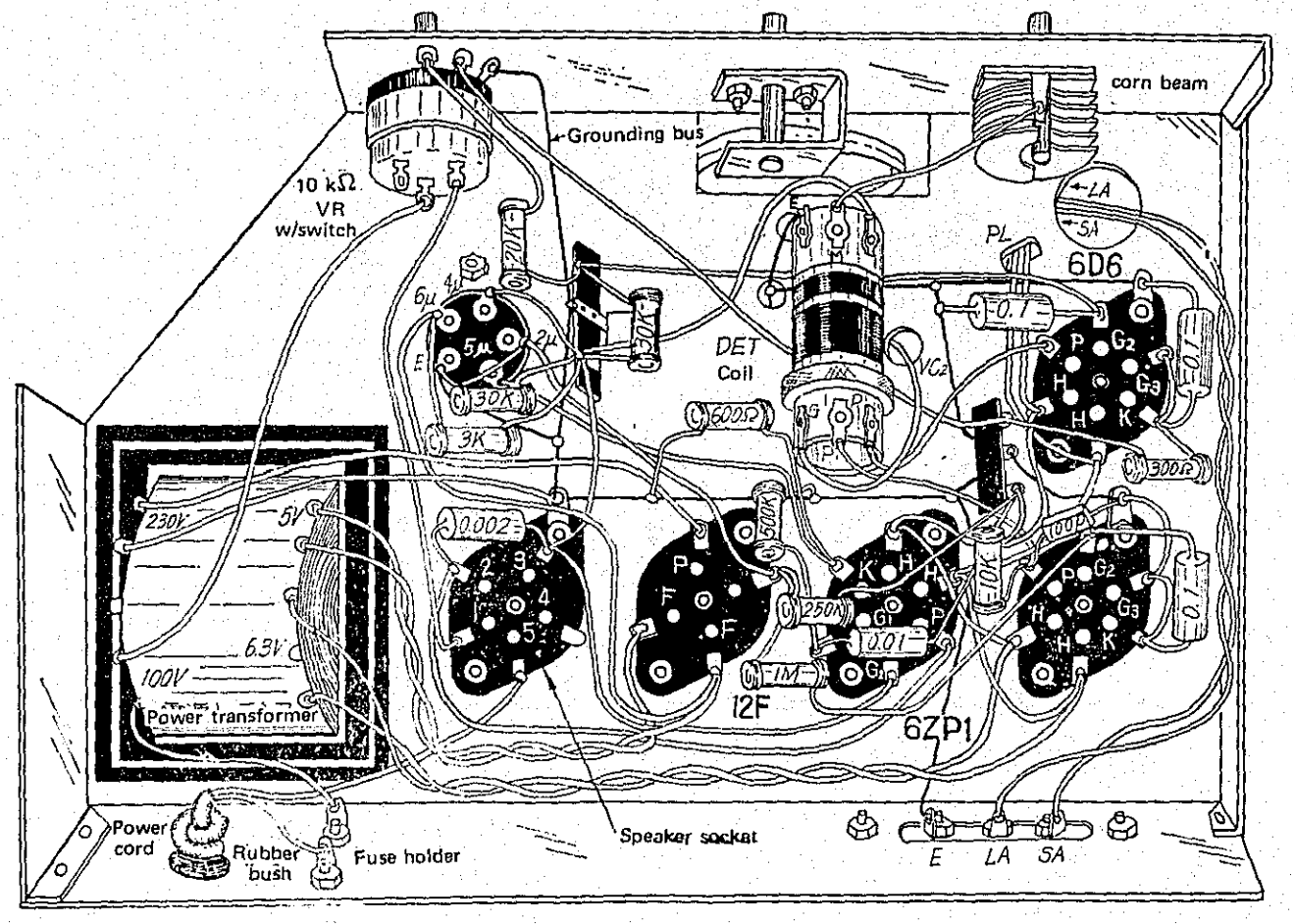
The tuning circuit should be adjusted to the dial beforehand. (Refer to the "Adjustment of tuning Circuit" explained before)



PART II TELEVISION

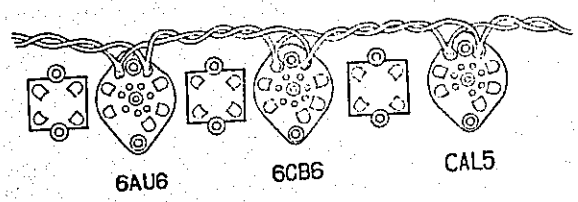
4-TUBE RF SINGLE STAGE AMPLIFIER RECEIVER

Grid Detection Circuit with Regenerative Elements

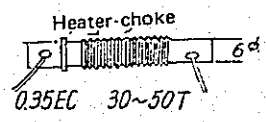


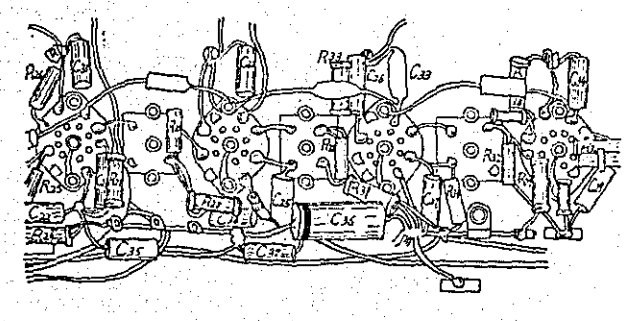
No.	No. 1, Part 2
Title	Wiring TV set
Subject	Wiring order
Material	TV kit, wires and wiring materials
Tool	Soldering iron, pincers, emery paper, long nosed side cutting pliers, nippers.

No.	Sequence	Explanation	Supplementary Notes
1.	Grounding	1. The grounding should in principle be made in the chassis. 2. Make grounding wire as short as possible.	1. Contact resistance increases. 2. Effects of length on stray capacitance and inductance.
2.	Insulated lug plate	1. When used as grounding terminal, set with machine screws first, and then solder.	1. Contact resistance will increase unless screws are soldered.
3.	Wiring according to color coding	1. Color coding of wires are required to discriminate séparate wires.	According to J.I.S.
4.	Wiring order	1. Heater circuit. 2. Power circuit. 3. Video I.F. circuit. 4. Video amplifier circuit (including detection circuit). 5. Audio I.F. circuit (including detection circuit). 6. Audio frequency circuit. 7. Synchronizing circuit. 8. Vertical oscillation and vertical output circuit. 9. Horizontal oscillation and horizontal output circuit.	
5.	Wiring of socket	For easy soldering, use rejected tubes.	
6.	Wireing diagram	It is advisable to red-mark wired sections.	
Remarks			



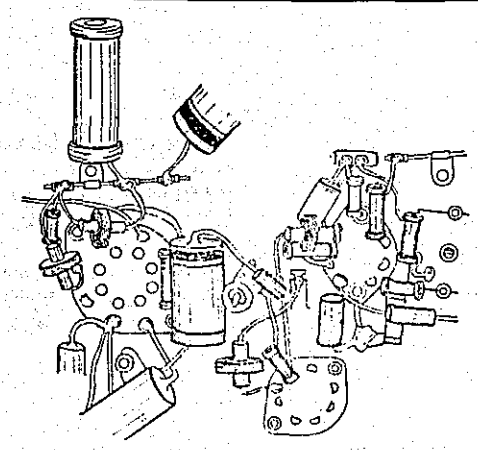
No.	No. 2, Part 2
Title	Wiring method of TV set
Subject	Heater wiring
Material	Soldering rod, tinned wire, insulated wire, empire tube.
Tool	Pincers, nippers, soldering iron.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparation	1. Solder both ends of the heater choke. 2. Solder capacitor leads. Cut tinned wire in pieces on actual measurement. 3. Use blue and black insulated wires.	Heater choke 
2.	Transformer	1. The transformer leads should be just up to the insulated terminals. 2. The transformer leads should not be grounded directly. (For grounding position, refer to step 4).	In case of transformerless TV kit, connect tube heater (except high voltage rectifier heater) in series, or connect RF, IF and audio and deflection circuits in parallel.
3.	Deflection circuit	1. Twist heater leads. 2. If the damper tube heater is provided with exclusive terminals, its leads should be wired ungrounded after insulated with vinyl tubes.	1. Make lead lengths as short as possible. 2- (1) High voltage is applied on the cathode; and it may happen to be applied the heater. (2) The circuit involves high tension danger.
4.	Video amplifier circuit	Black wire of twisted wires often grounded here.	Least vulnerable to electro-magnetic induction.
5.	Detected video signal intermediate frequency amplifier circuit	1. Bring twisted wires in front of the detector tube, and ground a black wire. 2. Solder the heater choke and capacitor to the blue wire.	(1) Heater choke must be covered in vinyl tube. Pay attention not to bring them in contact. (3) It is advisable to wire the heater choke on a mica sheet.
Remarks			

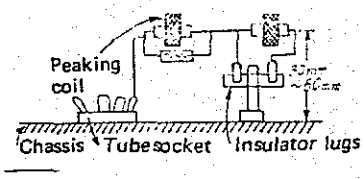


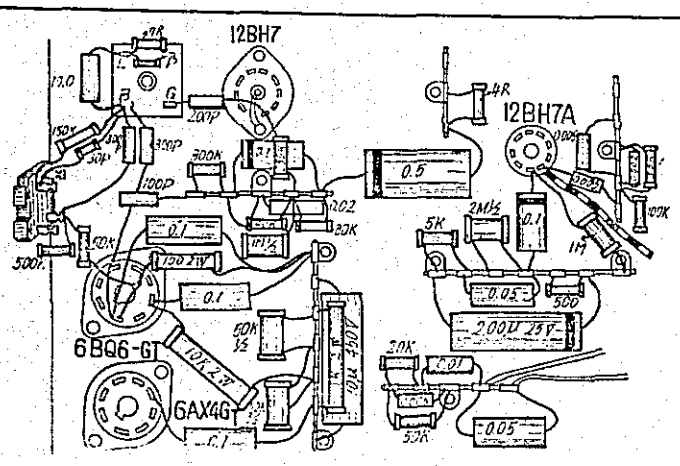
No.	No.3, Part 2
Title	Wiring method of TV set
Subject	Wiring of IF amplifier circuit
Material	A set of parts and wiring materials
Tool	Pincers, nippers, soldering iron, files, long-nosed side cutting pliers.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	Solder the parts terminals.	
2.	Grounding by soldering	Ground directly onto the chassis.	For soldering, use of a soldering iron of some 200 W is recommended.
3.	Grid circuit	Wire using bare conductors	
4.	Plate and screen grid circuits	1. Use lugs. 2. Use short bare conductors.	Leads should be kept apart from A.G.C. circuit. The decoupling capacitor should be grounded near the socket. Avoid coupling nuisance due to contact of the plate and screen grid.
5.	Cathode circuit	Ground the cathode resistor directly onto the chassis.	
Remarks			



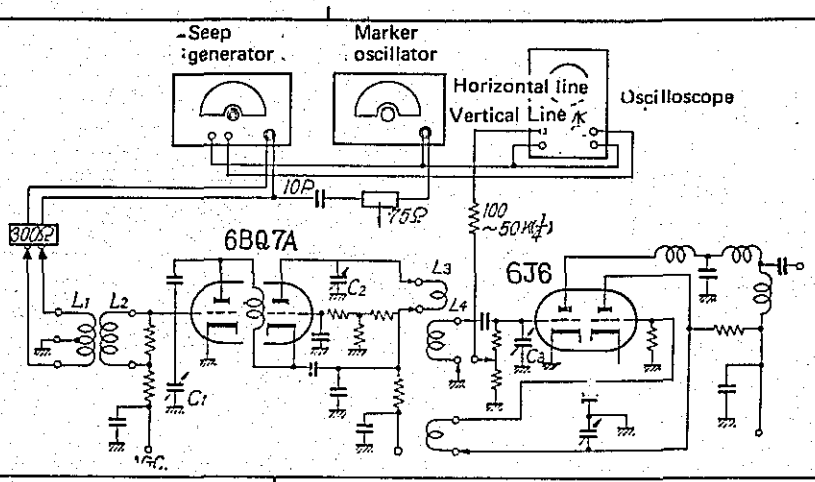
No.	No. 4, Part 2
Title	Wiring method of TV set and cathode ray tube circuit
Subject	Detection and video amplifier circuit
Material	A set of TV set and wiring materials, soldering rod.
Tool	Soldering iron, nippers, pincers, emery paper, long-nosed side cutting pliers.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Solder parts terminals beforehand. 2. Attach a resistor to series peaking coil in parallel.	
2.	Detection (1) *Peaking coil* (2) A.G.C. circuit	Keep detector circuit element apart from the chassis. 1. *Do not near A.G.C. by-pass capacitor to the detector circuit.* 2. Do not near A.G.C. to B-circuit.	Frequency characteristics will be degraded by the increase of stray capacity (high frequency corner will sag). 
3.	*Video amplifier circuit* (1) Peaking coil (2) Load resistor (3) Coupling capacitor (4) Cathode-ray tube input circuit (5) Brightness control circuit (6) Tuner/discriminator circuit	Pay attention to isolate the video amplifier circuit from detector circuit. Isolate the load resistor from ground. Isolate the coupling capacitor from chassis. The leads of brightness control circuit will become lengthy, but will not cause any difficulties. 1. The tuner/discriminator circuit should be apart from the chassis. 2. Do not near to B-circuit.	Owing to long leads.
Remarks			



No.	No. 5, Part 2
Title	Wiring of TV set
Subject	Deflection circuit
Material	A set of TV kit, wiring materials
Tool	Soldering iron, emery paper, nippers, pincers, long-nosed side cutting pliers.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	Solder parts leads.	
2.	Sync. circiut	1. Compound tubes are mostly employed. Carefully assort parts, and avoid overlapping. 2. Avoid external electromagnetic induction. 3. For integrating circuit, special attention should be paid to the soldering of grounding wire and parts arrangement.	Liability to have electromagnetic induction.
3	Vertical circuit	1. The shield wire to be led to the variable resistor (VR) for vertical sync. control should be grounded near the variable resistor (One-spot grounding is preferable). 2. Do not near to the horizontal sync. circuit. 3. Pay attention in fitting the B-source circuit.	1. To avoid hum influence. 2. To avoid electromagnetic induction to be caused by horizontal sync. circuit. 3. To avoid the influence of horizontal sync. circuit.
4.	Horizontal circuit	1. Lay out A.F.C. parts if provided. 2. The coutput tube circuit carries out high voltage emission, and it leads should be made as short as possible. 3. Soldered parts of the high voltage circuit should be as round as they can be formed.	Other effects should be taken into consideration. Horned parts are liable to discharge or develop coronas
Remarks			



No.	No. 6 Part 2
Title	Adjustment of RF circuit (tuner circuit)
Subject	Method of adjustment by sweep generator
Material	TV set, 50 – 100 kΩ, 10 PF, 300 Ω
Tool	Sweep generator, marker oscillator, oscilloscope, trimming rod.

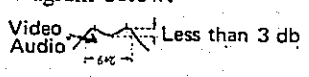
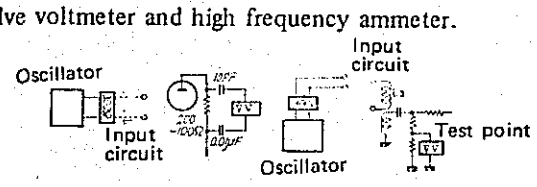
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect a resistor of about 100 – 50 kΩ to the oscilloscope, and wire as illustrated above. 2. Connect sweep generator as illustrated above. 3. Connect a capacitor of some 10 PF, to the marker generator, and wire as illustrated above. 4. Select a desired channel. 5. The vertical gain of the oscilloscope should be as large as possible.	1. Cut lead wires as short as possible. Resistors should be of small type (1/4 w) for RF use. 2. Pay attention to the impedance matching (300 Ω). 3. Capacitor should be as small as possible. 4. In case of turret type, begin with No.1 channel, and for the rotary type, with No.11 channel. 5. To reduce the sweep output. (Too much is nothing but worse to view)
2.	Make curves on oscilloscope screen	1. Bring curves to a good command view. 2. Adjust the sweep output and oscilloscope vertical gain.	Minimize distortion.
3.	Adjust sweep output	1. Pay attention so as to make working range go beyond the linear section of Eg – Ip characteristics curve.	To avoid waveform distortion.
4.	Try to meddle with leads of each instrument	Allocate leads so that they may not change the characteristics.	Malmatching of instrument, and the length and arrangement of leads may take the advantage of the system working characteristics.
5.	Generate a channel center frequency by means of the marker oscillator	Marker output should be least yet able to be discriminated.	Channel center frequency $fm=\sqrt{f_1 f_2}$ f_1 = Video carrier frequency f_2 = Audio carrier frequency
6.	Adjust L_1 and L_2	Bring the center frequency to the center.	Adjust the coupling between L_1 and L_2.
7.	Generate double marker with the marker oscillator tuned down with video carrier frequency	Marker output should be as little as possible.	Double marker can be obtained in the range of 4.5 MC by the marker generator.
8.	Adjust L_3 and L_4	In the lower frequency range, adjust C_2 and C_3 to change the coupling between L_3 and L_4. In the higher frequency range, adjust C_1 to change the coupling between L_3 and L_4.	Obtain a maximum output as shown in the diagram below. 
9.	Repeat the same method for each channel	For the rotary type, begin with the highest channel. For the turret type, start with the lowest channel.	
Remarks	Method of using valve voltmeter and high frequency ammeter. 		Plot an output curve by shifting frequencies from video carrier frequency to audio carrier frequency.

Fig. 1

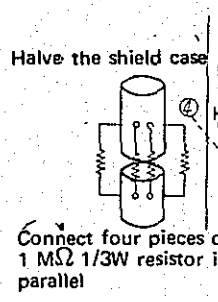
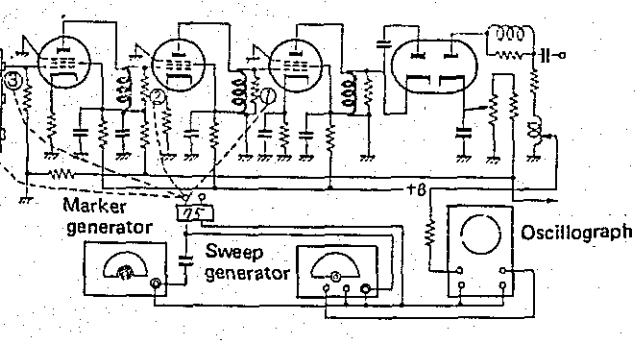
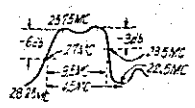


Fig. 2

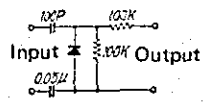


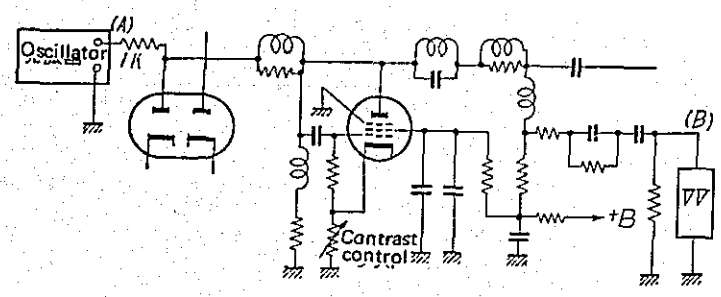
No.	No. 7, Part 2
Title	Adjustment of video IF amplifier circuit
Subject	Adjustment of characteristics.
Material	TV set, 10 pF, 100–50 kΩ.
Tool	Marker generator, sweep generator, oscilloscope, soldering iron, trimming rod.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Cease the oscillation of the frequency converter circuit. 2. Prepare a shielding means as shown in Fig. 1, and put it on 6J6. 3. Stager audio trap 4. Apply a fixed voltage on the AGC circuit. 5. Connect the oscilloscope as illustrated above. 6. Connect the sweep generator and marker oscillator to the grid in the prestage.	1. Cut off B-circuit. 2. Weaken the coupling 3. Shift the frequency to a lower value. 4. Something like 3V battery voltage will do. In case of D-A.G.C., no voltage is required, provided that the time constant should be set at a rated value. (Otherwise, characteristics will change)
2.	Adjustment	Begin with the circuit nearest to the detector circuit. Adjust to the center frequency of the IF transformer.	
3.	Put a 500Ω resistor	Provide a damping resistor for the adjusted transformer in parallel.	To avoid the influence of selectivity of IF transformer.
4.	Proceed to the next transformer	Carry out the same process as above for each stage.	
5.	Obtain overall characteristics	Undo 500Ω resistor all.	
6.	Adjust the characteristics	Mark the frequency, and adjust the trap.	 Try to change damping resistors with each other.
7.	Check the characteristics	Vary the bias voltage which has been fixed at 3 V.	When feedback has been carried out, characteristics will change.
8.	Examine overall characteristics beginning with the RF amplifier circuit	1. Maladjustment is responsible for mistune. 2. Adjust the oscillation frequency.	Repeat the adjustment. Bring the fine tuner (variable capacitor) at the center.

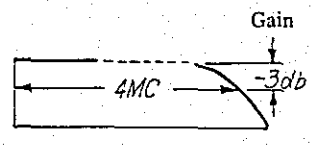
Remarks

1. For connecting instruments, soldering is preferable.
2. Provide a detector using germanium diode as shown on the right. When combined with oscilloscope, it can measure one transformer at a time.
3. The adjustment can be also done using an oscillator in combination with a valve voltmeter connected in parallel to the detector and with an ammeter in series.



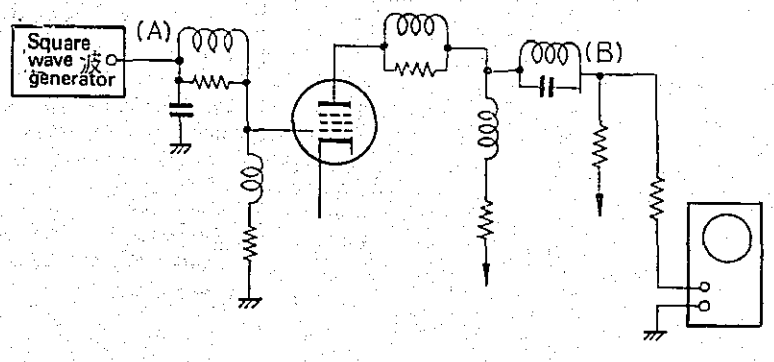


No.	No. 8, Part 2
Title	Adjustment of video signal amplifier circuit
Subject	Overall characteristics
Material	TV set
Tool	Valve voltmeter (P type), oscillator (50 ∞ – 5 MC), soldering iron.

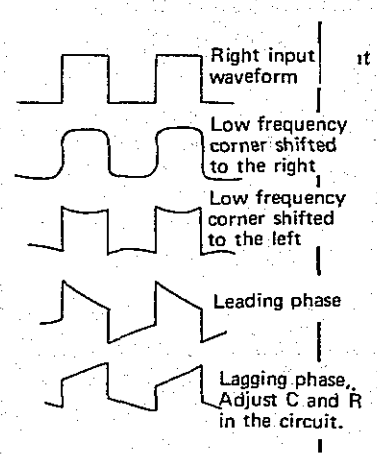
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Set the oscillator at point A. 2. Set the valve voltmeter (P type) at point B. 3. Turn the contrast control knob for a maximum value.	1. Pay attention to the output impedance of the oscillator. 2. (1) Pay attention to the input capacity of the connections. (2) Remove socket from the cathode ray tube. 3. Corresponding to the maximum gain. (Note that the stray capacity becomes maximum, too.)
2.	Apply LF oscillator output	Turn the oscillator output down but to the extent that the resolution of the characteristics can surely be maintained.	Too close examination is unnecessary.
3.	Record the deflection of the valve voltmeter	When changing the measuring range, adjust the voltmeter.	
4.	Apply HF oscillator output	Reduce output to a critical value at and over which the characteristics can be resolved. The output should be held constant for every frequency.	
5.	Record the deflection of the valve voltmeter	When changing the range, adjust the voltmeter.	Prepare a characteristics curve.  Adjust using peaking coil. Adjust the wire arrangement.

Remarks

Use oscilloscope and sweep generator for easy adjustment, if any. If 4.5 MC trap is provided, adjust it also.



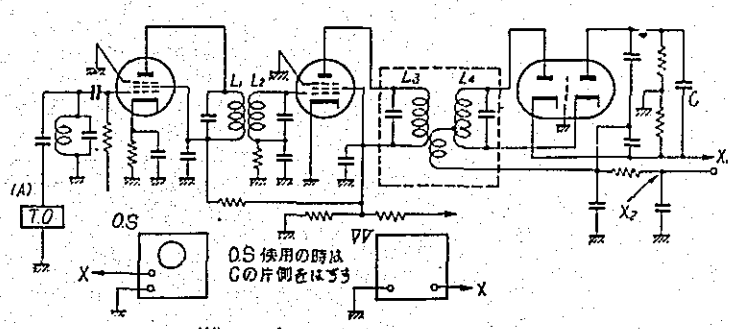
No.	No. 9, Part 2
Title	Adjustment of Video Signal amplifier circuit
Subject	Method of using square wave generator
Material	TV set, resistors 50–100 kΩ, (1/4 W)
Tool	Oscilloscope, square wave generator, soldering iron.

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect the square wave generator to point A. 2. Connect the oscilloscope to point B. 3. Maximize the contrast.	1. Make leads as shorts as pissible. 2. Use a small input capacity oscilloscope to avoid waveform distortion.
2.	Apply square wave voltages	Make the oscillator output as small as possible.	
3.	Examine the waveforms on the oscilloscope	Examine phase, level and other characteristics on the waveform and frequency; use 60 KC, 1000 KC and 100 KC square waves.	
4.	Check constrast	Examine waveforms.	

Remarks

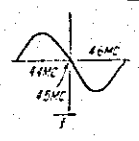
Square waveforms generated by the oscillator can be accurately examined on the oscilloscope.

Compare waveforms by varying frequency.

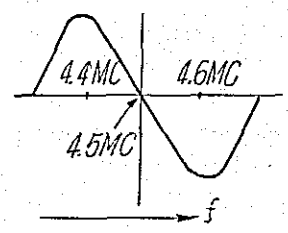


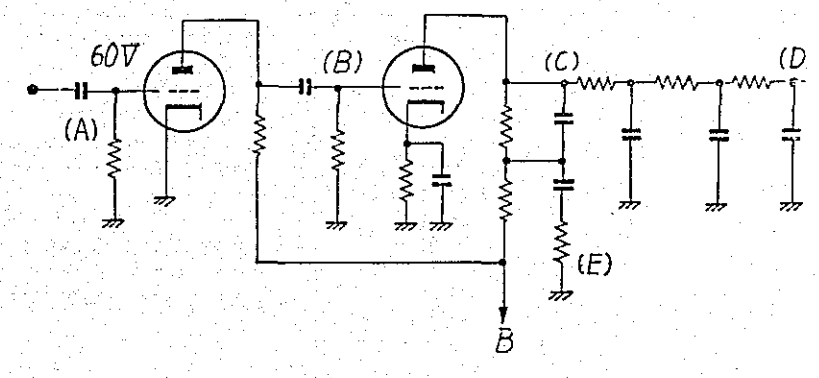
When using oscilloscope, disconnect one end of capacitor leads.

No.	No. 10-1, Part 2
Title	Adjustment of audio amplifier circuit
Subject	*Intermediate frequency circuit and ratio detector circuit*
Material	TV set
Tool	Oscilloscope, trimming rod, valve voltmeter, test oscillator, sweep generator

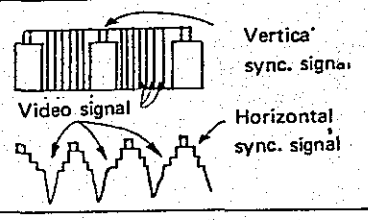
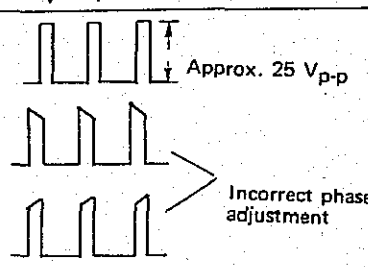
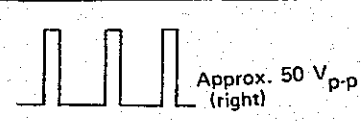
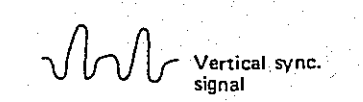
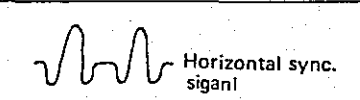
No.	Sequence	Explanation	*Supplementary Notes*
1.	Preparations (valve voltmeter)	1. Connect the test oscillator as instructed above. 2. *In case a voltmeter is used.*	1. Connect an ammeter as instructed above. (In case of voltmeter, disconnected ammeter) 2. Arrange the sweep generator (output impedance: 75 Ω) as in the marker generator.
2.	Generate 4.5 MC by the oscillator	This frequency serves as an audio center frequency.	
3.	Adjust the limiter	Connect V.V.to point X_1, and adjust L_1 and L_2 to obtain a maximum indication.	
4.	Adjustment of L_3	Obtain a maximum deflection of V.V by adjusting dust core.	
5.	Adjustment of L_4	Connect V.V. to X_2, and reduce output to a minimum.	
6.	Change the test oscillator frequency within ±200 KC.	Connect V.V. to X_2, and measure its deflections.	 Obtain the characteristics shown on the left. If not possible, readjust L_1, L_2, L_3 and L_4. If V.V. pointer deflects in the negative direction, reverse the connection of V.V.
Remarks			

No.	No. 10-2, Part 2
Title	Adjustment of audio amplifier circuit
Subject	Intermediate frequency amplifier circuit and detector circuit
Material	TV set
Tool	Oscilloscope, trimming rod, valve voltemeter, test oscillator, sweep generator

No.	Sequence	Exaplanation	Supplementary Notes
1.	Preparations (Sweep generator)	1. Connect the marker generator and sweep generator to A. 2. Connect oscilloscope to X_2.	
2.	Adjust the sweep generator 4.5 MC		Make the frequency range of sweep generator cover some ±200 kC.
3.	Adjust L_1, L_2, L_3 and L_4	S-curve will emerge from the oscilloscope. (Its shape is as shown on the right)	Adjust L_3 and L_4 so as to give symmetry to the S-curve. 
4.	Apply marker signal	When marker signal (4.5 MC) is applied, beat will develop. Shift frequency within ± 150 kC to check characteristics.	Readjust L_3 and L_4 if the characteristics fail to attain the above curve.
Remarks			



No.	No. 11, Part 2
Title	Adjustment of sync. circuit
Subject	Adjustment of waveform
Material	TV set, 100 kΩ 0.1 μF
Tool	Oscilloscope

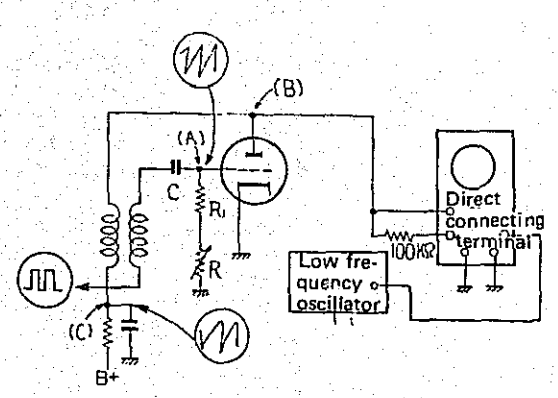
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect a resistor of 100 kΩ to the oscilloscope. 2. Receive waves.	1. Distortion of synchronous waveform. 2. To be replaced by the pattern generator. (In this case, pull out the oscilloscope tube.
2.	Connect the oscilloscope probe to point A	Watch input waveforms of the discriminating tube.	
3.	Connect the oscilloscope scope probe to point B	Watch input waveforms of the amplifier tube.	
4.	Connect the oscilloscope probe to point C	Examine the output waveforms of the amplifier tube	
5.	Connect the oscilloscope probe to point D	Adjust the oscilloscope synchronous frequency to 30 c/s. (The waveform as shown on the right)	
6.	Connect the oscilloscope probe to point E	Adjust the oscilloscope to 7875 c/s. (The waveform on the right)	

Remarks

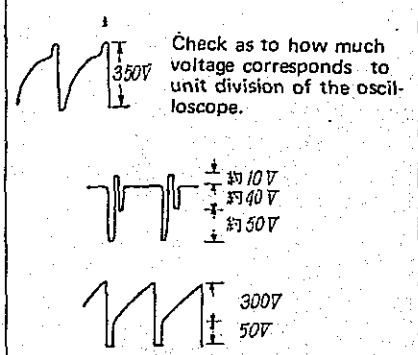
When it is required to connect capacitors to the oscilloscope, consult the following.

Horizontal sync. . . . . about 100 PF

Vertical sync. . . . . about 0.1 μF

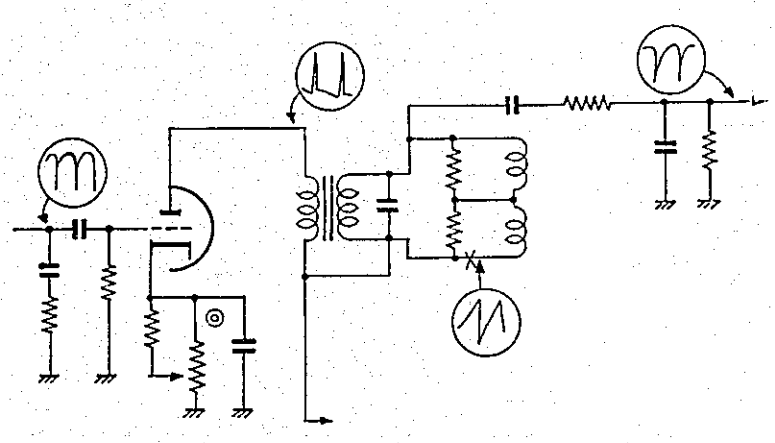


No.	No. 12, Part 2
Title	Adjustment of deflection circuit
Subject	Adjustment of vertical oscillating circuit
Material	Resistor of 100 kΩ or so
Tool	Low frequency oscillator, oscilloscope

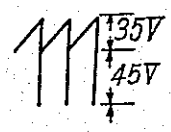
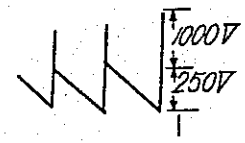
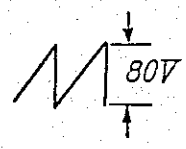
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	Connect a 100 kΩ resistor to the vertical deflection circuit of the oscilloscope.	When using direct connecting terminal, do not use the resistor.
2.	Watch waveforms	1. Connect the oscilloscope to point A as instructed in the above diagram, and examine the waveforms on the grid circuit. 2. Connect the oscilloscope to point B to examine the plate waveforms. 3. Connect the oscilloscope to point C to examine serration waveforms.	
3.	Measure the oscillating frequency	Connect the oscilloscope as instructed in the above diagram, and obtain Lissajou's figures.	
4.	Measure with R in center	In case of 60 ∞ c/s, vary R or C to bring R in center.	

Remarks

When measuring the frequency, the adjustment can be done by superimposing the synchronous signals over the waveform.

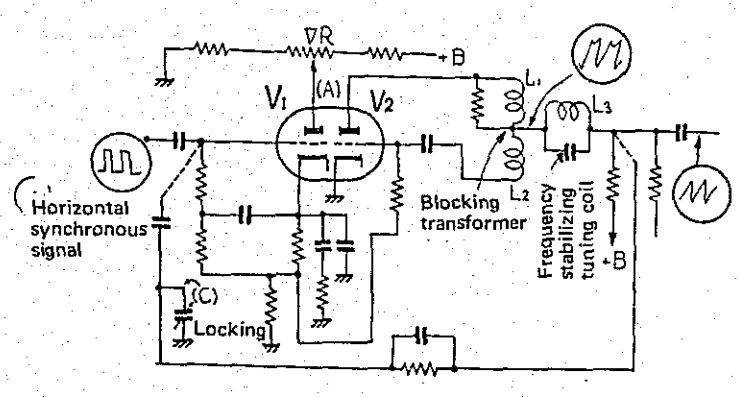


No.	No. 13 Part 2
Title	Adjustment of vartical deflection circuit
Subject	Adjustment of output circuit waveform
Materials	Resistors (100 kΩ, 50 Ω), paste
Tools	Soldering iron, pincers, oscilloscope

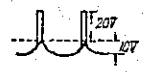
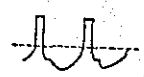
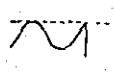
No.	Sequence	Explanation	Supplementary Notes
1	Preparations	Connect a resistor of some 100 kΩ to the oscilloscope.	
2	Connect the oscilloscope to the grid of the output tube	Obtain the patterns shown on the right.	
3.	Connect the oscilloscope to the plate of the output tube	Obtain the patterns shown on the right.	
4.	Examine the secondary current waveforms	Connect a 50 Ω resistor by disconnecting the part marked with X.	

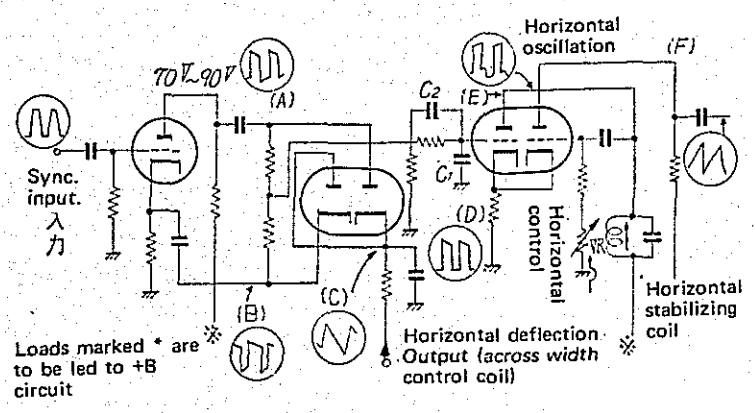
Remarks

Adjustment should be done while watching the raster on the screen of the cathode ray tube.

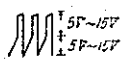
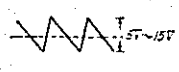
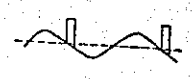
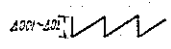


No.	No. 14, Part 2
Title	Adjustment of horizontal deflection circuit
Subject	Adjustment of pulse width A.F.C.
Materials	TV set, soldering rods, flux, capacitor (30 PF)
Tools	Oscilloscope, trimming rod

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	Connect a 30 PF capacitor to the oscilloscope.	
2.	Set VR at the center of rotation		
3.	Short circuit the tunig coil for frequency stabilization		
4.	Receive TV waves		
5.	Adjust L_1 and L_2	Tune with horizontal oscillating frequencies 15 kC and 75 kC.	Measure by nearing the or adjust on the Lissajou's figures or broadcasting signals.
6.	Adjustment of locking capacitor	Adjust the locking capacitor to stabilize the synchronization.	
7.	Examine V_1 grid waveform	Connect the oscilloscope to the V_1 grid, and try to turn VR.	
8.	Examine V_2 grid waveform	Connect the oscilloscope to V_2 grid.	Faulty oscilloscope connection tends to cause abnormal oscillations.
9.	Examine V_2 plate waveform	Connect the oscilloscope to V_2 plate.	
10.	Release the stabilizing coil from short-circuit		
11.	Connect the oscilloscope to point A, and adjust L_3.	 Obtain a figure shown on the left by adjusting L_3 (Place VR at the center of rotation)	
12.	If the synchronism is not stable adjust it repeatedly		
Remarks			



No.	No. 15, Part 2
Title	Adjustment of horizontal deflection circuit
Subject	Adjustment of tooth-wave AFC circuit
Materials	100 kΩ (100 pF)
Tools	Oscilloscope, trimming rod, screw driver, soldering iron

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Short-circuit the horizontal stabilizing coil. 2. Receive the waves. 3. Set the horizontal control at the center of ratation.	
2.	Examine waveforms on point A	 Positive synchronous signals.	
3.	Examine waveforms on point B	 Negative synchronous signals	The size of negative sync. signals should be equal to that of positive ones. Lengthen the flyback time of the saw-tooth wave as compared with the width of synchronous signal.
4.	Examine waveforms on point C		
5.	Examine waveforms on point D		
6.	Release the horizontal stabilizing coil, and adjust it.		
7.	Examine the waveforms on point E	Adjust the horizontal stabilizing coil to make pulses slightly lower than the crest of the wave.	
8.	Examine the waveforms on point F	With VR (horizontal control) turned in either direction, the synchronism should not be stepped out.  When a picture gets hatched, warped on the upper part or is liable to be warped, adjust C_1 and C_2.	This wave is applied to the grid of the output tube.
9.	Examine synchronism		
Remarks			

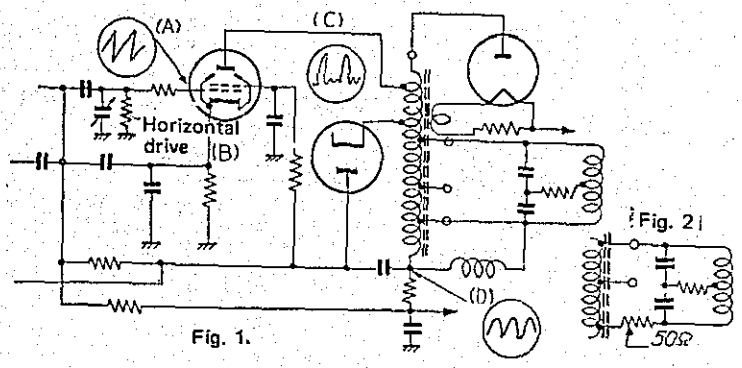
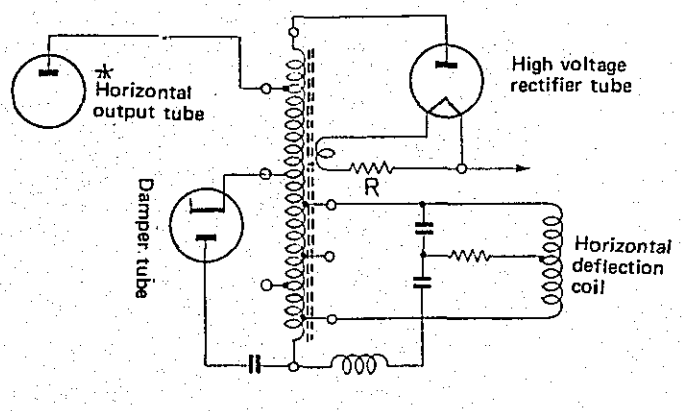


Fig. 1.

No.	No. 16, Part 2
Title	Adjustment of horizontal deflection circuit
Subject	Adjustment of output circuit
Materials	50 Ω, 100 PF (100 kΩ)
Tools	*Oscilloscope, trimming rod*

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect 100 pF (or 100 kΩ) to the horizontal drive circuit of the oscilloscope.	
2.	Examine the waveforms on point A	80-100V Adjust the drive capacitor.	Suppress the input level to a suitable value.
3.	Examine waveforms on point B.		
4.	Examine waveforms on point C	Get near the point C, but do not contact directly.	
5.	Examine waveforms on point D	80V 300V	
6.	Connect a resistor as instructed in Fig. 2		
7.	Examine yoke current waveforms	Connect the oscilloscope across the resistor (50 Ω).	Adjust the drive capacitor, linearity coil, and width coil.
8.	After adjustment, dismantle the resistor (50 Ω)		
Remarks	Adjustment should be done while watching the rasters on the screen. If there is no input, the tubes will be overloaded.		

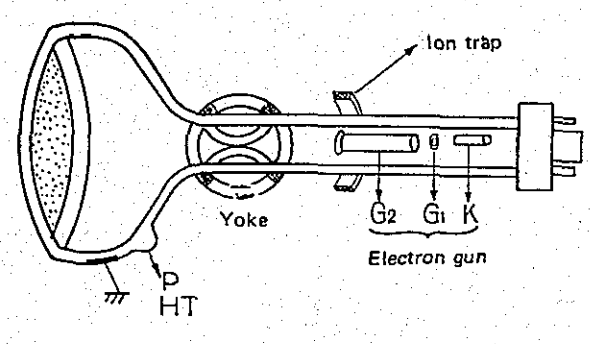


No.	No. 17 Part 2
Title	Adjustment of high voltage rectifier circuit
Subject	Voltage adjustment
Materials	TV set
Tools	Screw drivers, high voltage meter

No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	Ground the high voltage meter securely.	Electric shock danger is involved.
2.	Examine the igniting conditions of the heater	The heater should be cherry red. Adjust by increasing or decreasing resistance value of the resistor connected in series to the heater.	Red hot heater will shorten the service life and degrade the characteristics of the tube.
3.	Get a screw driver near the plate to discharge	Measure the distance over which discharge develops. This distance provides a clue upon which to know the given voltage.	Use a well-insulated screw driver.
4.	Measure a rectifier voltage	Measure on the high voltage meter.	

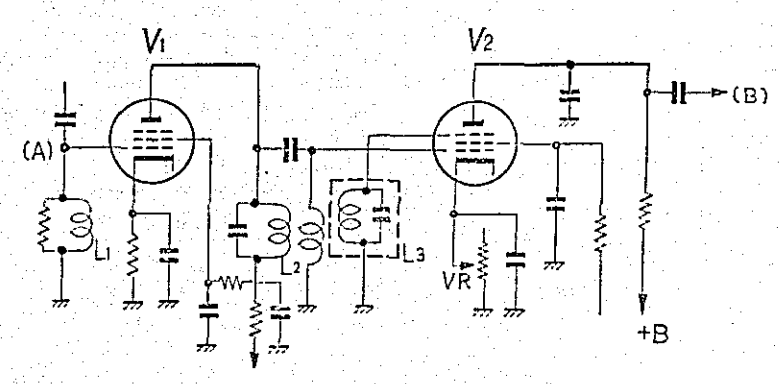
Remarks

Pay attention to dust particles, humidity, etc. Utmost attention must be exercised at all times when measuring high voltages.

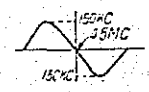


No.	No. 18 Part 2
Title	Adjustment of cathode ray tube
Subject	Adjustment of cathode ray tube
Materials	TV *set*
Tools	Circuit tester

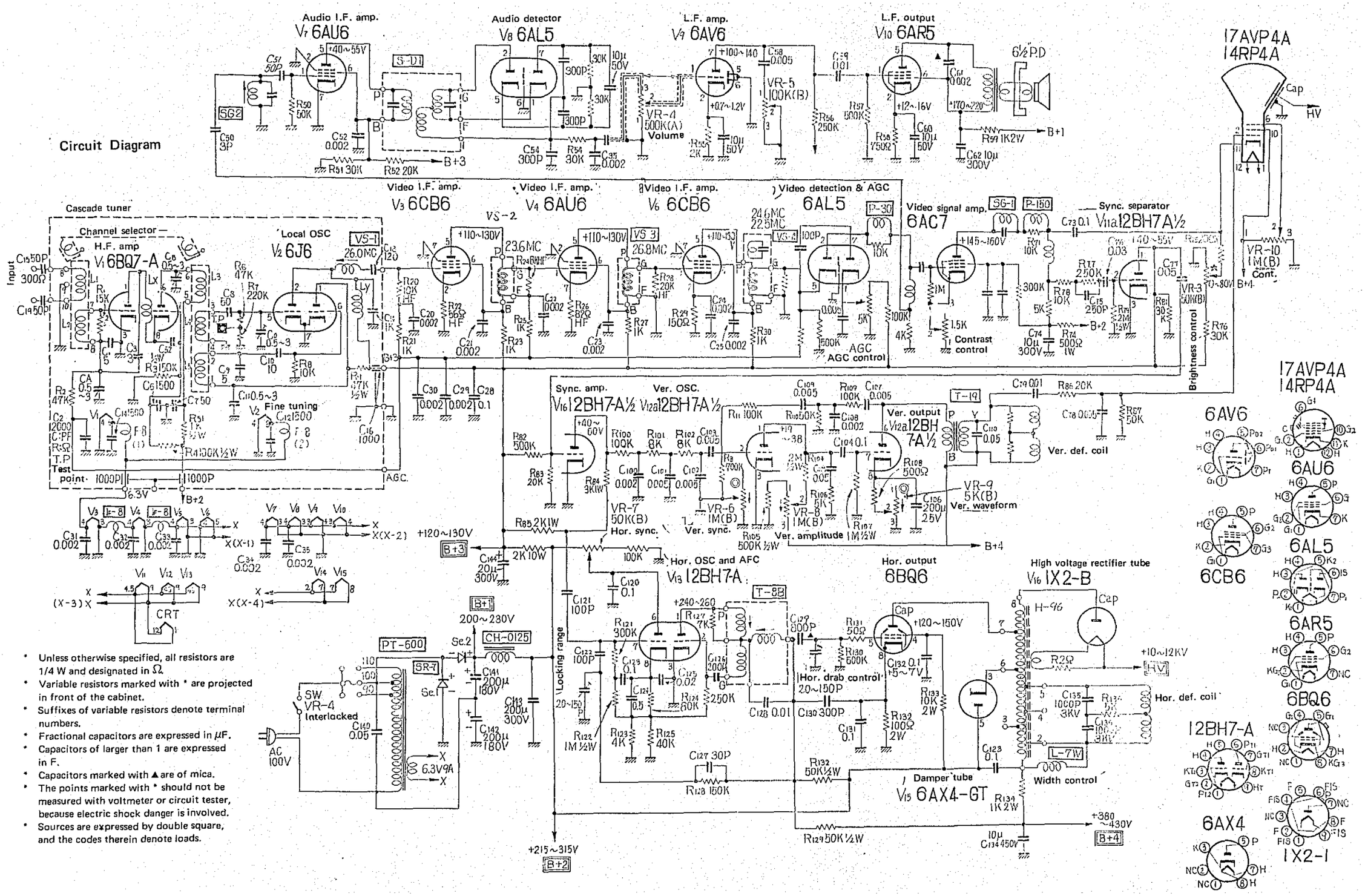
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Work the TV set. 2. Receive TV broadcasting signals.	Pattern generator can be used instead.
2.	Brightness control	Turn the brightness control, and measure voltages.	(Approx. 40 – 70 V)
3.	Adjustment of ion trap location	Maximize the brightness on the screen.	1. Do not mar the fluorescent screen. 2. Use iron trap to conform to the specifications of the cathode ray tube.
4.	Centering the picture	Center the raster by adjusting the deflection coil and the *centering magnet*.	
5.	Adjustment of focus	Focus the picture by means of the adjusting resistor which is connected in parallel with the focus coil.	The same is applicable to the electrostatic focusing system.
Remarks			



No.	No. 19, Part 2
Title	Adjustment of audio detection circuit
Subject	Adjustment of gated beam detector circuit
Materials	TV set
Tools	Oscilloscope, trimming rod, sweep generator, marker generator

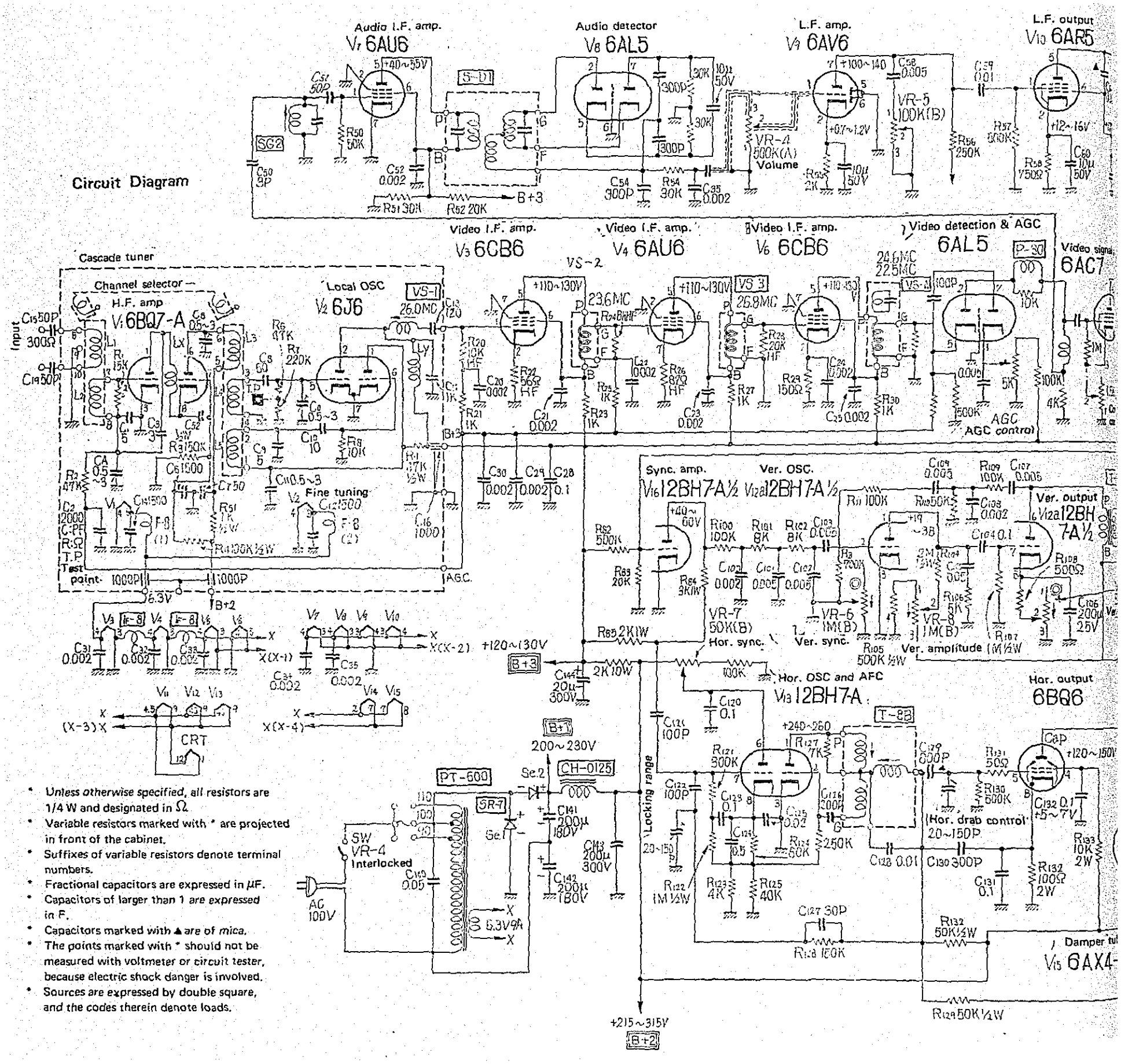
No.	Sequence	Explanation	Supplementary Notes
1.	Preparations	1. Connect the sweep generator and marker generator to point A. 2. Connect the oscilloscope to point B with 100 kΩ resistor being connected to the oscilloscope.	The output impedance of the sweep generator is 75 Ω.
2.	Tune the center frequency of the sweep generator to 4.5 MC	Delineate S-lettered figure on the screen.	Sweep frequencies should be ±200 kC.
3.	Tune the marker generator to 4.5 MC (Modulate a marker frequency of 4.5 MC with 400 c/s)	Minimize the 400 c/s output on the screen.	
4.	Adjust VR	Bring R at the center of rotation	
5.	Adjust L_1 and L_2	Maximize S-lettered figure.	
6.	Adjust L_3	Bring 4.5 MC marker at the center.	
7.	Shift the marker in both directions	Check to see if the marker just lies on the crest of S-lettered curve when shifted within ±150 kC.	If not, readjust L_1, L_2, L_3 and VR.
Remarks	A method of adjustment upon actual signal reception.		
1.	Preparations	Receive broadcasting signals.	
2.	Turn L_3	Trace a point at which buzzing sound is minimized whereas the audio signal is maximized.	The tuning frequency of L_3 is 4.5 MC. Therefore, the center of S-lettered curve should come to 4.5 MC. In this case, the buzzing sound should be minimized.
3.	Turn R	Trace a point at which buzzing sound can be minimized.	
4.	Turn L_1	Trace a point at which speaker sounds the loudest.	
5.	Turn L_2	Trace a point at which speaker sounds the loudest.	
6.	Repeat the adjustment of L_3, R, L_1 and L_2	Trace a point at which the buzzing sounds are minimized while maximizing the voice.	Make R as near the center of rotation as possible.
Remarks			

Circuit Diagram



- Unless otherwise specified, all resistors are 1/4 W and designated in Ω.
- Variable resistors marked with * are projected in front of the cabinet.
- Suffixes of variable resistors denote terminal numbers.
- Fractional capacitors are expressed in μF.
- Capacitors of larger than 1 are expressed in F.
- Capacitors marked with ▲ are of mica.
- The points marked with * should not be measured with voltmeter or circuit tester, because electric shock danger is involved.
- Sources are expressed by double square, and the codes therein denote loads.

Circuit Diagram



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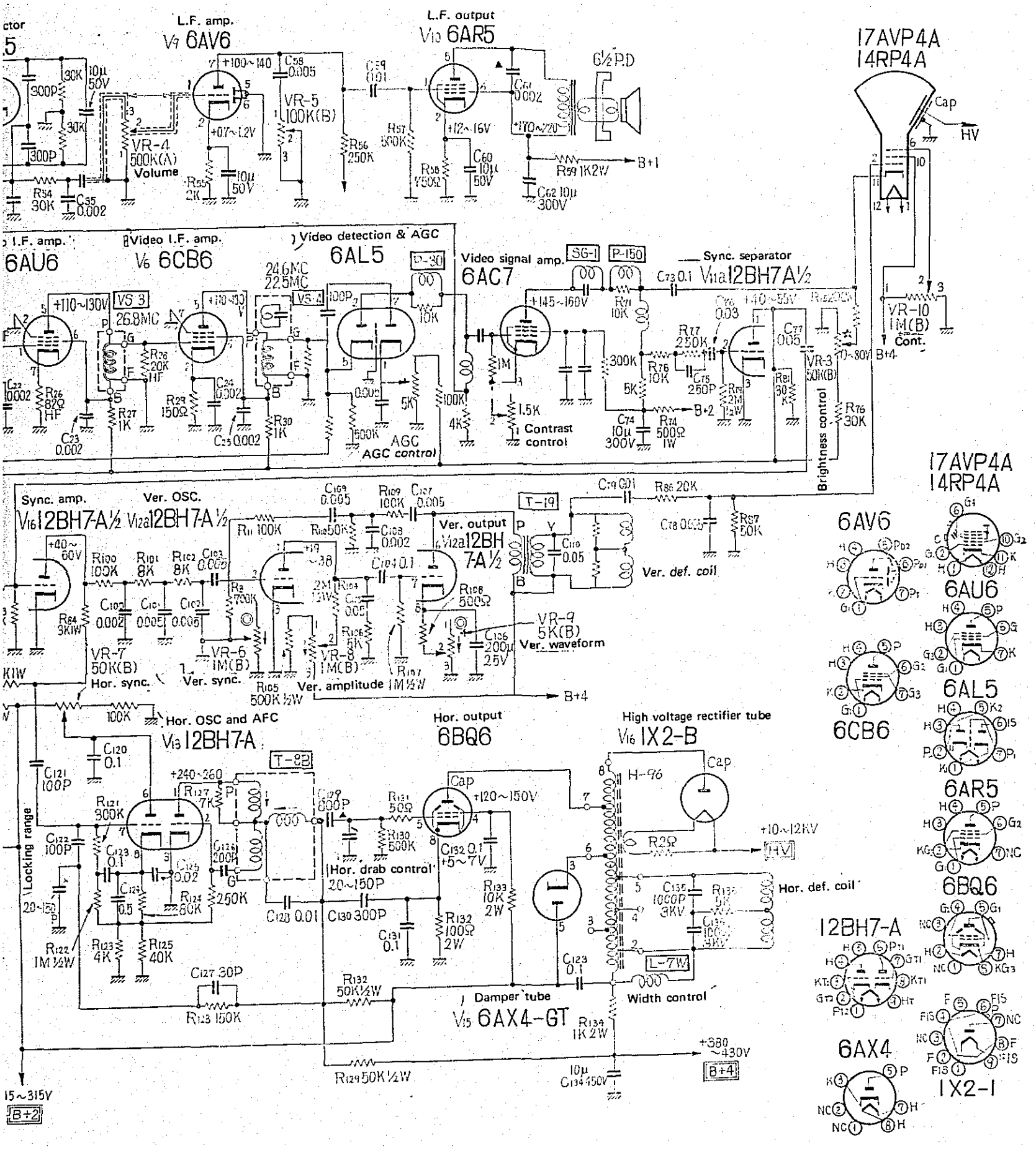
L.F. amp.
V7 6AV6
L.F. output
V10 6AR5
6½P.D
17AVP4A
14RP4A
Cap
HV
VR-4 500K(A) Volume
VR-5 100K(B)
VR-10 1M(B) Cont.
Video I.F. amp.
V6 6CB6
Video detection & AGC
6AL5
Video signal amp.
6AC7
Sync. separator
V11a 12BH7A½
VR-3 50K(B)
Brightness control
Contrast control
AGC control
Sync. amp.
V16 12BH7-A½
Ver. OSC.
V12a 12BH7-A½
Ver. output
V12a 12BH 7-A½
Ver. def. coil
VR-7 50K(B)
Hor. sync.
VR-6 1M(B)
Ver. sync.
VR-8 1M(B)
VR-9 5K(B)
Ver. waveform
Ver. amplitude
Hor. OSC and AFC
V13 12BH7-A
Hor. output
6BQ6
High voltage rectifier tube
V16 1X2-B
Hor. drab control
Hor. def. coil
Width control
Damper tube
V15 6AX4-GT
Locking range
B+1
B+2
B+4
+10~12KV
+360~430V
+215~315V
6AV6
6AU6
6AL5
6CB6
6AR5
6BQ6
12BH7-A
6AX4
1X2-1